Passive Wireless Sensor Technology (PWST)
WiSEE 2018

Technical Program

Co-Chair: NASA/NESC – Omar Torres
Co-Chair: Pegasense – Donald C. Malocha
Co-Chair: NASA/NESC – George Studor

December 11 -13, 2018

v1.2

Welcome to the PWST workshop of 2018

On behalf of the PWST chairs, I would like to welcome you to the 2018 Passive Wireless Sensor Technology workshop at the WiSEE 2018 conference. The PWST workshop is a unique forum for building relationships between cutting edge developers and potential users of passive wireless sensing.

The workshop is in its 8th instance, and with 61 speakers and three discussion panels, it's the largest one so far. We are excited about the number and high quality of the technical presentations prepared for this workshop. The topics of this year's sessions will reach different corners of engineering where the need for innovative technology on passive wireless sensing is necessary due to the impracticality of batteries, wires, connectors, and penetrations.

As is customary, on the last day we have the one-on-one sessions that enable short, face-to-face conversations between potential users and PWS technology developers to encourage the formation of partnerships that foment the advancement of technology and expand PWS application areas. Also, this year the workshop speakers and participants will join in a discussion panel on how 3D printing and additive manufacturing can expand PWS applications for energy and infrastructure, followed by another for aerospace and remote applications. We have also added a session to discuss how passive wireless sensor RF characteristics may affect for international ICAO and RTCA requirements under development.

As highlighted by the variety of current and past workshop session topics, the need for passive wireless sensing is ubiquitous. Taking advantage of new technologies such as 3D printing and innovative manufacturing methods that allow for embedded passive sensing, the opportunity to develop sensing and intelligent nodes in almost everything is now a real possibility.

I am confident that the excellence of presentations and discussions will extend knowledge and energize innovation of passive wireless sensor technologies.

The workshop chairs hope you find this workshop stimulating, inspiring, and productive. Thank you for participating and for making this workshop a success.

Omar Torres
PWST Co-Chair

PWST Workshop Chairs

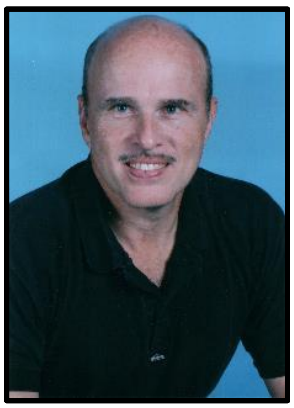
Omar Torres
omar.torres@nasa.gov
757-864-1535

NASA Engineering and Safety Center (NESC)
Lead, Wireless Avionics Community of Practice
NASA Langley Research Center

Mr. Omar Torres serves as the lead of the NASA Wireless Avionics Community of Practice where he is responsible for bringing together engineers and managers from across the agency to share knowledge and lessons learned relating to wireless technologies. Mr. Torres has been resident at Langley Research Center in Hampton, VA for 15 years where he has contributed significantly to the research of Signals of Opportunity using GPS signals for remote sensing purposes. In addition, Omar has years of experience as an instrumentation and analysis engineer supporting the NASA Engineering and Safety Center (NESC) in high profile tests.

Dr. Don Malocha
dcmalocha@cfl.rr.com
407-758-4446

CTO, Pegasense, LLC
Pegasus-Professor Emeritus, E&CE Dept
University of Central Florida, Orlando FL



Dr. Donald C. Malocha is currently the CTO of Pegasense LLC, specializing in solid-state acoustic devices, wireless RF communications systems, and sensors. He is also Pegasus-Professor Emeritus in the Electrical and Computer Engineering Dept., University of Central Florida (UCF), Orlando. Don received a dual BS in electrical engineering (EE) and computer science (CS), an MS in EE, and Ph.D. degree 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 an Associate Editor of the IEEE TRANSACTIONS ON ULTRASONICS, FERROELECTRICS AND FREQUENCY CONTROL (UFFC), a UFFC AdCom Emeritus-member, and past-President of the IEEE UFFC Society. He is chair of IEC TC49.

George Studor
George.f.studor@nasa.gov
(281) 415-3986

NASA Engineering and Safety Center
Avionics Technical Discipline Team, consultant
Wireless Avionics Community of Practice

Mr. George Studor retired after 30 years with NASA in October 2013 in various senior program, engineering, educational and technology positions. Since then, he has concurrently been a consultant to the NASA Engineering and Safety Center for three Technical Discipline Teams (TDTs): Avionics TDT - Wireless Avionics Connections, Non-Destructive Evaluation TDT – In Space Inspection, and Robotic Spacecraft TDT – applying Natural Systems to System Engineering problems. Through the USAF, he received his BS in Astronautical Engineering from the USAF Academy in 1976, flew 2,000 hours as a C130 Pilot, and after receiving his MS in Astronautical Engineering from the Air Force Institute of Technology in 1982, he was detailed to NASA/JSC. Major Studor retired from the USAF in December 1999 after his "Fly-by-Wireless" project for the AFRL.

WiSEE 2018 Program

WiSEE 2018	Dates Rooms /	Tue, Dec 11					Wed, Dec 12					Thu, Dec 13				
		Rm A	Rm B	Rm C	Rm D	Rm E	Rm A	Rm B	Rm C	Rm D	Rm E	Rm A	Rm B	Rm C	Rm D	Rm E
0700am	**0800am**	**Registration and breakfast**					**Breakfast**					**Breakfast**				
30 min KN	10 min Q/A	**KN Session Chair: Wilkerson/Edmonson**					**KN Session Chair: Birrane/Preble**					**KN Session Chair: Mosavi/Alirezaei**				
0800am	**0840am**	WiSEE KN - Larry Leopard (NASA MSFC)					WiSEE KN - Amitbh Mishra (US Army CERDEC)					STINT KN - David Israel (NASA GSFC)				
0840am	**0920am**	SAT KN - Marshall Smith (NASA MSFC)					SSP KN - Tadashi Takano (JAXA)					MISS KN - Habib Rashvand (U of Warwick, UK)				
0920am	**0945am**	**Coffee break**					**Coffee break**					**Coffee break**				
0945am	**1145am**	SSP T1	WiSEE S1	PWS S1C	PWS S1D	SAT S1	SSP T4	WiSEE S4	PWS S4C	PWS S4D	STINT S1	SSP S7	MISS	PWS S7C	PWS S7D	STINT S4
1145am	**1230pm**	**Lunch break**					**Lunch break**					**Lunch break**				
30 min KN	10 min Q/A	**KN Session Chair: Torres/Malocha**					**KN Session Chair: Boyd/Joiner**					**NASA MSFC Tour:** Buses leave Westin at 1:00pm and return to Westin at 4:30pm. Passport information will be requested by NASA security office after the registration		**3D Printing / Additive Manufacturing Applications for Passive Wireless Sensors**	**PWST WAIC Discussions (1:00pm - 4:15pm)**	
1230pm	**0110pm**	PWS KN - Roy Olsson (DARPA)					WiSEE KN - Manos Tentzeris (GaTech)									
0115pm	**0315pm**	SSP T2	WiSEE S2	PWS S2C	PWS S2D	SAT S2	SSP S5	WiSEE S5	PWS S5C	PWS S5D	STINT S2					
0315pm	**0340pm**	**Networking break**					**Networking break**									
0340pm	**0540pm**	SSP T3	WiSEE S3	PWS S3C	PWS S3D	SAT S3	SSP S6	WiSEE S6	PWS S6C	PWS S6D	STINT S3					
0630pm	**0800pm**	**Reception Session Chair: Gorur Keynote: Oscar Gonzales (NASA, Retired)**					**Banquet Session Chair: Wilkerson Keynote: Robert Lightfoot (NASA, Retired)**									

Program Key:

MISS	Massive Intelligent Sensor Systems	**WiSEE**	Wireless for space and extreme environmentrs (main track)
PWS	Passive Wireless Sensor Technology Workshop	**KN**	Keynote
SAT	Small Satellite Workshop	**Rm**	Room
SSP	Space Solar Power Workshop	**S1**	Session 1
STINT	Space-Terrestrial Inter-Networking	**T1**	Tutorial 1

PWST Workshop Daily Agenda

Tuesday, December 11

Session 1:

Time	S1-C: Spacecraft User Needs *Chair: Dr. Raymond S. Wagner*	S1-D: Nuclear Power User Needs *Chair: Mr. Chris Hough*
9:45 AM	**George Studor**, NASA NESC. "PWS Workshop Overview".	
10:15 AM	**Derek Doyle,** AFRL/VSSV-Space Vehicles. "Spacecraft Sensing Needs and Limitations from Cables".	**Sacit Cetiner,** DOE/ORNL. "Nuclear Power Generation: Technology Needs for Passive Wireless Sensing".
10:45 AM	**Bill Toscano**, NASA ARC. "On-Astronaut Wireless Sensor System (OAWSS) to Support Crew Health Monitoring for Exploration".	**Jim Gleason,** GLSEQ, LLC. "The Need for Wireless Sensor Technology for Commercial Nuclear Applications".
11:15 AM	**George Studor,** NASA NESC "Space Shuttle & Space Station Lessons Learned: Less Wires for Current & Future Spacecraft".	**Mark King,** NASA MSFC. "Sensor Needs for Nuclear Thermal Propulsion (NTP)".

Session 2:

Time	S2-C: WAIC Technology *Chair: Mr. Reamonn Soto*	S2-D: Off-the-Shelf Technology *Chair: Dr. Mont Johnson*
1:15 PM	**Matt Waldersen,** NASA AFRC. "Software Defined Wireless Avionics for Flight Test".	**Michael Christopher,** Calspan Corporation. "Airborne Testing of Passive Wireless Sensors and their uses in Commercial and Experimental Aircraft".
1:40 PM	**Victor Plessky**, GVR Trade/Resonant. "Hyperbolic Frequency Modulation (HFM) and Passive Wireless Microphone".	**John Stevens**, Visible Assets. "RuBee (IEEE 1902.1) Wireless Sensor Tag Applications in Aerospace & Defense:An Introduction to Harsh Environment Wireless Sensors and Prognostic Health Management".
2:05 PM	**Don Malocha,** Pegasense. "Achieving 4.2-4.4GHz Radios and other recent PWST R&D".	**Chris Hough & Jean-Luc Favre,** TMI-Orion. "COTS Aerospace-qualified Wireless Data Loggers Active Technology in Harsh Environments Integrated with PWS Interrogators".
2:30 PM	**Taimur Aftab,** IMT-Univ of Frieburg. "Passive Wireless Sensing at Microwave Frequencies: Challenges and Approaches".	**Bamboo Zhong,** Inductosense. **Thomas Fink,** Techno-Fink "Embedded Passive Wireless Ultrasonic Sensor for Non-Destructive Testing".
2:55 PM	**Jean-Michel Friedt**, FEMPTO. "Passive RADAR Acoustic Delay-line Sensor Measurement: Demonstration Using a WiFi (2.4 GHz) Emitter and WAIC-band (4.3 GHz)".	**Roozbeh Ghaffari,** Northwestern University. "Skin-Interfaced Systems with Microfluidics and Biosensors for Physiological Monitoring and Biochemical Sensing".

PWST Workshop Daily Agenda

Session 3:

	S3-C: Launch Vehicle User Needs *Dr. Robert A. Smith*	**S3-D: Near-Zero Power Technology** *Chair: Mr. Thomas Fink*
3:40 PM	**Mont Johnson**, NorthrupGrumman-OrbitalATK “Wireless Instrumentation System Opportunities and Challenges for Large Solid Rocket Motor Flight Applications”.	**Jonathan Bernstein,** Draper. “Zero Power Wake-Up Sensors for Acoustic and Vibration Wireless Detection”.
4:05 PM	**Johannes Sebald**, ArianeGroup “Launcher Wireless Internal Infrastructure Perspectives”.	**Matteo Rinaldi**, Northeastern University/SMART. “Near-Zero Power Integrated Microsystems for the IoT”.
4:30 PM	**Michelle Barber**, Boeing-Space Launch System “Opportunities and Challenges for Launch Vehicle Wireless Sensors”.	**Drew Hall**, University of California San Diego. “A 6.1 nW Wake-Up Receiver Achieving −80.5 dBm Sensitivity via a Passive Pseudo-Balun Envelope Detector”.
4:55 PM	**Reamonn Soto,** Sensatek. “Extreme Environment Monitoring needs for Jet and Rocket Turbine Test and Operations”.	**Steven Bowers,** University of Virginia. “Asleep Yet Aware: Near-Zero Power RF Wakeup Receivers with Automatic Offset Compensation”.
5:20 PM	**Rodney Rocha,** NASA JSC Structural Eng Div. "Instrumentation & Sensor Technology Quantum-Leap Needs for Exploration Spacecraft Structures".	**Songbin Gong,** University of Illinois Urbana. “Extremely Low Loss Lithium Niobate Acoustic Delay Lines for Zero Power Wireless Sensing and Signal Processing”.

Wednesday, December 12

Session 4:

	S4-C: Commercial Aircraft User Needs *Chair: Dr. Eduardo Rojas*	**S4-D: Oil & Gas User Needs & Technologies** *Chair: Dr. Jean Michel Friedt*
9:45 AM	**Steven Rines,** Zodiac/AVSI. “Wireless Avionics Intra-aircraft Communications Requirements for RTCA & ICAO Consideration”.	**John Nyholt**, American Petroleum Institute. San Jacinto College. “Passive Wireless Sensor Needs in Oil & Gas Asset Integrity Management”.
10:15 AM	**Chris Gibson**, Ametek/VTI Instruments. “Leveraging IOT technologies to improve distributed data acquisition for large-scale integrated tests”.	**Paul Ohodnicki,** DOE NETL. “Functionalized SAW Sensors for Chemical Sensing in Fossil Energy Applications”.
10:45 AM	**Robert A. Smith**, Boeing. Research & Technology “The Opportunity Space for Wireless Sensor Systems in Aircraft Platforms and Production and PWST - Opportunities for Aerospace”.	**Dave Lafferty**, Scientific Technical Services. “Realizing Value From Passive Wireless Sensing”.
11:15 AM	**Petermann Christopher,** Lutfthansa Technik. “Commercial aircraft needs for a retrofitable wireless sensor network”.	**Michael Panfil**, Aon Risk Solutions. “Sensors for Fire and Explosion in the Waste Management Process”.

PWST Workshop Daily Agenda

Session 5:

S5-C: Extreme Environments Technology
Chair: Mr. James F. Gleason

1:15 PM **Ben Griffin**, DARPA.
"Aluminum Nitride Enabled MEMS for Near-Zero Power Wakeup and High Temperature Capable Sensing".

1:40 PM **John Fraley**, Wolfspeed/Cree.
"Additive Manufacturing Approaches for Harsh Environment Telemetry".

2:05 PM **Debbie Senesky**, Stanford Univ/Aero-Astro.
"Tiny-but-Tough" Gallium Nitride Nanoelectronics for Extreme Harsh Environments.

2:30 PM **Jeffrey Brogan**, CVD Mesoscribe Technologies.
"MesoPlasma™ Printed Instrumentation for High Temperature Applications".

2:55 PM **Owen Mays,** Lawrence Livermore Natl. Lab.
Susana Carranza, Makel Engineering.
"Integrated Passive Antenna/Sensor Structures".

S5-D: Electric Grid/Buildings User Needs
Chair: Dr. Yang Wang

1:15 PM **Teja Kuruganti**, DOE ORNL.
"Building Monitoring Needs for PWS Technologies".

1:40 PM **Steven Lopez**, Elect Power Research Institute.
"Nuclear Power Plant Modernization and the Advanced Use of Wireless Sensors".

2:05 PM **Ken Morris**, Knectiq.
"Eavesdropping, Packet Inspection and other wireless sensor security matters".

2:30 PM **Joe Ianotti,** GE Global Research.
"GE Needs for PWS Technologies from Energy to Aerospace".

2:55 PM **Tom Greene,** Applied Engineering Inc.
"Vapor Intrusion and Ground Water Sensor Needs".

Session 6:

S6-C: Passive RFID Technology
Chair: Prof. Dr. Leo M. Reindl

3:40 PM **Ramaswamy Nagarajan**, U Mass, Lowell.
"Printed Wireless Sensors for Structural Health Monitoring".

4:05 PM **Yang Wang**, Georgia Tech.
"Passive Wireless Strain Measurement Using an Antenna Sensor".

4:30 PM **J.C. Chiao**, Univ of Texas, Arlington.
"Miniature Batteryless Wireless Sensors".

4:55 PM **Geoff Grove,** Pilgrimscrew, Inc.
"Opportunities for PWS in Aerospace Quality, Bolted Assemblies".

5:20 PM **Ray Wagner**, NASA JSC.
"Internal Radio-Frequency Instrumentation System (IRIS): RFID-Enabled Wireless Vehicle Instrumentation".

S6-D: 3D Printing Technology
Chair: Dr. Charles Wu

3:40 PM **Tolga Aytug**, DOE ORNL.
"High Surface Area Nanostructured Films for Surface Acoustic Wave (SAW) Sensors".

4:05 PM **Marissa Morales-Rodriguez**, DOE ORNL.
"Fabrication of Printed Passive Wireless Surface Acoustic Wave Sensors by Aerosol Jet System".

4:30 PM **Ken Church**, nScrypt.
"Direct Digital Manufacturing for Next Generation Electrically Functional RF Structures".

4:55 PM **Michael Zenou & Herve Javice**, I-O Tech.
"Laser Assisted Deposition for Metals, Ceramics and Polymers".

5:20 PM **Simon Fried**, Nano Dimension USA.
"Additive Manufacturing of Multilayer and Non-planar Electronics".

PWST Workshop Daily Agenda

Thursday, December 13

Session 7:

	S7-C: Additive Manufacturing Technology Vision *Chair: Dr. Debbie G. Senseky*	**S7-D: Wireless SAW Sensor Technology Vision** *Chair: Prof. Victor Plessky*
9:35 AM	**Niki Werkheiser & Curtis Hill**, NASA MSFC. "In-Space Manufacturing (ISM) Project with an emphasis on Printed Electronics".	**Balam A. Willemsem**, Resonant. "Fast, Highly Accurate, Full-FEM SAW Simulation".
10:00 AM	**Bryan Germann**, Optomec. "Direct Write of Non-Planar and 3D Sensors and Antenna using Optomec's Aerosol Jet Technology".	**Yuki Sato**, Keio University. "Multiple Subcarrier Multiple Access: A Frequency Efficient Concurrent Wireless Access Method for Backscatter Sensors".
10:25 AM	**Panos Datskos,** DOE NREL. "Advantages of 3D Printed Graphene for PWS Sensors/Antennas".	**Leo Reindle**, IMTEK-Univ Freiberg. "Recent achievements in wireless sensing technology at the IMTEK - University of Freiburg".

Session 8: One-on-One Sessions

	S8-C: One-on-One Sessions	**S8-D: One-on-One Sessions**
10:50AM	Seven One-on-One Sessions at 10 minutes each.	Seven One-on-One Session at 10 minutes each.
12:00 PM	**Lunch**	**Lunch**

Session 9: Panels and Discussions

	3D Print Additive Manufacturing	**PWST for WAIC Requirements**
1:00 PM	**Panel Moderator: Tim McIntyre**, DOE ORNL. "Applications & Performance Needs for PWST in **Energy & Infrastructure Industries** driving 3D Printing/Additive Manufacturing capability".	**Panel Moderator – Steven Rines,** Zodiac – RTCA Subcommittee Chair for WAIC. "Passive Wireless Sensor Applications for WAIC Consideration"
2:30 PM	**Break**	**Break**
2:45 PM	**Panel Moderator: Curtis Hill,** NASA MSFC. **"**Applications & Performance Needs for PWST in **Aerospace and Remote Operations** driving 3D Printing/Additive Manufacturing capability"	

Passive Wireless Sensing Technology (PWST) Workshop Overview

George Studor
George.f.studor@nasa.gov
(281) 415-3986

NASA Engineering and Safety Center
Avionics Technical Discipline Team, consultant
Wireless Avionics Community of Practice

Abstract: This talk will introduce the Passive Wireless Sensor Technology (PWST) Workshop purpose, objectives, agenda, and also introduce the other PWST Co-Chairs: Mr. Omar Torres (NASA/Langley) and Dr. Don Malocha (Pegasense, LLC and University of Central Florida). **The Purpose** of the PWST Workshop is to bring technology developers, manufacturers and potential industry and government end-users together to increase awareness of needs and potential solutions and to trigger technology maturation and new applications. **The Objectives** of the PWST Workshop are to (1) understand various PWS technologies, actual & potential uses, and maturity, (2) share applications, benefits & limitations of PWS between industries and agencies, (3) precipitate individual and group "next step" thinking, and (4) build an accessible library of PWS Workshop publicly released presentations.

A review will be provided of the **motivation for** and **nature of** passive wireless sensors, the updated summary of previous PWST Workshop presentations available on the website. **Passive Wireless Sensors are unique** in that they have NO Wire to the sensor, NO Battery, NO Complex Electronics, Low Production cost, Low Operations cost, Low Safety concerns, High Modularity, operability in Extreme Environments, Wide Applications in industry, government and world-wide IOT.

The activities of the PWST **One-on-One Sessions** and **3D Printing and Additive Manufacturing Panel** on Thursday will be clarified, and moderators introduced to the audience. Finally, we will introduce the **draft session topics for the next PWST Workshop at WiSEE2019 in Ottawa.**

Background:

Mr. George Studor retired from NASA in October 2013. Since then he has concurrently been a consultant to the NASA Engineering and Safety Center for three Technical Discipline Teams (TDTs): Avionics TDT - Wireless Avionics Connections, Non-Destructive Evaluation TDT – In-Space Inspection, and Robotic Spacecraft TDT – Application of Natural Systems to Systems Engineering process. George organized and chaired seven previous Passive Wireless Workshops since 2011 supported by the Avionics TDT, IEEE WiSEE Conference, the Industrial Society for Automation and DOE, Oak Ridge National Labs. In addition, he has been consultant to the Image Science and Analysis Group at Johnson Space Center through Jacobs Engineering to develop a detailed study of Soyuz Spacecraft In-Space Inspection. As a senior project engineer for technology applications in the Strategic Opportunities and Partnership Development Office of the Johnson Space Center. In the past 20 years, he has championed numerous successful wireless flight instrumentation projects for dual-purpose technology -operational use demonstrations on Space Shuttle Orbiters and International Space Station. Applying the lessons learned, he has promoted changes to future vehicle architectures to enable reduced wires and connectors through a comprehensive approach called "Fly-by-Wireless". He is a retired Air Force officer and C-130E pilot, with about half of his 20 years working with the WPAFB AFRL Flight Dynamics Laboratory. George was honored by Marquis Who's Who in December 2017 for Professional Excellence in Aerospace Engineering.

Spacecraft Sensing Needs and Limitations from Cables

Derek Doyle
AFRL/VSSVOrgMailbox@us.af.mil
(505) 846-2152

Air Force Research Laboratory, Space Vehicles
Energetic Responsive Structures Lead
Kirtland AFB, NM

Abstract: Most aspects of our digital daily lives are dependent in some way to the infrastructure we have available in space from internet searches, banking, GPS, and entertainment. Spacecraft are operating in an increasingly contested environment and as a result are increasingly concerned with improved situational awareness and understanding of anomalous events. Additionally, industry is looking for novel solutions to reduce costs of satellites and move systems to lower orbits to reduce space access costs. In order to help identify methods for dropping costs and schedules of various satellite activities from ground testing to orbital operations, the Space Vehicles Directorate has invested in various methodologies for utilizing Structural Health Monitoring (SHM) approaches and has demonstrated these concepts on multiple flight experiments. This talk will provide an overview of those areas of sensing interest and challenges faced in pursuing these methods due to hardware limitations. Ideally, this discussion will provide researchers with an understanding of the type of sensing AFRL/RV is interested in, the scope of data needed, and point of contact for potential solutions

Background:

Dr. Derek Doyle is the technical area lead for the Energetic Responsive Structures group on the Integrated Structural Systems Team within the Spacecraft Component Technology branch at AFRL, Space Vehicles Directorate. He has worked with the organization since 2007 developing technologies related to SHM, electromagnetically tailored materials, and additive manufacturing. He has patented and published in a variety of conferences, journals, and books. His most recent efforts have been focused on multiple flight experiments transitioning his research with SHM to flight structures on the International Space Station and on a separate free flyer GEO satellite.

On-Astronaut Wireless Sensor System (OAWSS) to Support Crew Health Monitoring for Exploration

Bill Toscano, PhD.
william.b.toscano@nasa.gov
650-604-3085
408-891-4248 (cell)

NASA Ames Research Center, Research Scientist
Human Systems Integration Division
Moffett Field, CA

Abstract: Long-duration space exploration missions present many challenges concerning human performance under extreme conditions. At NASA, the Human Research Program (HRP) has been established to investigate the specific risks to astronaut health and performance during space exploration, in addition to developing necessary countermeasures and technology to reduce risk and facilitate safer, more productive missions. The Exploration Medical Capabilities (ExMC) Element of HRP seeks to reduce the risk of adverse health outcomes and decrements in performance during these missions and for long term health. Within this risk context, the ExMC element is specifically concerned with establishing evidenced-based methods of monitoring and maintaining astronaut health and advancing techniques that identify, prevent, and treat any health threats that may occur during space missions. ExMC has identified a number of technology gaps that are relevant to this concern. This presentation will discuss some of the gaps and the advancing technologies like crew worn wireless sensors necessary to answer these gaps.

Background:

Dr. Bill Toscano is a research scientist in the Human Systems Integration Division at NASA Ames Research Center since 2001. His primary work involves advancing biosensor monitoring capabilities to support crew health and performance during future exploration missions. In 2015 he served as Principal Investigator of a study evaluating a biosensor monitoring system (Astroskin) with crew in a high-fidelity space flight analog at JSC. He is the technical lead of an International Agreement with the Canadian Space Agency who is collaborating on this work. Upcoming work in this area will involve validation tests of CSA's next generation wireless patch sensor system and its integration with a prototype Medical Data Architecture system currently under development at Ames. In addition, Dr. Toscano is working with the ExMC systems engineering team on developing requirements for the proposed Deep Space Habitat Crew Health and Performance Medical System. In his earlier work Toscano was a co-investigator on ground-based studies whose primary goal was to evaluate the efficacy of physiological countermeasures for mitigating space motion sickness and post-flight orthostatic intolerance. As a Senior Research Associate at UC San Francisco he collaborated with NASA researchers on studies aboard the Space Shuttle and Russian MIR Space Station.

Space Shuttle & Space Station Lessons Learned: Less Wires for Current & Future Spacecraft

George Studor
George.f.studor@nasa.gov
(281) 415-3986

NASA Engineering and Safety Center
Avionics Technical Discipline Team, consultant
Wireless Avionics Community of Practice

Abstract: Successful wireless instrumentation has been used by NASA to overcome various challenges to instrumentation needs since the Wakeshield facility was place in orbit in 1995. George will quickly walk through successful spacecraft wireless instrumentation missions on the Space Shuttle and International Space Station assembly and operations, discuss lessons learned and then apply these lessons to various current manned spacecraft with the support of publicly available presentations from previous NASA PWST Workshops and In-Space Inspection Workshops. Finally, various concepts for the application of passive wireless sensor technology to future spacecraft missions will be discussed. Among them are manned missions such as Orion, Gateway and inflatable habitats, as well as unmanned missions, such as cubesats, planetary exploration vehicles and deployed sensors for atmospheric and planetary surface uses. PWS for modular instrumentation on long-lived habitats and the use cases for in-space passive wireless sensor 3D printing and additive manufacturing will be discussed.

Background:

Mr. George Studor retired from NASA in October 2013. Since then he has concurrently been a consultant to the NASA Engineering and Safety Center for three Technical Discipline Teams(TDTs): Avionics TDT - Wireless Avionics Connections, Non-Destructive Evaluation TDT – In-Space Inspection, and Robotic Spacecraft TDT – Application of Natural Systems to Systems Engineering process. George organized and chaired 7 previous Passive Wireless Workshops since 2011 supported by the Avionics TDT, IEEE WiSEE Conference, the Industrial Society for Automation and DOE, Oak Ridge National Labs. In addition, he has been consultant to the Image Science and Analysis Group at Johnson Space Center through Jacobs Engineering to develop a detailed study of Soyuz Spacecraft In-Space Inspection. As a senior project engineer for technology applications in the Strategic Opportunities and Partnership Development Office of the Johnson Space Center. In the past 20 years, he has championed numerous successful wireless flight instrumentation projects for dual-purpose technology -operational use demonstrations on Space Shuttle Orbiters and International Space Station. Applying the lessons learned, he has promoted changes to future vehicle architectures to enable reduced wires and connectors through a comprehensive approach called “Fly-by-Wireless”. He is a retired Air Force officer and C-130E pilot, with about half of his 20 years working with the WPAFB AFRL Flight Dynamics Laboratory. George was honored by Marquis Who's Who in December 2017 for Professional Excellence in Aerospace Engineering.

Nuclear Power Generation: Technology Needs for Passive Wireless Sensing

Sacit Cetiner
cetinerms@ornl.gov
(865) 241-3608

Data Analytics and I&C Team Lead
Advanced Reactor Engineering Group
Reactor and Nuclear Systems Division
Oak Ridge National Laboratory

Abstract
Nuclear power plants are complex engineering systems with many interconnected systems, structures and components that are dynamically coupled through feedback effects—some quite strong. Continuous monitoring of system dynamics and equipment condition is a critical element of generating proper protection and control actuations, and thus maintaining a safe, reliable and commercially viable operations. All sensing and instrumentation related to safety and operation of the plant use hard-wired connections. Furthermore, adoption of digital I&C technologies still remains to be a contentious topic of debate primarily due to strict interpretation of current regulations that were originally written for analog technologies—at least for the safety functions. Therefore, it does not seem to be feasible to expect that passive wireless sensing would be embraced to replace the current technology for those functions in the foreseeable future.

On the other hand, there are potential areas where passive wireless sensors can play an important role by way of acquiring auxiliary information on non-critical functions. For instance, equipment condition monitoring and diagnostics are areas where this technology can make immediate meaningful contributions. Cabling in a nuclear power plant is one of the costliest line items—especially for the existing reactors where cost of adding new cabling can be prohibitive. Furthermore, incorporation of an active condition monitoring network into the plant's maintenance plan can help avoid unnecessary plant shutdowns thus providing significant cost savings. In this context, passive wireless sensing can be an important technology for current generation of reactors as well as for advanced reactors.

This presentation will provide insights into the requirements and needs for adoption of passive wireless sensing technologies into the nuclear power generation domain.

Background:

Dr. Sacit Cetiner is the Team Lead for the Data Analytics and Instrumentation and Control (DAIC) Team within the Advanced Reactor Engineering (ARE) Group at Oak Ridge National Laboratory. Dr. Cetiner holds an M.S. Degree in Electrical Engineering, and a Ph.D. in Nuclear Engineering—both from The Pennsylvania State University. In his current position, Dr. Cetiner focuses on development of advanced sensing and control technologies for nuclear systems. He is the technical co-lead for Instrumentation and Control (I&C) system design for the Transformational Challenge Reactor (TCR). Dr. Cetiner was the General Co-Chair for the 2017 International Topical Meeting on Nuclear Plant Instrumentation, Control, and Human-Machine Interface Technologies (NPIC & HMIT) Meeting, and served as the Chair of the Human Factors, and Instrumentation and Controls Division (HFICD) of American Nuclear Society.

The Need for Wireless Sensor Technology for Commercial Nuclear Applications

James F. Gleason
Jim.gleason@glseq.com
315 664-3771 cell

President, of GLSEQ, LLC
13220 South Shawdee Rd
Huntsville, AL 35803

Abstract: Mr. James Gleason developed the Severe Accident Hydrogen Monitoring System which won the Japanese international competition for advanced hydrogen monitoring equipment following the Fukushima nuclear accidents. Mr. Gleason's presentation will focus on this new innovative type of nuclear safety equipment and its evolution as wireless sensor technology.

Background:

James Gleason is the founder and primary owner of GLSEQ, LLC located in Huntsville, AL. He is a licensed professional engineer with over forty years of professional experience with nuclear safety for nuclear power plants and nuclear fuel facilities. Jim is a recognized expert in nuclear Equipment Qualification, Environmental Qualification, Seismic Qualification, Commercial Grade Dedication, and Severe Accidents.

Mr. Gleason started GLSEQ, LLC in 1993 following a successful career as the Director of Nuclear Engineering for Wyle Laboratories as well as a team member for the NASA Apollo moon missions.

James has performed nuclear safety and equipment qualification assignments for several domestic and international clients including the US Nuclear Regulatory Commission, the USDOE's Yucca Mountain Project, General Electric Company, China's State Nuclear Power Technology Corporation, the Shanghai Power Equipment Research Institute, most US commercial nuclear power and nuclear fuel facilities and several others.

Mr. Gleason has been past-chairman of IEEE Nuclear Power Engineering Qualification Standards Committee, and a member of American National Standards Institute, American Society of Mechanical Engineers and the American Nuclear Society. He is the recipient of the IEEE Nuclear Power Engineering Committee Distinguished Service Award as well as the Standards Developer of the Year Award.

James Gleason has a BS from Rensselaer Polytechnic Institute and MS from The Ohio State University.

Sensor Needs for Nuclear Thermal Propulsion (NTP)

Mike Houts, Les Johnson, Harold Gerrish, Sonny Mitchell, Ken Aschenbrenner, Mark King

Mark King
mark.s.king@nasa.gov
(256) 544-3413
(256) 603-0068 (cell)

Partnerships and Formulation Office
Science & Technology Office
NASA Marshall Space Flight Center, AL

Abstract: Nuclear Thermal Propulsion (NTP) offers significant advantages for operations in cis-lunar space and for human Mars missions. NTP could also enable highly advanced science and exploration missions, and systems derived from NTP could enable a power-rich environment anywhere in the solar system (or beyond). For cis-lunar operations, NTP enables rapid plane changes and other high delta-V maneuvers. For human Mars missions, NTP can reduce crew time away from earth from >900 days to <500 days while still allowing adequate time for Mars surface exploration. NTP can reduce crew exposure to space radiation, microgravity, and other hazards. NTP enables abort modes not available with other architectures, including the ability to return to earth anytime within 3 months of the earth departure burn, and also the ability to return immediately upon arrival at Mars. A stage/habitat optimized for use with NTP could further reduce crew exposure to cosmic rays and provide shielding against any conceivable solar flare. NTP can reduce the cadence and total number of SLS launches for human Mars and other missions. First generation NTP systems are a stepping stone to fission power systems and highly advanced nuclear propulsion systems that could help enable detailed exploration and utilization of the solar system. This presentation will discuss NTP and potential ways in which passive wireless sensor technologies could help enable both near term and advanced uses of NTP and derived systems.

Background:

Dr. Mike Houts obtained his PhD in Nuclear Engineering from the Massachusetts Institute of Technology. He was employed at Los Alamos National Laboratory for 11 years where he served in various positions including Team Leader for Criticality, Reactor, and Radiation Physics and Deputy Group Leader of the 70-person Nuclear Design and Risk Analysis group. Dr. Houts currently serves as Nuclear Research Manager for NASA's Marshall Space Flight Center and is also the principal investigator for NASA's Nuclear Thermal Propulsion (NTP) project. Recent awards include a NASA Exceptional Service Medal and a NASA Exceptional Engineering Achievement Medal. Dr. Houts is an Associate Fellow of the American Institute of Aeronautics and Astronautics.

Mr. Mark King is a senior systems engineer with 30+ years of technical and management experience at NASA, ranging from space flight hardware development to program formulation. He has extensive launch vehicle experience with NASA's flagship programs including Space Launch System, Constellation, and multiple X-vehicles. Currently he leads technical and programmatic collaboration between NASA Centers, other Government Agencies, and the private sector. Mr. King has BS and MS degrees in Electrical and Computer Engineering from the University of Tennessee. He is a PMI Project Management Professional and the recipient of many NASA awards, including the Silver Snoopy.

Software Defined Wireless Avionics for Flight Test

Matt Waldersen
matthew.waldersen@nasa.gov
(661) 276-5708

AST, Flight Systems Design
Flight Instrumentation & System Integration Branch
NASA Neil A. Armstrong Flight Research Center

Abstract: Wireless avionics could revolutionize current flight systems by reducing nonrecurring engineering, providing a means to rapidly develop and implement flight systems, and providing unprecedented insight into vehicle health, maintenance, and performance. Despite these benefits, there is still a relatively high level of cost and complexity associated with flight testing wireless systems.

"Software Defined Wireless Avionics for Flight Test" will explore the following topics:

- Challenges associated with flight testing experimental wireless avionics
- Software defined radio (SDR) based avionics architecture designed to rapidly test and integrate emerging wireless technology
- Activities that have been completed to preliminarily validate the proposed SDR wireless avionics architecture
- Opportunities and challenges facing the proposed SDR wireless avionics architecture.

Background:

Matt Waldersen is a research and development engineer at NASA's Neil A. Armstrong Flight Research Center. After receiving a B.S. in Electrical Engineering from Purdue University in 2013, he worked as a design and research engineer within Orbital ATK's (now Northrop Grumman) propulsion system division. While at Orbital ATK, his primary areas of focus included flight instrumentation, avionics, and electrical ground support systems for the Space Launch System solid rocket boosters and the Orion spacecraft launch abort system. He was also an integral member of various research and development teams at Orbital ATK, conducting research into advanced avionic and instrumentation systems. In December 2015, he began his career at NASA where he has worked as a researcher in both the Sensors and Systems Development Branch and Flight Instrumentation and System Integration Branch. His current research focuses include avionics systems, flight instrumentation, autonomous systems, electric and hybrid electric propulsion, and aircraft telemetry.

Hyperbolic Frequency Modulation (HFM) and Passive Wireless Microphone

Victor Plessky
victor.plessky@gmail.com
vplessky@resonant.com
+41 76 3081418 (mob)

GVR Trade SA / Resonant
2025, Chez-le-Bart, Switzerland

Abstract: The presentation includes two parts. The first part is about SAW temperature sensors exploiting Ultra-Wide-Band (UWB) Hyperbolically Frequency Modulated (HFM) signals. The sensors operate in the 2000MHz-2500MHz frequency range (band B=500MHz). The dispersive grooved reflectors have HFM pulses as an impulse response with durations of 1000ns (B*T = 500). Packaged devices were measured and show close to expected behavior with the compressed pulses having durations of around 2ns. Preliminary results of simultaneous remote measurements of 3 sensors with a "reader" are presented. A new set of 10 sensors to be simultaneously interrogated is under development. The proposed modulation radically simplifies the algorithm of compression of the chirp pulses making this compression algorithm temperature independent.

In the second part, the feasibility of passive wireless microphone is discussed. The device includes a submicron suspended $LiNbO_3$ platelet used as a membrane and electrodes situated on a separate dielectric substrate at a distance from said platelet. This device is simulated using our in-house FEM software "Layers" [1] and in Comsol Multiphysics. For the first time, the sensitivity of this kind of sensor to sound waves with strength lower than 1Pa is demonstrated.

Background:

Prof. Victor Plessky has worked in the field of SAW technology for more than 40 years. He is known for being one of the authors of the STW (Surface Transverse Waves), and as the author of the "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 filters, SAW-ID tags and sensors. In total he has published about 300 papers on SAW technology and authored more than 20 patents. Prof. Plessky has been a Visiting Professor for many years in HUT, Helsinki, in Uppsala University, in EPFL, Lausanne, and in Freiburg University. During years 2010-2012, he 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 was an owner and director of consulting company GVR Trade SA (Gorgier, Switzerland) active in design of SAW devices, software development, consultations, etc. Recently (July 2016), the company became a wholly owned subsidiary of Resonant Inc., S. Barbara, and now concentrates on advanced SAW device development. V. Plessky continues research in the area of wireless SAW sensors in frames of Swiss-Lithuanian project Eurostars E!10640 UWB_SENS.

REFERENCES

[1] D. Nenov, "Fast, highly accurate, full-FEM SAW simulation", S7-D1 in this Workshop

Achieving 4.2-4.4 GHz Radios and Other Recent PWST R&D

Donald "Don" Malocha, CTO
dcmalocha@cfl.rr.com
donald.malocha@ucf.edu
(407) 758-4446

Pegasense, LLC
1511 E State Road 434 STE 2001
Winter Springs, Fl. 32708-5646

Pegasus Professor, Emeritus
University of Central Florida
Electrical & Computer Engineering Department
Orlando, FL. 32816

Abstract: The WAIC band at 4.3 GHz provides intra-communications within a single aircraft for safety-related applications. As such, a primary focus is on passive wireless sensor technology as part of communication-sensor network. The 200 MHz WAIC band is simultaneously a rather wide absolute frequency band but a narrow fractional bandwidth at 4.3 GHz, which offers opportunity to effectively use wideband communication techniques. This presentation will discuss some of the opportunities in using wideband versus narrowband approaches in the communication links. The communication links could use device and transceiver encoding techniques, spread spectrum, and matched filter approaches to minimize some problems and issues, such as fading, interference with critical systems (such as radio-altimeters), inter-sensors, and other. Other topics of importance are signal-to-noise ratio, power, adaptive/software defined radio (SDR) transceivers, and noise-like communication links. Concepts from the DARPA program on Signal Processing at RF (SPAR) currently in progress will also be discussed in relation to WAIC.

Background:

Donald C. Malocha is currently the CTO of Pegasense LLC, specializing in solid-state acoustic devices, wireless RF communications systems, and sensors. He is also Pegasus-Professor Emeritus in the Electrical and Computer Engineering Dept., University of Central Florida (UCF), Orlando. Don received a dual BS in electrical engineering (EE) and computer science (CS), an MS in EE, and Ph.D. degree 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 an Associate Editor of the IEEE TRANSACTIONS ON ULTRASONICS, FERROELECTRICS AND FREQUENCY CONTROL (UFFC), a UFFC AdCom Emeritus-member, and past-President of the IEEE UFFC Society. He is chair of IEC TC49 for piezoelectric dielectric and electrostatic devices and materials for frequency control standards. He is the 2004 UCF Distinguished Researcher and received the 2013 Dean's Research Professorship Award, the IEEE UFFC 2008 Distinguished Service Award, the 2005 J. Staudte Memorial Award, the 2000 IEEE Third Millennium Medal, and the 1998 Electronic Industries Association's David P. Larsen Award. He has over 250 technical publications, 13 patents awarded, and several pending. Don is a Fellow of the Institute of Electrical & Electronics Engineers (IEEE).

Passive Wireless Sensing at Microwave Frequencies: Challenges and Approaches

Taimur Aftab
aftab@imtek.de
+49 761 203 7183

Laboratory of Electrical Instrumentation
Institute of Microsystems Engineering (IMTEK)
University of Freiburg, Germany

Abstract: In this talk, passive wireless sensing in microwave frequencies - 1 to 100 GHz - will be discussed. Why is sensing in the GHz frequency range of interest to the aerospace industry? What are the limits of SAW and BAW micro-acoustic devices at these frequencies? Are high-gain antennas a blessing or a curse? Are there alternate approaches to passive wireless sensing for these frequencies? What are the figure of merits and how do the technology compare?

An overview of state of the art in microwave PWST along with recent findings in dielectric resonator based wireless passive sensing from Prof Reindl's research lab in IMTEK shall be discussed in this talk.

Background:

Taimur Aftab is a researcher from the Institute of Microsystems Engineering at the University of Freiburg. Born and raised in Pakistan, where he has a Bachelor's degree in electronics engineering from the GIK institute, he developed mechatronic systems for precision engineering in Karachi. After completing a Master's degree in microsystems engineering from the university of Freiburg where he performed research on radar interrogated electromagnetic wireless sensors, he nowadays works at the department of microsystems engineering - IMTEK - at the University of Freiburg in the field of passive wireless sensing in harsh environments.

Passive RADAR Acoustic Delay-line Sensor Measurement: Demonstration Using a WiFi (2.4 GHz) Emitter and WAIC-band (4.3 GHz)

J.-M Friedt, G. Goavec-Merou FEMTO-ST Time & Frequency dpt, Besancon, France
W. Feng, M.Sato CNEAS, Tohoku University, Sendai, Japan
jmfriedt@femto-st.fr Associate professor, consultant with SENSeOR

Abstract: SAW transducers have emerged as an attractive solution for harsh environment sensing, whether addressing measurement challenges on moving parts in which no wires can be attached (rotor), or environments too harsh for silicon-based electronics. However, unlike the RadioFrequency IDentification (RFID) industry, the passive wireless Surface Acoustic Wave (SAW) sensor industry has not been able to obtain the allocation of dedicated radiofrequency bands: short-range RADAR-like readers aim at fitting within existing radiofrequency emission regulations, making the certification challenging. Here we address the passive RADAR approach in which existing, non-cooperative emitters are used to probe acoustic sensors. Rather than using the magnitude of the echoes as indicators of sensor characteristics – prone to multiple artifacts including varying link budget and multipath interferences – we focus on precise time-of-flight identification through phase measurement. Such a measurement is demonstrated first using a noise-RADAR centered on various carrier frequencies including the 4.3 GHz WAIC band, in which the carrier spectrum is spread using binary-phase shift keying modulation, and then using a commercial, off the shelf 802.11 (WiFi) transceiver. The selection of the non-cooperative emitter to probe the wireless sensor must meet three criteria: spectrum matching between sensor and emitted signal both in carrier frequency and spectrum width, and sufficient power to compensate for the link budget decaying as the fourth power of the bistatic range. WiFi meets the requirement of a 15 MHz bandwidth suitable for separating echoes delayed by more than 100 ns, 2.4 GHz carrier as found in multiple commercial SAW sensors, and power up to 20 dBm allowing for meter range bi-static range interrogation. Spatial Division Multiple Access is demonstrated by using a single emitter and a receiver antenna array to separate the contributions of multiple sensors illuminated simultaneously, as demonstrated using Synthetic Aperture RADAR (SAR) processing. Other non-cooperative sources might include Terrestrial Digital Video Broadcast (DVB-T) or mobile phone, at the expense of dedicated SAW transducer design meeting such emitter spectral characteristics.

Background:

Dr. Jean-Michel Friedt is associate researcher at the University of Franche Comte in Besancon. He obtained his PhD in 2000 on topics related to biosensors and scanning probe microscopy. He has been involved, as a systems engineer, in passive wireless sensors based on acoustic transducers, since 2006 with the company SENSeOR. He joined university in 2014 while remaining a consultant for his former employer, prototyping diverse short range RADAR architectures for wireless sensor interrogation. His latest interest focuses on Software Defined Radio and its use in RADAR applications and time dissemination.

Airborne Testing of Passive Wireless Sensors and their uses in Commercial and Experimental Aircraft

Michael Christopher **Calspan Corporation**
michael.christopher@calspan.com **Aerospace Sales Manager**
(716) 444-7226

Abstract: This discussion will cover how Passive Wireless Sensor Technology (PWST) can be tested in the application-based environment of a real-world airborne testbed. As new technologies are developed, inclusive of sensor technology, it is vital to the functionality and certification of this technology for flight that it be tested in the flight environment. The second half of the discussion will discuss several use cases for PWST within both the civil aircraft business and the world of flight-testing.

Within the topic of test and certifications of technologies, Calspan Corporation's experience in testing new technologies on our airborne testbed aircraft will be presented in a light applicable to the testing of PWST. Calspan operates a fleet of testbed aircraft (both Gulfstream and Learjet aircraft) which for years have been used to fly in the experimental category with new technologies aboard. This makes for the perfect platform for testing early-stage technologies, honing them into their final faces of development, then eventually supporting the certification of said technologies. This process, applicable to PWST, will be discussed.

During the second half of the discussion, the many vital applications of PWST in the world of civil aviation and the arena of aircraft test flight will be presented. The modern civil aircraft is a system of systems, to say the least. The monitoring of these components and systems is vital to the safe, efficient, and value-added operation of civil aircraft in today's competitive environment. As aircraft owners place more demands on these vehicles, the flow of fast and accurate data to both the cockpit and the ground is vital to the success of aircraft ownership. Beyond utilizing PWST in the civil aviation environment, as an operator of airborne testbed aircraft Calspan will present the use case for this technology in the aircraft test world. In summary, our philosophy of cradle-to-grave development and use of new technologies will be applied to the realm of PWST.

Background:

Mr. Michael Christopher is an aerospace engineering professional, with current focus on business development efforts pertaining to transonic wind tunnel testing and flight-testing. Michael began his career at Moog In-Space-Propulsion (formerly AMPAC-ISP) as a Development Engineer working on satellite and upper-stage propulsion. While with Moog, Michael also worked in an engineering capacity on electrohydraulic servocontrols, specifically applied to actuation utilized on the NASA SLS main engines. From the technical world of space and defense based controls, Michael transitioned to business development, serving on the business development team of Servotronics, Inc. in Elma, NY in the servocontrols industry. Currently, Michael has the exciting task, with Calspan Corporation of Buffalo, NY, of connecting customers with our transonic wind tunnel and flight test operations (inclusive of full aircraft modifications). Michael enjoys seeing these test platforms be applied to new technologies with each new Calspan project. Michael's educational background consists of a B.S. Aeronautical Astronautical Engineering degree from Purdue University and an MBA from the Simon Business School at the University of Rochester..

RuBee (IEEE 1902.1) Wireless Sensor Tag Applications in Aerospace and Defense: An Introduction to Harsh Environment Wireless Sensors and Prognostic Health Management

John K Stevens Ph.D.
john@rubee.com

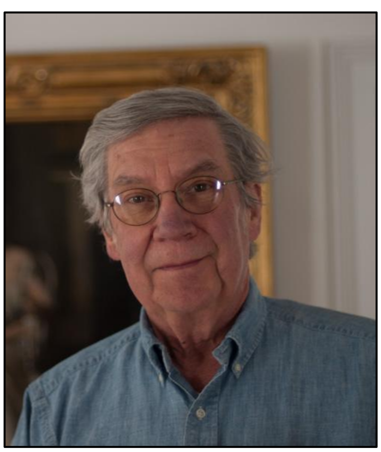
CEO, Visible Assets, Inc.
Stratham, NH 617-395-7601
www.rubee.com

Abstract: RuBee, (IEEE 1902.1) is an active, wireless magnetic transceiver technology that does not produce any significant Radio Frequency (RF) energy. RuBee magnetic AIT solutions have unique advantages over RF based AIT solutions;

- 100% read accuracy on steel, though steel, humans, dirt, snow, and liquids;
- Field proven 25 year battery life;
- Sealed, potted tag, sensors include: vibration, shock, temperature, pressure and humidity;
- No Compromising Emanations, no eavesdropping, tempest or target risk;
- "Spatial Certainty" - no nulls, no multipath spatial reflections or skips;
- RuBee wireless tags meet MIL-STD 810G, IP69K, ATEX Zone 1 or 0, ANSI 501 Class 1 Div. 1, IEC 60079 Zone 0;
- Tags and readers - zero safe separation distance on fused ordnance (HERO ZERO);
- Tags and readers - zero safe separation distance on explosives (HERF ZERO);
- RuBee tags approved by the DoE (Sandia Labs) for use on or near nuclear warheads.

We will demonstrate and review the physics, the advantages and the disadvantages of RuBee wireless data links and sensor tags. We will examine the requirements and challenges seen for a variety of active RuBee sensor deployments on missile systems, in-storage munitions, warheads, sensitive items, firearms, and aircraft parts. Finally, we will discuss Prognostic Health Management (PHM) of sensitive defense and aerospace items based on these sensor tags using RuBee IO systems platform, the Bluefin Kernel, and our PHM application platforms.

Background:



John K. Stevens Ph.D. Stevens is the founder of Visible Assets Inc. Visible develops, manufactures and sells wireless RuBee AIT and IoT sensor solutions based on IEEE 1902.1. Stevens has 40 years of entrepreneurial business experience and has founded four other technology-based companies all with successful international products. The most recent Visible Genetics Inc. (VGEN), a Biotech company specializes in DNA sequencing and genotyping. He served as Chairman and CEO of VGEN for nine years. Under his leadership VGEN developed a full product line of FDA approved DNA sequencers, and kits (HIV, HepC, HepB). Dr. Stevens holds a Ph.D. in biophysics from the University of Pennsylvania (1974), and has held faculty positions at University of Pennsylvania (Associate Professor), University of Toronto (Tenured Full Professor).

COTS or Customized High Performance Data Loggers, Wired or Wireless Data, Proven Robust Technologies in Harsh Environments

Chris Hough
chris.hough@tmigi.com
+1 703-668-0116

TMI USA, Inc.
Global Sales Director

Jean-Luc Favre
jeanluc.favre@tmigi.com
+33.4.99.52.67.10

TMI-Orion, SA
C.E.O.

Abstract: TMI has over two decades of experience building ruggedized embedded data solutions for harsh environments. We have proven COTS solutions complete with a well received integrated software platform. TMI develops and manufactures wireless high performance data loggers to measure and control a wide range of industrial applications such as aeronautics, food, pharmaceutical, hospitals, manufacturing, brick and tile, high heat metallurgy, automotive 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 collaborate relationships in passive wireless technology to transmit through metal and water, as well as expand our current offerings and penetrate the automotive, aeronautical, nuclear, and very high heat metallurgy and manufacturing markets.

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, SAP global integration projects, as well as authoring white papers at the Central Intelligence Agency.

Jean-Luc Favre. With a Master degree in General Physics from Montpellier University (France), Jean-Luc joined IBM France in 1969 where he had different positions related to the test methodology of very large-scale integrated semi-conductor systems. He spent six years at different IBM Corp laboratories in the US.

Based on this scientific and international background, he founded TMI-Orion in 1994. Since then he has given to the company an inflexible direction of quality and innovation.

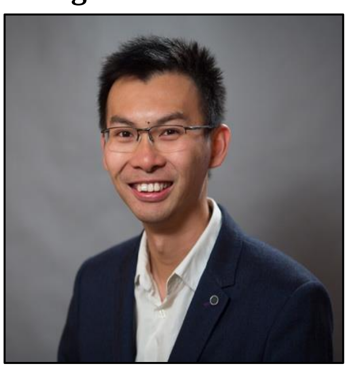
Embedded Passive Wireless Ultrasonic Sensor for Non-Destructive Testing

Dr. ChengHuan (bamboo) Zhong — **Chief Technology Officer**
bamboo@inductosense.com — **Inductosense, Ltd, Bristol, UK**
00-44-7809671566 — **www.inductosense.com**

Thomas Fink — **TechnoFink**
thomasf@technofink.com — **Houston, Texas**
346-331-6200

Abstract: The WAND system from Inductosense is a novel, patented technology that uses battery-free, wireless, compact ultrasonic sensors for permanent monitoring of internal corrosion/erosion. The system consists three parts (i) an intrinsically safe, passive sensor that can be permanently installed or embedded into a structure (ii) a handheld data collection probe that wirelessly provides the power to, and acquires the data from, the sensor (iii) analysis software for trending of the corrosion/erosion rates. The sensors can operate underneath layers of material, such as a range of coatings, insulation or repairs (including glass, aramid composite repair, uni-directional and bi-directional carbon). The WAND system has been successfully used for monitoring of pipelines. It has also been used to take measurements from structures where conventional ultrasonic non-destructive testing is a problem – such as structures in a hard access area or inside a structure (eg embedded within a honeycomb composite panel). As the sensor is permanently installed, repeatable accurate measurements from the same location can be achieved within a second, without accurate alignment, coupling gels or human error associated with conventional ultrasonics non-destructive testing. The sensors also have RFID tags which enable tracking of data over time and analysis is performed with the Inductosense data management software.

Background:



Dr. ChengHuan (bamboo) Zhong is the Chief Technology Officer and co-founder of Inductosense Ltd in Bristol, UK.. Inductosense was established in 2015 as a spin-out from the Ultrasonics and Non-Destructive Testing Group at the University of Bristol. Since 2013 'bamboo' has worked with Professor Paul Wilcox and Dr. Anthony Croxford on inductively coupled transducer systems for Non-destructive testing (NDT). He has delivered numerous successful ultrasonic NDT operational solutions for companies in oil and gas, nuclear, aerospace and renewable industries.

Thomas Fink, currently the CEO of TechnoFink, has built seven companies operating in over 37 countries worldwide. His 25 years of entrepreneurship have gained him broad experience in surface preparation and corrosion protection. Thomas has invented and patented three technologies, these include thermoplastic corrosion protection, and others. Thomas is on the Latin American Advisory Council for the Society for Protective Coatings (SSPC) and recently started the Brazilian Chapter. In his free time, he spends a lot of time with his family, and also he enjoys golfing, fishing, and sports.

Skin-Interfaced Systems with Microfluidics and Biosensors for Physiological Monitoring and Biochemical Sensing

Roozbeh Ghaffari
rooz@northwestern.edu
617-251-3686

Northwestern University
Research Associate Professor
Center for Bio-Integrated Electronics
Evanston, IL

Abstract: Novel classes of bioelectronics enabled by recent advances in materials science and mechanics can be designed with physical properties that approach the physical properties of human skin. These systems are ideal for wearable monitoring applications by virtue of their curvilinear formats and soft mechanics compared to conventional packaged electronics and sensors. They have been widely deployed and used to collect important biometrics, providing actionable data and outcomes across patient and subject populations. However, there are additional sensing modalities beyond standard electronic-based capabilities that are highly attractive, and which could lead to a more holistic picture of personalized health and wellness. Wearable microfluidic platforms that collect and analyze sweat from the skin can reveal insights into physiological and metabolic processes that are not easily realized using motion and physiological sensors. In this talk, I present an overview of recent advances in integrating novel microfluidic and flexible hybrid electronic (FHE) systems that incorporate arrays of sensors, microfluidic channels, and biochemical assays, configured in ultrathin formats for continuous monitoring of kinematics, cardiac signals, and electrolyte balance. I will further highlight the corresponding design and manufacturing challenges of producing such systems and discuss the vision for how they can be fabricated at high volumes.

Background:

Prof. Roozbeh Ghaffari obtained his BS and MEng degrees in electrical engineering from the Massachusetts Institute of Technology in 2001 and 2003. He received his PhD degree in biomedical engineering from the Harvard Medical School-MIT Program in Health Sciences and Technology in 2008. Upon completion of his PhD, Dr. Ghaffari co-founded MC10 Inc and served as its Chief Technology Officer. In this role, Dr. Ghaffari led the development and launch of the BioStamp® and the My UV Patch™ wearable biosensing products. His contributions in soft bioelectronics, micro/nano-scale systems, and auditory neuroscience have been recognized with the Helen Carr Peake PhD Research Prize (2008), the MIT100K Grand Prize (2008), the Harvard Business School Social Enterprise Grand Prize (2008), MIT Technology Review Magazine's Top 35 Innovators Under 35 (2013), IEEE Emerging Technology Award (2016), and TEDx Gateway invited speaker (2016). He joined the Center for Bio-Integrated Electronics (CBIE) at Northwestern University in May 2017, where he is currently the Director of Translational Research and Research Associate Professor in the Department of Biomedical Engineering. In his translational role, Dr. Ghaffari serves on the Editorial Board of Digital Biomarkers Journal and Board of Advisors of the University of Vermont, Department of Biomedical Engineering. He is also co-founder and CEO of Epicore Biosystems, a CBIE spin-out pursuing commercialization of wearable microfluidics technology.

Wireless Instrumentation System Opportunities and Challenges for Large Solid Rocket Motor Flight Applications

Mont Johnson
mont.johnson@ngc.com
435-863-3798
435-279-0948 (cell)

Director, Research and Development
Fellow, Measurement Acquisition/Analysis
Northrop Grumman Innovation Systems
Flight Systems Group/Propulsion Systems Division
Promontory, Utah

Abstract: An advanced wireless instrumentation system could provide several advantages over systems currently employed for solid rocket motor flight applications. Current flight instrument systems, while mature and robust, tend to be labor intensive to install, integrate, and check out. They also carry a significant weight penalty, particularly with the associated harnesses and thermal protection materials required to shield them in a Solid Rocket Motor, or SRM, flight environment. These measurement systems also are not readily scalable, and as such have a significant baseline cost associated with them regardless of the number of sensing channels employed. Target capabilities for a wireless instrumentation system for SRM flight applications will be presented as well as objectives for reducing the impact of the measurement system on the vehicle. Some key challenges in implementing such a system will also be discussed, as well as potential insertion opportunities.

Background:

Dr. Mont Johnson is the Director of a group of ~75 Research and Development scientists and engineers working in a variety of Solid Rocket Motor related areas including; energetics and propulsion, analytical chemistry, advanced thermal and structural materials, and modeling and service life assessment. Prior to this he was the Manager of a group of 20-24 electrical and mechanical engineers working Instrumentation, Test Integration, Cables/Harnesses, Avionics Components and Ground Support Equipment (GSE) for NASA SLS (Space Launch System) and various commercial programs. He has over 20 years of experience in developing and implementing instrumentation systems in harsh environments – particularly as applied to Solid Rocket Motors. For several years he functioned as the Project Engineer responsible for designing and developing the Developmental Flight Instrumentation system for the SLS boosters with over 400 channels of data. He also led efforts to successfully instrument and collect data from over 400 sensors during the Ares-IX test flight. Before this he was the R&D Lead for an embedded instrumentation smart sensor node development effort. During that time he was also the Principle Investigator in the application of fiber optic sensors to the measurement of critical solid rocket motor parameters, including pressure, temperature, strain, and bond-line stress.

Launcher Wireless Internal Infrastructure Perspectives

Johannes Sebald
johannes.sebald@ariane.group
+49-421-4372-5565
+49-421-4372-28—5565

ArianeGroup
Engineering Upper Stage Avionics
Bremen, Germany

Abstract: The Avionic of the current Ariane 5 launcher is based on a design from the early Eighties of the last century. All sensors are wired to centralized acquisition boxes and most of them are providing analog signals. This design has a significant impact on harness mass and installation effort. On top changes in the measurement plan require a significant amount of work for configuration updates. Therefore, wireless sensor networks received attention in the last years and are a promising technology to optimize future launcher avionic concepts. The appropriate wireless technologies have to be selected and matured. The current status and future development options will be presented and discussed.

Background:

Mr. Johannes Sebald is working for the ArianeGroup GmbH in Bremen, Germany, since 2009 in the department of Upper Stage Avionic Engineering and is a company nominated expert in the field of Communications. He is involved in production support, development and pre-development activities with a focus on technologies related to wireless sensor. In the preceding years Johannes worked for Airbus in the area of System Design as a Safety/Reliability System Engineer and in the Automotive Industry as Technical Writer and Software Development Engineer. He studied Electronics and Chemistry at the University of Bremen and graduated as engineer (Dipl.-Ing.) in Communication Engineering and as Chemist (Dipl. Chem).

Opportunities and Challenges for Launch Vehicle Wireless Sensors
and
Passive Wireless Sensing Technologies – Opportunities for Aerospace

Michelle Barber
Michelle.H.Barber@boeing.com
256-774-8947
256-724-2572 (cell)

Boeing Defense Systems
Associate Technical Fellow
Huntsville, AL

Abstract: Wireless sensor systems for launch vehicles and production will be explored based on Internet of Things (IoT) architectures that are being investigated for Commercial and NASA launch vehicles and efficiency improvements in production facilities. Deployment of wireless systems is an enabler for a reduction in wires and cables for launch vehicles which translates to simpler integration and reduced test planning and execution. Deployment in the production environment enables real time monitoring of assets for location and health and provides ubiquitous data collectors to provide meaningful data analytic solutions. The opportunity space looks at potential needs: (1) on launch vehicle sensor acquisition, (2) acquisition of data that is useful for launch vehicle ground and test operations and (3) sensor systems that enable production efficiencies.

Background:

Michelle H. Barber is a Boeing Associate Technical Fellow with more than 10 years of experience with the Boeing Company. Prior to Boeing, she has ten years of experience with the telecommunications industry. She holds the title of Designated Expert for The Boeing Company's Wire Design, Installation, and Integration community. Her expertise is called upon across multiple Boeing Defense, Space and Security and Boeing Commercial Airplanes programs not only as an electrical engineer but also as a stress analyst. She is currently the Ground Mid-course Defense (GMD) Booster Chief Engineer. Michelle recently moved to GMD from the Space Launch System Chief Engineer's Office as the technical lead for electrical design and integration. Michelle holds a B.S. in Electrical Engineering from the University of Alabama in Tuscaloosa, and a M.S. in Aerospace Engineering from UA.

Extreme Environment Monitoring needs for Jet and Rocket Turbine Test and Operations

Reamonn Soto
rsoto@sensatek.com
386-281-6750

Sensatek Propulsion Technology, Inc.
Founder and President
Daytona Beach, FL
www.sensatek.com

Abstract: While instrumentation sensors have historically been hard-wired to a sensor data acquisition package, it is desirable to have wireless capability for some, if not all, sensors in the instrumentation suite. Wired systems discourage system flexibility with regards to sensors and sensor locations in jet and rocket turbine test and operations, due to extraneous machining associated with the cables. Additionally, the reduction or elimination of an onboard cable infrastructure would help reduce the overall weight of the propulsion system. About 30% of electrical wires are potential candidates for a wireless substitute that could achieve high reduction in the time and cost of propulsion systems development and tests. During this discussion Reamonn will reveal extreme monitoring needs of jet and rocket turbine test and operations from over 340 interviews throughout the industry. Use case will be discussed to show how extreme environmental monitoring can accelerate propulsion system development schedules, while eliminating time from wiring sensors through critical hot section components.

Background:

Reamonn Soto is a U.S. Marine Corps Veteran and Founder, CEO of Sensatek Propulsion Technology, Inc. Reamonn holds a Bachelors in Physics from Florida A & M University and Masters of Science in Aeronautics at Embry-Riddle Aeronautical University. He received hands on training in scientific research in the field of astrophysics and condensed matter physics at the Center for Plasma Science and Technology (CePAST) and U.S. Department of Energy's Brookhaven National Laboratory. At CePAST, he conducted research on synthesizing Single Walled Carbon Nanotubes using Chemical Vapor Deposition (CVD) Process to explore material stresses on Airframe for the U.S. Air Force. At Brookhaven, he constructed an antenna for Project Mixed Apparatus Radio Investigation of Atmospheric Cosmic Rays of High Ionization (MARIACHI). He is an active member of the IEEE Sensors Council, Antennas and Propagation Society. Prior to founding Sensatek, he was a Certified Business Analyst and Economic Development Finance Professional with the Florida SBDC at Florida A & M University. His great business acumen assisted over 200 clients in creating 68 new businesses, that raised over $9.6 million in capital, and generated more than $79 million in sales and government contracts. Reamonn is on the ASME International Gas Turbine Segment Aircraft Engine Technology Committee, ASME International Gas Turbine Segment Controls, Diagnostics, and Instrumentation Committee, and a member of the Propulsion Instrumentation Working Group (PIWG).

Instrumentation & Sensor Technology Quantum-Leap Needs for Exploration Spacecraft Structures

Rodney Rocha
rodney.rocha@nasa.gov
(281) 483-8889 office

Aerospace Engineer
Structural Engineering Division
NASA Johnson Space Center (JSC)

Abstract: This talk will describe the needs for "quantum leap" improvement and capability in sensor and measurement technology for NASA's human-rated exploration space vehicles, specifically during the pre-flight conditions of a launch vehicle under transporter roll-out from hangar to launch pad and to the severe flight conditions of lift-off, ascent, staging dynamics, Earth-orbit insertion, and Earth-orbit escape to a deep space target destination. There will be a new imperative imposed on future exploration spacecraft and launch vehicles, namely, that super lightweight, yet strong and reliable enough, structures will emerge as the top requirement and priority in structural design. This design objective is one of several key ones that must be met if human crews are ever to explore the solar system. The emphasis here will be on wireless sensor and instrumentation technology needing orders-of magnitude improvement for vehicle structures, specifically for measurement of vehicle accelerations, vibrations, stress & strain, temperatures, pressures, structural deflections, impact detection, and more. These capabilities will not only allow structural designers and analysts a wealth of data to become ever smarter about structural designs, their limitations, and external environments acting on the vehicle, but will realize unprecedented weight reductions in launch vehicles and their human-rated spacecraft. They will also lead to large expansion of spacecraft operational capabilities.

Background:

Mr. Rodney Rocha is an expert in structural dynamics in the Loads & Dynamics Branch within the Structural Engineering Division, NASA JSC). He has participated in NASA's major projects such as the Apollo-Soyuz Test Project, Space Shuttle program, International Space Station, Constellation Program, X-38 and Project Morpheus, and was a key principle investigator for an orbital flight experiment. He served as NASA manager for the structural, vibration, and acoustic laboratories. During the Space Shuttle program he was in the role of Orbiter chief engineer and technical chairperson of the Shuttle Loads & Dynamics Panel. He currently provides technical support to the Space Launch System (SLS) & Orion-Multiple Purpose Crew Vehicle (MPCV) as an integrated dynamics system and is a team member for planning the SLS/MPCV ground tests for pre-flight validation of the modal vibration mathematical models.

Zero Power Wake-Up Sensors for Acoustic and Vibration Wireless Detection

Jonathan Bernstein, Eugene H. Cook, Michael J. Tomaino-Iannucci, Daniel P. Reilly, Mirela G. Bancu, Douglas A. Gauthier, S. Golmon, J. LeBlanc, Perri R. Lomberg, Jason A. Danis, Richard Elliott, Jonathan S. Ung, Marc S. Weinberg, Gregory F. Cardinale, and Amy E. Duwel

Jonathan Bernstein
jbernstein@draper.com
617-258-2513
978 835-5337 (cell)

Draper
Microsystems and Advanced Materials
Lab Technical Staff
Cambridge, MA USA

Abstract: We present novel MEMS resonant acoustic and vibration wake-up switches which are actuated by ambient sound waves or vibration, consuming zero power while waiting for a signal at their resonant frequency and less than 10 nW when the signal is detected. The systems uses a battery to charge a capacitor through MEMS switches activated only by the target acoustic or vibration signals. These wake-up sensors reduce cost and extend battery life for Passive Wireless Systems (PWS), Unattended Ground Sensors (UGS) or Internet of Things (IOT) by reducing power draw to zero except when a known signal of interest is present. The sensors are of rotational design allowing them to be insensitive to off-frequency and static gravity forces. Frequency tuning of the acoustic devices is achieved by adjusting a Helmholtz cavity volume. The vacuum-packaged vibration sensor has a Q between 100 and $>10^5$ (by setting the pressure in the package) and is frequency tunable via a voltage applied to tuning electrodes. Device fabrication uses a simple process starting with SOI bonded wafers and provides metal-metal electrical contacts. The acoustic devices successfully detect 80 Hz sound as low as 0.005 Pa RMS (48 dB SPL referenced to 20 µPa) from a gasoline-powered generator. Sensors at various frequencies may be combined through Boolean logic (AND, OR and NOT) to require multiple acoustic or vibration signals to trigger a detection or to inhibit detection by off-frequency clutter signals.

Background:

Dr. Jonathan Bernstein received his BS in electrical engineering and physics at Princeton University, and M.S. and Ph.D. from U.C. Berkeley in EECS. At Draper Laboratory he developed MEMS inertial sensors such as the Tuning Fork Gyro (TFG), accelerometers for combined GPS/Inertial projects and seismic sensors. He also developed MEMS hydrophones and microphones for acoustic and ultrasonic detection and solid state ion-conducting atom sources. From 2000–2003, Dr. Bernstein was Vice President of Technology at Corning IntelliSense Corporation, where he led the development of optical, RF and other MEMS devices such as 2-axis electromagnetic mirror arrays for optical switching, dynamic spectral equalization and wavelength selective switches. He has more than 50 issued patents and 65 papers. Among his awards are the Motorola Engineering Excellence Award, Draper Laboratory Distinguished Performance Award, Draper Lab Annual Award for Best Technical Patent 1992 and 1994, Draper Lab Engineering Vice President's Annual Award for Best Publication 1993, 2011, 2013, and 2017.

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Near-Zero Power Integrated Microsystems for the IoT

Prof. Matteo Rinaldi
rinaldi@ece.neu.edu
617-373-2751

Director, Northeastern SMART
Northeastern University
Boston, MA

Abstract: The recent advancements in terms of sensor miniaturization, low power consumption and low cost allow envisioning a new era for sensing in which the data collected from multiple individual smart sensor systems are combined to get information about the environment that is more accurate and reliable than the individual sensor data. By leveraging such sensor fusion, it will be possible to acquire complete and accurate information about the context in which human beings live, which has huge potential for the development of the Internet of Things (IoT). To address the growing demand of such large wireless sensor networks, there is a need for wireless sensors with dimensions and power consumption that are orders of magnitude smaller than the state-of-the-art. *Energy is the key challenge.* Batteries have limited capacity, and existing sensors are not "smart" enough to identify targets of interest. Therefore, *they consume power continuously to monitor the environment even when there is no relevant data to be detected.* This talk presents a new class of *zero-power microsystems* that fundamentally brake this paradigm, remaining dormant, with zero-power consumption, until awakened by a specific physical signature associated with an event of interest. In particular, a zero-power infrared (IR) digitizing sensor microsystem consisting of plasmonically-enhanced micromechanical photoswitches is presented. Such a passive IR digitizer is capable of producing a wake-up bit when exposed to a specific IR spectral signature associated to a target of interest (such as the exhaust plume of a car, a forest fire, or a human body) while rejecting background interference. The capability of these zero-power sensors of consuming power only when useful information is present results in a nearly unlimited duration of operation, with a groundbreaking impact on the proliferation of the IoT.

Background:

Matteo Rinaldi is an Associate Professor in the Electrical and Computer Engineering department at Northeastern University and the Director of *Northeastern SMART*, a recently launched university research center that, in collaboration with federal agencies and industrial members, aims to conceive and pilot disruptive technological innovation in smart devices and systems required by The Fourth Industrial Revolution in a number of fields, including microsystems, nanotechnology, quantum computing and biotechnology. The Internet of Things (IoT), digital agriculture, robotics, artificial intelligence and autonomous vehicles. Dr. Rinaldi received his Ph.D. degree in Electrical and Systems Engineering from the University of Pennsylvania in December 2010. He worked as a Postdoctoral Researcher at the University of Pennsylvania in 2011 and he joined the Electrical and Computer Engineering department at Northeastern University as an Assistant Professor in January 2012. Dr. Rinaldi's group has been actively working on experimental research topics and practical applications to ultra-low power MEMS/NEMS sensors (infrared, magnetic, chemical and biological), plasmonic micro and nano electromechanical devices, medical micro systems and implantable micro devices for intra-body networks, reconfigurable radio frequency devices and systems, phase change material switches, 2D material enabled micro and nano mechanical devices.

A 6.1 nW Wake-Up Receiver Achieving −80.5 dBm Sensitivity via a Passive Pseudo-Balun Envelope Detector

Drew A. Hall
drewhall@ucsd.edu
858-534-3855

Department of Electrical and Computer Engineering
University of California, San Diego
La Jolla, CA

Abstract: The high-power consumption of conventional low-power wide-area network (LPWAN) radio receivers employed in applications such as smart meters, environmental sensors, threat monitors, and other Internet of Things (IoT)-like applications often dictates overall device battery life. Even though many such applications communicate at low-average throughputs, the power of the radio can be high due to the need for frequent network synchronization. To reduce the power consumption, wake-up receivers (WuRXs), which tradeoff sensitivity and/or data rate for low-power operation have been proposed to monitor the RF environment and wake-up a high-performance (and higher power) conventional radio upon the reception of a predetermined wake-up packet. The two most important metrics for WuRXs used in low average-throughput applications are the power consumption and sensitivity, as the power of always-on WuRXs ultimately determines the battery life of low-activity devices, while sensitivity determines the communication distance and therefore deployment cost via the total number of nodes required to achieve a given network coverage. Typically, sensitivity and power consumption trade-off with one another, making the design of WuRXs that simultaneously achieve both challenging. In this talk, a WuRX that achieves -80.5 dBm sensitivity with only 6.1 nW of power is presented. High sensitivity is achieved via a passive pseudo-balun envelope detector (ED) with a high input impedance (>750 kΩ || <1.4 pF) that: 1) enables a 30.6 dB passive voltage gain transformer; 2) has 6.1 dB higher SNR and no 1/*f* noise compared to an active ED; and 3) improves the sensitivity by 1.5 dB compared to a conventional single-ended input passive ED.

Background:

Dr. Drew A. Hall, received the B.S. degree in computer engineering with honors from the University of Nevada, Las Vegas, NV, USA, in 2005, and the M.S. and Ph.D. degrees in electrical engineering from Stanford University, Stanford, CA, USA, in 2008 and 2012, respectively. From 2011 to 2013, he was a Research Scientist in the Integrated Biosensors Laboratory at Intel Corporation. Since 2013, he has been with the Department of Electrical and Computer Engineering, University of California at San Diego, as an Assistant Professor. His research interests include bioelectronics, biosensors, analog circuit design, medical electronics, and sensor interfaces.

Dr. Hall received the First Place in the Inaugural International IEEE Change the World Competition and First Place in the BME-IDEA invention competition, both in 2009. He received the Analog Devices Outstanding Designer Award in 2011, an Undergraduate Teaching Award in 2014, the Hellman Fellowship Award in 2014, and an NSF CAREER Award in 2015. He is also a Tau Beta Pi Fellow. He has served as an Associate Editor of the IEEE TRANSACTIONS ON BIOMEDICAL INTEGRATED CIRCUITS since 2015 and has been a member of the CICC Technical Program Committee since 2017.

Asleep Yet Aware: Near-Zero Power RF Wakeup Receivers with Automatic Offset Compensation

Steven Bowers **Assistant Professor**
sbowers@virginia.edu **Charles L. Brown Department of Electrical and Computer Engineering**
434-924-3599 **University of Virginia, Charlottesville, VA**

Abstract:
Event driven sensor nodes are wireless sensors that take measurements only when an environmental event of interest occurs, or when a wireless command is sent by the network. As such, they can operate in very low sleep states most of the time, only waking up periodically to take measurements. For event driven sensor nodes with activity rates that fall below a measurement per hour, the power consumption of the portions of the node that cannot be put into sleep state but must always remain on can dominate over the active power dissipation during the measurement itself. One critical 'always on' block is the RF wakeup receiver, which must always listen for a wakeup command to be sent when a measurement is desired, and power levels in the nanowatt range can extend node lifetimes from days and weeks to months and years. In utilizing only nanowatts of power, the challenge of calibration and compensation for variation in process or environmental conditions is a significant challenge.

In this talk, a wakeup receiver is presented that consumes 7.4 nW of power while being capable of sensing a -76 dBm RF signal while receiving in the MURS band (152 MHz), or -71 dBm sensitivity while receiving in the 433 MHz ISM band. To accommodate the limited available power, a passive envelope detector first architecture is utilized, followed by low frequency IF amplification, a digital comparator, and digital correlation to allow for multiple wakeup codes. A fully automated offset compensation loop monitors the output of the comparator to automatically set the offset to the optimum value, including rejection of external in-band non-constant-envelope RF interference with no external calibration of any kind required.

Background:

Dr. Steven M. Bowers received the B.S. degree in electrical engineering from the University of California at San Diego, La Jolla, CA, USA, and the M.S. and Ph.D. degrees in millimeter-wave circuits and systems from the California Institute of Technology, Pasadena, CA, USA. He joined the faculty of the Charles L. Brown Department of Electrical and Computer Engineering, University of Virginia, Charlottesville, VA, USA, in 2014, where he is currently an Assistant Professor. Dr Bowers' research involves low power and/or high-speed RF and mm-wave circuits and integrated electromagnetics, with applications in ultra-low-power wireless sensor networks, high bandwidth wireless communication, and mm-wave imaging. He is the director of the Integrated Electromagnetics, Circuits and Systems Lab at the University of Virginia. Dr. Bowers is a member of the HKN and TBP. He was the recipient of the Caltech Institute Fellowship in 2007 and the Analog Devices Outstanding Student Designer Award in 2009. He was a recipient of the IEEE RFIC Symposium Best Student Paper Award in 2012, the IEEE IMS Best Student Paper Award in 2013, and the 2015 IEEE MTT Microwave Prize.

Extremely Low Loss Lithium Niobate Acoustic Delay Lines for Zero Power Wireless Sensing and Signal Processing

Prof. Songbin Gong
songbin@illinois.edu
217-244-6454

Department of Electrical Computer Engineering
University of Illinois at Urbana Champaign
Urbana, 61822, IL

Abstract: Recently, IoT has sparked great research interest in developing the next generation wireless sensors and front ends that can meet the more stringent requirements on multi-modalities, sensitivity, bandwidth, power consumption, and wireless connectivity. This talk will discuss a new type of zero-power radio frequency micro-system that can seamlessly fuse conventional signal processing functions (e.g. filtering and impedance transformation), or new ones (e.g. RF correlation and non-reciprocity) with an assortment of sensing modalities for IoT applications. Specifically, the most recent development on low loss lithium niobate MEMS delay lines and their functional derivatives will be first presented, and followed by the discussions on overcoming the remaining technology bottlenecks in their paths to commercialization.

Background:

Prof. Songbin Gong received the Ph.D. degree in electrical engineering from the University of Virginia, Charlottesville, VA, USA, in 2010. He is currently an Assistant Professor and an Intel Alumni Fellow with the Department of Electrical and Computer Engineering and the Micro and Nanotechnology Laboratory, University of Illinois at Urbana–Champaign, Urbana, IL, USA. His research primarily focuses on design and implementation of RF-MEMS devices, components, and subsystems for reconfigurable RF front ends. In addition, his research explores hybrid microsystems based on the integration of MEMS devices with photonics or circuits for imaging sensing and signal processing. He is a recipient of the 2014 Defense Advanced Research Projects Agency Young Faculty Award and the 2017 NASA Early Career Faculty Award. Along with his students and postdocs, he received the Best Paper Award from the 2017 IEEE International Frequency Control Symposium and 2nd place in Best Paper Competition at 2018 International Microwave Symposium. He has been a guest editor for the special issue on RF-MEMS in the Journal of Micromechanics and Microengineering, and also a Technical Committee Member of MTT-21 RF-MEMS of the IEEE Microwave Theory and Techniques Society, International Frequency Control Symposium, and International Electron Devices Meeting.

Wireless Avionics Intra-aircraft Communications Requirements for RTCA & ICAO Consideration

Steven H. Rines
Steven.rines@zii.aero
+1 714 854-8713

Zodiac Inflight Innovations
Staff Systems Engineer
2929 E. Imperial Highway
Brea, CA 92821

Abstract: Wireless Avionics Intra-aircraft Communications (WAIC) are intended for wireless communications between aircraft functions that impact safety and regularity of flight. WAIC devices operating in the 4.2-4.4 GHz band will only be allowed to operate aboard commercial aircraft if they can be shown to not interfere with radio altimeters that share the same frequency band and after international standards have been put in place. The Aeronautical Vehicular Systems Institute (AVSI) at Texas A&M is performing the analyses to verify non-interference while RTCA SC-236 and EUROCAE WG-96 are jointly developing WAIC regulatory standards.

AVSI performed a four-part analysis to 1) quantify the susceptibility of radio altimeters to representative aggregate signals from WAIC devices; 2) identify worst case aircraft populations and distances; 3) define a WAIC maximum power flux density threshold that ensures non-interference; and, 4) establish a test procedure to verify compliance. The state of that analysis and testing and the relationships to WAIC regulatory standards will be presented.

Regulatory standards are under development by RTCA/EUROCAE in support of the International Civil Aviation Organization (ICAO), the Federal Aviation Agency (FAA) and the European Aviation Safety Agency (EASA) to establish equipment standards, operational constraints and verification test procedures to ensure non-interference with other aircraft. An overview of the regulatory process and will be presented and committee progress toward standards will be reviewed.

Discussion will include the unique challenges of spectrum management and configuration management of multiple onboard WAIC networks comprised of combinations of active devices and passive wireless sensors. Attendees will be encouraged to participate in the PWST Workshop Panel addressing considerations for including Passive Wireless Sensor technologies in the various WAIC international regulatory documents under development.

Background:

Steven Rines is Chair of the RTCA SC-236 Wireless Avionics Intra-Communications (WAIC) Committee and SWG-2 leader for WAIC Architectures and Network Services. Steve is an active member of AVSI, having previously led the effort to open the 60 GHz wireless band for use on aircraft. Steve worked for VT Miltope as Systems Architect for wireless networks and as a Chief Engineer on the Connexion by Boeing satellite broadband system project specializing in wireless connectivity –all subsequent to retiring after 30 years from Rockwell-Collins as Manager of European Special Engineering projects.

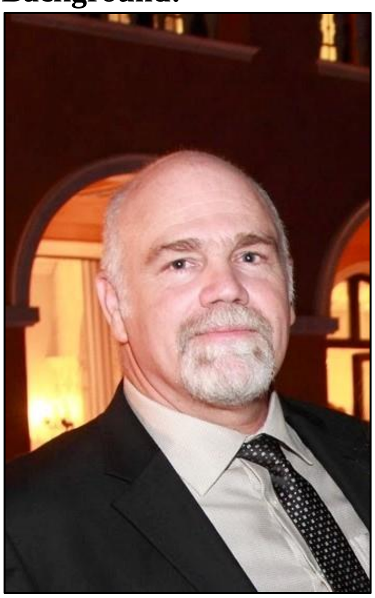
Leveraging IOT Technologies to Improve Distributed Data Acquisition for Large-Scale Integrated Tests

Chris Gibson
chris.gibson@ametek.com
425-508-0887(cell)

VTI Instruments, part of Ametek
Data Acquisition Business Development
San Diego, CA

Abstract:
Test and measurement has learned to leverage emerging technologies from the larger consumer markets to lower testing costs and improve performance. The IOT or Internet of Things world has spawned a number of new technologies necessary to make it work for the everyday consumer. One of these is a data centric middleware or connectivity framework that is now being investigated and promoted to improve capabilities for the Test and Measurement market. DDS or Data Distribution Service looks to be able to provide real work capabilities that will be able to transform test and measurement to make it truly distributed in nature. It brings several features and benefits that can be leveraged and used in both a wired sensor world or wireless sensor future.

Background:



Chris Gibson is currently employed by the Ametek Corporation supporting business development and product management activities for the data acquisition products. Chris has worked for VTI/Ametek and supported the products for over 15 years while with VTI. Prior to VTI, Chris worked for Agilent/HP Instruments supporting the structural data acquisition products now currently owned by Ametek. Chris originally started as a systems level test engineer for General Dynamics Space Systems working on testing the Atlas and Centaur as well as other misc. spacecraft projects. Chris was later transferred to Lockheed Martin Space where he continued to perform similar system level testing activities. System level testing included reverberant acoustics testing, modal testing, pyro shock separation testing, full scale spacecraft thermal cycling and misc vibration tests. Chris is currently active with the SEM Western Region Strain Gage committee and works to promote new technologies in large scale static structural and fatigue testing.

The Opportunity Space for Wireless Sensor Systems in Aircraft Platforms and Production
and
Passive Wireless Sensing Technologies – Opportunities for Aerospace

Robert Smith
robert.a.smith8@boeing.com
256-464-7116
256-508-4676 (cell)

Boeing Research & Technology
Technical Fellow
Huntsville, AL

Abstract: Wireless sensor systems for aircraft platforms and production will be explored based on Internet of Things (IoT) architectures that are being investigated for Commercial airliners and efficiency improvements in production facilities. Deployment of wireless systems is an enabler for a reduction of wires and cables for aircraft platforms which translates to simpler integration and reduced test planning and execution. Deployment in the production environment enables real time monitoring of assets for location and health and provides ubiquitous data collectors to provide meaningful data analytic solutions. The opportunity space looks at potential needs: (1) on aircraft sensor acquisition, (2) acquisition of data that is useful for aircraft ground operations and (3) sensor systems that enable production efficiencies. In addition, enabling technologies such as energy harvesting and communication protocols will be addressed.

Background:

Dr. Robert A. Smith is a Boeing Technical Fellow with more than 20 years of experience with the Boeing Company and a NextFlex Consortium Fellow. Prior to Boeing he has ten years of experience with Navy programs and as an Electrical Engineer for the Space Shuttle Solid Rocket Boosters. In his current role with the Advanced Electromechanical Technologies (AET) organization of Boeing Research and Technology, his research focus areas are optical and radio frequency remote sensing, millimeter wave sensing technology, RFID, component fabrication utilizing additive and subtractive technology for SWAP constrained platforms and advancing Flexible Hybrid Electronic (FHE) devices for Asset Tracking, Health Monitoring and Antenna applications. Robert has been the program manager and principal investigator for multiple advanced technology research projects and multiple remote sensing government contracts for Boeing Defense Systems including missile defense, international space station, satellite systems and commercial space ventures. He has 15 patents including 2 foreign patents and was the recipient of a Boeing Special Invention award in 2010.

Commercial aircraft needs for a retrofit-able wireless sensor network

Christopher Petermann **Lufthansa Technik AG**
Christopher.petermann@lht.dlh.de **Manager for Innovation and Research Projects**
+49 40 5070 60939 **Product Division Original Equipment Innovation**

Abstract: The presentation will highlight the advance from planned to predictive maintenance in the aviation industry and how it drives the need for additional data sources. Sensors in that regards are a key enabler to gain insight on the condition of systems, components and environments on board the aircraft. A lot of data is already being monitored from various systems and components but until now the focus is not on gathering the right data which is needed for predictive maintenance. Within a MRO company many years of expertise in maintaining almost every aircraft system and component are combined. This knowledge provides insight to a wide range of potential systems and components where the present degree of installed sensors does not facilitate the needed data basis for applying predictive maintenance approaches.

A main focus of the presentation is to highlight the different points of view when looking at the integration of sensors into an aircraft. From an aiframer's point of view integration sensors can be realized much more effectively during the design phase of an aircraft. This aspect is also observed by the increasing amount of additional sensors on each new aircraft generation. Lufthansa Technik on the other hand is engaged in retrofit installations, which raises a variety of very different challenges and requirements. Taking the retrofit aspect into account sensors need to be low weight, low cost, energy independent and very importantly capable to be integrated into an existing aircraft infrastructure. Passive wireless sensors (PWS) have huge potential but the aircraft is a very difficult environment for passive systems. It has to be carefully evaluated where passive sensors are beneficial compared to their active counterpart or if a hybrid approach might be the better solution.

Background:

Mr. Christopher Petermann joined the Lufthansa Technik AG (LHT) in 2016. He started working in the Foresight & Insights team within the department "Original Equipment Innovation"(OEI). OEI holds the production approval for LHT and is therefore responsible for manufacturing components for the construction of aircraft. Within OEI the Foresight & Insight Team is responsible for technology trend analysis and performing R&D projects in order to identify new products for the aviation industry. Since joining LHT Christopher started working as an innovation engineer in the research project "Cabin 4.0" which is focusing on how to implement the IoT into an aircraft cabin. Around this topic he has overseen many subprojects dealing with different technologies like WAIC, Rubee and Energy harvesting. In addition to his part taking in Cabin 4.0, in 2018 he has been named the project lead for a new research project called which engages in the development of independent retrofitable sensor system architecture for the purpose of predictive maintenance (ReSA). With ReSA, LHT looks at setting the basis for bringing additional sensors into an existing aircraft infrastructure.

Passive Wireless Sensor Needs in Oil & Gas Asset Integrity Management

John Nyholt
john.nyholt@sjcd.edu
281-4789-2739
713-594-1746 (cell)

John Nyholt Consulting, LLC
API Subcommittee for Inspection and AIM
Non-Destructive Testing Specialist
San Jacinto College

Abstract: Remote sensing technologies are used to monitor detect and monitor the onset of material damage in Oil and Gas pressure equipment, storage tanks, transportation and infrastructure. While many remote sensor technologies monitor process temperature, pressure, chemistry and other conditions that affect the life of operating equipment and structures, the vast majority of direct non-destructive testing (NDT) inspections are still performed manually by hands-on skilled technicians that require manual access to each inspection location with all of the associated safety hazards and costs. Permanently installed NDT sensors can reduce or completely eliminate inspection related safety incidents while achieving higher data reliability and repeatability. However current use of permanently installed NDT sensors for land and marine based drilling, production, storage and processing equipment are on an exception basis. This discussion will overview the challenges, barriers to success and value case for large scale implementation of wireless permanently installed wireless NDT sensors.

Background:

John Nyholt is a Non-Destructive Testing and Inspection Consultant with 39 years of NDE experience in the Petrochemical and Aerospace industries. He retired as a Non-Destructive Testing and Inspection Subject Matter Expert from BP America in 2015 after operating a Non-Destructive Testing applications laboratory for BP and the Amoco Oil Company. John currently operates an independent NDT laboratory and teaches advanced NDT at the San Jacinto College Central campus in Pasadena, Texas. The NDT lab works with industry partners for NDE application development, research and development, evaluation of new technologies and NDT technician training and qualification examination program development.

John has or has held ASNT Level III, NBIC, API-510, API-570 and AWS-CWI certifications. He is a member of the API Subcommittee for Inspection and Mechanical Integrity, serves as the API Inspection Code Master Editor, and is the API QUTE Exam Program Administrator. He also serves as the NDT Education Chairman for the Greater Houston ASNT Section.

Functionalized SAW Sensors for Chemical Sensing in Fossil Energy Applications

Paul Ohodnicki
Paul.Ohodnicki@netl.doe.gov
412-386-7389
412-973-4416(cell)

National Energy Technology Laboratory, US DOE
Materials Scientist, Technical Portfolio Lead
Materials Engineering & Manufacturing Directorate
Research & Innovation Center Pittsburgh, PA

Abstract: Emergent needs exist for advanced sensing and measurement approaches to enable a more flexible, resilient, efficient, and reliable energy infrastructure. For example, increased penetration of renewables and other distributed generation resources are placing greater burdens on conventional large-scale fossil-based generators requiring increased cycling and ramping. Improved measurement and monitoring approaches can help to maintain efficiency and long-term reliability. An abundance of low-cost natural gas made possible through unconventional resource recovery processes has also increased the demand and placed a greater burden on the natural gas infrastructure. Low-cost and ubiquitous sensing can allow for early detection of conditions that would otherwise lead to potential catastrophic failures and can also more accurately identify low-level leaks to better characterize and ultimately minimize the environmental impacts associated with methane emissions due to natural gas transport and storage. NETL Research and Innovation Center research efforts focus on enabling ubiquitous chemical sensing functionality through functionalized sensor devices targeted at key parameters relevant for monitoring of the fossil energy infrastructure including CO_2, CH_4, corrosion, water condensation, and others. An overview of relevant research efforts will be presented along with accomplishments to date, with particular emphasis placed on functionalized surface acoustic wave sensor devices and enabling technology.

Background:

Dr. Paul R. Ohodnicki, Jr. is a Materials Scientist in the Materials Engineering & Manufacturing Directorate of the National Energy Technology Laboratory. He earned undergraduate degrees in Engineering Physics and Economics from the University of Pittsburgh in 2005, and he earned masters and doctoral degrees in Materials Science and Engineering from Carnegie Mellon University in 2006 and 2008, respectively. Upon graduation, he joined PPG Industries as a Research Engineer and a Visiting Scholar where he worked on designing and scaling up large-area glass coatings for energy efficient architectural windows and concentrating solar power applications. In 2010, Paul joined the National Energy Technology Laboratory where he is currently a senior staff scientist overseeing a number of major programs focused on research and development of advanced functional materials and devices for sensors, power electronics, and energy conversion applications. He has co-authored more than 100 publications and is a co-inventor on more than 25 patent applications with 10 awarded to date. He is currently serving as vice-Chair for the Functional Materials Division of TMS and has earned a number of prestigious recognitions throughout his career, with the most recent honors including the Presidential Early Career Award in Science and Engineering (2016), the Advanced Manufacturing and Materials Innovation Award from the Carnegie Science Center (2017), and a nomination for the Samuel J. Heyman Service to America Promising Innovations Medal (2017).

Realizing Value From Passive Wireless Sensing

Dave Lafferty
Dave.lafferty@sts-global.net
+1 630 853 7625

Scientific Technical Services
President
Barker, TX

Abstract: Passive wireless sensors (PWS) have a great potential of lower operating costs, improving efficiencies and enhancing safety for oil and gas. However, realizing the value of PWS has proven to be difficult. This presentation will discuss the barriers that prevent realizing value from PWS and how to overcome those barriers. Specific use cases will be provided.

Background:

With over 40 years of experience in the oil and gas industry, David provides business development, sales support, project management and technology consulting for the oil and gas segment – with special emphasize in bringing new technologies to the oil and gas market.

Mr. Lafferty is considered a thought leader in oil and gas technology and has made over 30 presentations on IoT for oil and gas, machine learning, analytics, “drones” and blockchain. Besides technical presentations, roles included severing as conference chairman, providing key note “landscape setting” presentations and chairing discussion sessions. David has also developed an “IoT for Oil and Gas Masterclass” that provides a day long deep dive into the technology stacks of sensors, communications, big data, analytics and visualization.

Mr. Lafferty provides business development services for a number of companies including Adaptive Wireless Solutions, BSquare, CTG, Exterra Monitoring, Falkonry, Infodat, TimeLi, IoTech, IOTium, ReMuv, Sumitomo, University of Cincinnati, VisualAIM and WellAware.

David is an IoT advisor to major companies such as Intel, Apergy (Dover Automation), Yokogawa and Emerson. David also advises startups such as IoTium, WellAware and Rheidiant.

Mr. Lafferty is an ARC Associate for ARC Advisor Group and provides executive summaries for leading oil and gas technology issues. David is also an advisor to incubators such as LaunchAlas- ka and Houston Technology Center. David provides IoT advisory services for clients of Alpha Sights, Coleman and Gerson Lehrman Group Councils.

Prior to STS, David was at the BP Chief Technology Office (CTO) where he spearheaded a wide range of innovative projects including:

- Developing the “Digital Umbrella” concept and the resulting ISA100.15 effort
- Wireless Measurements systems including WirelessHART, ISA100, corrosion and passive sensors
- Predictive Analytics
- Mobility projects

David has a BS in Computer Science from the University of Wisconsin – La Crosse

Sensors for Fire and Explosion in the Waste Management Process

Mike Panfil
mike.panfil@aon.com
312-381-3970 office
312-543-6122 mobile

Aon
Managing Dir., US, Property Risk Consulting
Global Risk Consulting
Commercial Risk Solutions

Abstract: Can Passive Wireless Sensor Technology be adapted to detecting smoldering combustion (or flammable/combustible vapors) in the solid waste disposal and management industry? Fires are becoming more frequent in the waste industry. They are occurring "on-body" (in compactors, 50-yard haulers), and at waste transfer stations and Materials Recovery Facilities (MRFs). The increase in frequency of the fires is believed to be due the increase in the use and improper disposal of lithium ion batteries. Other undesirable waste includes flammable liquids and gases, including small propane cylinders and tanks. The challenge is to detect/suppress the fires before catastrophic loss of vehicles or transfer stations and MRFs without disrupting the process flow from curb to landfill.

Once at the transfer stations and MRFs, waste and recyclable materials are "tipped" from the vehicles, most often into a building, before sorting begins. The "tipping floor" piles can be 600 cubic meters in size and can be static for up to 4 or 5 days. Tipping is done at a brisk pace with smaller MRFs accepting 500 tons/day of recyclables. A large front-end loader is used to manage the pile. At times, "hot loads" are tipped into the building.

The piles can contain items that are prone to spontaneous combustion, with the pile being an ideal environment for smoldering combustion. Video footage (obscured due to dirty camera lens) of a recent fire revealed a slow growing fire. Eye witness accounts of other fires support the notion that smoldering combustion is prevalent.

On-body fires are an issue, also. These fires are only detected by human observation. Once discovered, the drivers find an "isolated" area to park the vehicle, call the fire department, and wait for their arrival to extinguish the fire.

Early detection, using PWST, of hot loads (or flammable/combustible vapors) can be done in a cost-effective manner that does not disrupt the process flow from curbside to the transfer station/MRF. There is a possible advantage of having 3D Printed Passive Wireless Sensors for lower cost and ability to provide better RF contact with some space between antennas and possible conducting material.

Background:

Mr. Mike Panfil has been working at Aon for over 29 years, providing property loss prevention advice to clients in industries ranging from waste management to commercial aviation to heavy manufacturing. He began his career with FM Global. He is a member of the Society of Fire Protection Engineers and the National Fire Protection Association.

Aluminum Nitride Enabled MEMS for Near-Zero Power Wakeup and High Temperature Capable Sensing

Benjamin Griffin **DARPA**
benjamin.griffin@darpa.mil **Microsystems Technology Office (MTO) Program Manager**

Abstract: With the proliferation of the commercial handset, the market for piezoelectric, aluminum nitride (AlN)-based MEMS is well established through bulk acoustic wave (BAW) devices such as film bulk acoustic resonators (FBARs) and solidly mounted resonators (SMRs). The maturation of this material has led to new opportunities in the application space. In this talk, I will address two such applications of AlN MEMS demonstrated by Sandia National Laboratories MEMS Technologies Department: high temperature capable MEMS and near zero power wakeup sensors.

Sandia demonstrated a MEMS material set that combined piezoelectric AlN with silicon carbide (SiC) for sensors that can withstand extreme temperatures. Piezoelectric transduction of AlN has been shown at temperatures exceeding 1000°C. SiC is a well-known high temperature capable semiconductor material. SiC and AlN are a promising material combination due to their high thermal, electrical, and mechanical strength and closely matched coefficients of thermal expansion. In this presentation, I will review Sandia's XMEMS process for AlN/SiC composite MEMS on SiC wafers for high temperature environments.

A second application space for AlN-based MEMS is in near zero power sensors. Sandia has demonstrated a passive, AlN-based MEMS accelerometer coupled to a sub-threshold, CMOS ASIC to create a near-zero power wakeup system. Resonant sensitivities as large as 490 V/g (in air) are obtained at frequencies as low as 43 Hz. Two accelerometers are coupled with the circuit to form the wakeup system which consumes only 5.25 nW before wakeup and 6.75 nW after wakeup. The system is shown to wake up to a generator signal and reject confusers in the form of other vehicles and background noise.

Background:

Dr. Benjamin Griffin received the B.S. and M.S. degrees in aerospace engineering and the Ph.D. degree in mechanical engineering from the University of Florida (UF), Gainesville, in 2003, 2006, and 2009, respectively. He was a National Science Foundation Graduate Research Fellow at UF. From 2009 to 2011, he was an Engineer with the Interdisciplinary Consulting Corporation, developing next generation sensing technology for the aerospace community. From 2011 to 2018, he was a technical staff member with the MicroElectroMechanical Systems (MEMS) Technologies department at Sandia National Laboratories, Albuquerque, NM, where he led research programs in the area of MEMS sensors, actuators and resonators with a focus on piezoelectric devices. Dr. Griffin is currently a program manager with the Defense Advanced Research Projects Agency's Microsystems Technology Office.

Sandia National Laboratories is a multimission laboratory managed and operated by National Technology & Engineering Solutions of Sandia, LLC, a wholly owned subsidiary of Honeywell International Inc., for the U.S. Department of Energy's National Nuclear Security Administration under contract DE-NA0003525.

Additive Manufacturing Approaches for Harsh Environment Telemetry

John Fraley
John.Fraley@Wolfspeed.com
479-435-2530
479-883-1130 (cell)

Wolfspeed, A Cree Company
Development Engineering Manager
Advanced Research and Development
Fayetteville, AR

Abstract: Harsh environment wireless telemetry systems are being developed for turbine component instrumentation, including F and G-class natural gas power generation systems. Turbine blades operate in a hot gas path with ever-increasing temperatures, where even the coolest portion of the blade can experience temperatures above 500 °C. Combine these temperatures with rotational velocities that result in extreme g-forces, and any type of electronics deployed to monitor the health of the turbine blades must be able to operate both upward of 500 °C and with centrifugal forces exceeding 15,000 g's. In order to build electronic systems that can survive these hellish conditions, engineers and designers are working to apply modern additive manufacturing techniques to achieve the challenging designs necessary for deployment. This talk will address some of the approaches currently being investigated in the additive manufacturing design space, as well as some of the resulting electronic components.

Background:

John Fraley graduated with Honors from the B.S.E.E program at the University of Arkansas in 2005 and is currently a lead engineer and engineering manager at Cree Fayetteville, Inc. Mr. Fraley formally joined Cree Fayetteville, Inc. in March 2006, as an engineer involved in wireless circuit design and extreme environment packaging. He has led over $8M of applied research contracts for government and industry, ranging from the development of extreme environment telemetry systems to the development advanced power electronics systems. Mr. Fraley is currently a PI on an Advanced Research Projects Agency – Energy (ARPA-E) IDEAS program, a DoE Phase II SBIR, a DoE Phase II Crosscutting Program, as well as multiple commercial contracts. Mr. Fraley was recently an invited guest speaker to the NASA Engineering Safety Council to discuss extreme environment electronic systems.

Mr. Fraley's expertise includes high temperature packaging design, low temperature and high temperature co-fired ceramic processing, high temperature materials, radio frequency circuit design, wireless telemetry system and circuit design using advanced semiconductor components, and advanced modeling software. Mr. Fraley has been a key team member in the development of a variety of extreme environment wireless electronic modules and has worked towards transitioning these technologies to manufacturing and sales. Mr. Fraley holds 15 U.S. and multiple international patents and has multiple patents pending in the field of extreme environment electronics. He has authored over 15 publications on advanced extreme environment telemetry systems.

"Tiny-but-Tough" Gallium Nitride Nanoelectronics for Extreme Harsh Environments

Debbie G. Senesky
dsenesky@stanford.edu
1-650-723-2844
Twitter: @debbiesenesky

Stanford University
Assistant Professor
Aeronautics and Astronautics
Stanford, CA

Abstract: Gallium nitride (GaN) nanoelectronics have operated at temperatures as high as 1000°C making it a viable platform for robust space-grade ("tiny-but-tough") electronics and nano-satellites. In addition, there has been a tremendous amount of research and industrial investment in GaN as it is positioned to replace silicon in the billion-dollar (USD) power electronics industry, as well as the post-Moore microelectronics universe. Furthermore, the 2014 Nobel Prize in physics was awarded for pioneering research in GaN that led to the realization of the energy-efficient blue light-emitting diode (LED). Even with these major technological breakthroughs, we have just begun the "GaN revolution." New communities are adopting this nanoelectronic platform for a multitude of emerging device applications including the following: sensing, energy harvesting, actuation, and communication. In this talk, we will review and discuss the benefits of GaN's two-dimensional electron gas (2DEG) over silicon's p-n junction for space exploration applications. In addition, we will discuss opportunities for advancement of this nanoelectronic device platform to realize future GaN-based wireless electronic systems.

Background:

Debbie G. Senesky is an Assistant Professor at Stanford University in the Aeronautics and Astronautics Department and by courtesy, the Electrical Engineering Department. In addition, she is the Principal Investigator of the EXtreme Environment Microsystems Laboratory (XLab). Her research interests include the development of nanomaterials for extreme harsh environments, high-temperature electronics, and robust instrumentation for Venus exploration. In the past, she has held positions at GE Sensing (formerly known as NovaSensor), GE Global Research Center, and Hewlett Packard. She received the B.S. degree (2001) in mechanical engineering from the University of Southern California. She received the M.S. degree (2004) and Ph.D. degree (2007) in mechanical engineering from the University of California, Berkeley. Prof. Senesky recently chaired the 2018 Women in Aerospace Symposium (WIA2018) at Stanford University. She has served on the technical program committee of the IEEE International Electron Devices Meeting (IEEE IEDM), International Conference on Solid-State Sensors, Actuators, and Microsystems (Transducers), and International Symposium on Sensor Science (I3S). She is currently the co-editor of three technical journals: IEEE Electron Device Letters, Sensors, and Micromachines. In recognition of her research, she received the Emerging Leader Abie Award from AnitaB.org in 2018, Early Faculty Career Award from the National Aeronautics and Space Administration (NASA) in 2012, Gabilan Faculty Fellowship Award in 2012, and Sloan Ph.D. Fellowship from the Alfred P. Sloan Foundation in 2004.

MesoPlasma™ Printed Instrumentation for High Temperature Applications

Jeffrey Brogan
jbrogan@mesoscribe.com
(631) 981 7081

CVD MesoScribe Technologie
355 South Technology Drive
Central Islip, NY 11722

Abstract: MesoPlasma™ Direct Write printing is an additive manufacturing process based on plasma spray technology, whereby materials are printed onto substrates or conformal components in precise patterns. The technology provides innovative product designs and solutions enabling integrated sensing, heating, and communication for applications in aerospace, satellites, power generation, and for the US Defense industry. The versatility of the process allows a wide range of materials to be deposited including metals, sensor alloys, precious metals, and ceramic dielectrics. A key advantage is the ability to fabricate sensor patterns directly onto conformal surfaces that demonstrate performance and durability in high temperature, demanding environments.

The Company's MesoPlasma™ printing technology is currently used to manufacture sensors for commercial aircraft and is being qualified for many applications requiring embedded instrumentation on flight hardware. The technology has been successfully been used to fabricate thermocouples onto high temperature gas turbine engine components for diagnostic sensing and used in scramjet combustors to monitor heat flux transients. Sensors and RF circuitry can be fabricated on a wide variety of substrate materials and component geometries. Passive wireless sensors employing printed capacitors, inductors and integrated antennas have been used to measure temperature through changes in resonant frequency.

This presentation will summarize the Company's MesoPlasma™ printing capabilities, products, and opportunities for printed, structural electronics.

Background:

Dr. Jeffrey Brogan, is the Director of Sales & Marketing for CVD Materials Corporation, a subsidiary of CVD Equipment Corporation. Jeff served as CEO of MesoScribe Technologies, Inc, and guided the Company which led to its acquisition in 2017. Jeff has been involved in the development and commercialization of advanced materials, coatings, sensors and multifunctional structures for 20 years. During his career, Jeff has held technical management, research & development and various leadership positions. Jeff has worked closely with customers and organizations within the US, Europe and Asia to develop innovative products and expand the Company's business. Jeff has managed Government programs including contracts from the US Air Force, Department of Energy, Navy and Missile Defense Agency. Jeff has been a Strategic Advisory Board member of Propulsion Instrumentation Working Group (PIWG) and has been active in a number of professional societies including ASM International. Jeff received his PhD degree in Materials Science and Engineering from Stony Brook University, Long Island, NY

Integrated Passive Antenna/Sensor Structures

Owen Mays[1]	**mays8@llnl.gov**	**(925) 422-1178**
Susana Carranza[2]	**scarranza@makelngineering.com**	**(512) 589-0718**
Joseph Tringe[1]	**tringe2@llnl.gov**	**(925) 422-7725**
Darby Makel[2]	**dmakel@makelngineering.com**	**(530) 895-2771**

[1] Lawrence Livermore National Lab, Livermore, CA
[2] Makel Engineering, Inc., Chico, CA

Abstract: One of the barriers to implementing instrumentation is the difficulty to route wires between sensors and the data acquisition systems. This is an even larger barrier when retrofitting instrumentation in existing systems. The use of wireless sensors significantly reduces the installation burden by eliminating the wires at the sensor level. MEI and LLNL have been collaborating on the development of integrated passive wireless antenna/sensor structures. Proof of concept 2D and 3D passive sensors have been fabricated, incorporating resistive and capacitive sensor elements for measurements such as temperature, pressure, strain and chemicals into the antenna structure. The passive antennas are interrogated by sweeping frequencies in the microwave range. Changes in the system (such as pressure, temperature, strain, etc.) are observed by the corresponding changes in resonant frequency of the antenna due to resistance or capacitance changes in the sensor material and captured by the reflected energy spectra.

Background:

Dr. Owen Mays is a researcher with experience in theoretical, computational, and experimental analyses of electromagnetic propagation in complex environments. His work focuses on diagnostics and sensors for dynamic events. Prior to joining LLNL his research work centered on microwave system design with an emphasis on medical diagnostic and therapeutic applications. He has extensive antenna design and experimental protocol development experience, including spearheading a study of the impact of microwave energy on human breast tissue for tumor treatment applications.

Dr. Susana Carranza joined Makel Engineering, Inc. in 1998. Dr. Carranza has lead multiple projects focused on the development of MEMS sensors for a wide range of application, from handheld devices to systems for harsh environment. Her areas of expertise include selection of materials, sensor design, packaging and sensor integration into systems.

Building Monitoring Needs for Passive Wireless Sensor Technologies

Teja Kuruganti
kurugantipv@ornl.gov
865-241-2874

Computational Sciences and Engineering Division
Oak Ridge National Laboratory
Oak Ridge, TN

Abstract: Buildings consume 74% of the electricity and 40% of the energy produced in the US.[1] Significant portion of buildings, particularly small/medium commercial buildings, have very sparse sensing technologies integrated into control of building equipment. Novel wireless sensors have the potential to reduce energy consumption in buildings by 20–30%, representing 0.3–0.4 quad in total energy savings[2], when deployed in the existing stock of small–medium-size buildings. The key challenge to address in this domain is to develop sensor technologies that are 1) low-cost to manufacture, 2) easy to commission, and 3) access to sensor data for integrating into novel control systems that optimize energy efficiency. Passive wireless sensors have the potential to address these challenges and enable applications including spatial monitoring needs, in-situ monitoring of building equipment and air distribution systems (often times at places where access to power is highly limited), and refrigeration systems (where operational temperature limits the use of battery-powered systems). In this presentation an overview of current landscape in building monitoring will be presented along with a presentation of innovative applications that Passive Wireless sensors can enable in buildings.

Background:

Dr. Teja Kuruganti is the Group Leader for Modeling and Simulation in the Computational Sciences and Engineering Division at Oak Ridge National Laboratory (ORNL), where he has worked since 2003. He currently leads ORNL activities in developing novel sensors and controls for improving energy efficiency of buildings and novel techniques for enabling grid-responsive building loads. Dr. Kuruganti is also a Joint Faculty Associate Professor in Department of Electrical Engineering and Computer Science, University of Tennessee, Knoxville. Dr. Kuruganti's R&D expertise includes modeling of communications and controls systems, wireless sensor networks, wireless modulation techniques, and novel sensor development. He won an R&D 100 award in 2012 for co-developing an electromagnetic wave propagation simulation engine for harsh environments. He earned M.S. and Ph.D. degrees in Electrical Engineering from University of Tennessee, Knoxville and a B.S. in Electronics and Communications from Osmania University. He has authored/co-authored 95+ peer-reviewed conference and journal papers and 10+ book chapters/refereed technical reports.

[1] Energy Information Administration. 2009. *Commercial Buildings Energy Consumption Survey 2009*. U.S. Department of Energy, Washington, D.C.
[2] S Katipamula, RM Underhill, JK Goddard, DJ Taasevigen, MA Piette, J Granderson, RE Brown, SM Lanzisera, T Kuruganti, *Small- and Medium-Sized Commercial Building Monitoring and Controls Needs: A Scoping Study*, PNNL-22169, Pacific Northwest National Laboratory, Richland, WA, 2012.

Nuclear Power Plant Modernization and the Advanced Use of Wireless Sensors

Stephen Lopez
slopez@epri.com
704-595-2975
704-579-7985 (cell)

Electric Power Research Institute
Senior Technical Leader
Instrumentation & Control
Charlotte, NC

Abstract: Nuclear power plants have identified equipment health and condition monitoring as one area in which significant benefits and savings can be achieved through enhanced equipment and area monitoring techniques. Wireless sensor technology offers one avenue to realize these benefits. However, there are currently limited options for industrial-grade wireless condition monitoring sensors that introduce minimal risk associated with electromagnetic and radio-frequency interference (EMI/RFI). This presentation provides the vision for modernization within the nuclear power industry including the need for various wireless sensor technologies that are commercially available to support the modernization effort.

Background:

Mr. Lopez joined EPRI in 2014 as a technical leader. During his time at EPRI, he has managed several I&C projects and helped to solve technical issues in the area of reliability, monitoring, and electromagnetic compatibility.

Before joining EPRI, Mr. Lopez worked at Bechtel Plant Machinery Incorporated in various project engineering, and project management positions. Mr. Lopez's initial nuclear experience was as a project engineer at Bechtel Plant Machinery Incorporated, where he worked on primary plant, core protection, and nuclear instrumentation systems for the U.S. Navy.

Mr. Lopez earned a Bachelor’s of Science and Master’s of Science in Electrical Engineering from UNC Charlotte and Columbia University, respectively, and a Master’s in Business Administration from Duquesne University.

Eavesdropping, Packet Inspection and Other Wireless Sensor Security Matters

Kenneth Morris
kmorris@knectiq.com
651.343.3117(cell)

CEO, KnectIQ
724 Bielenberg Drive
Woodbury, MN 55125

Abstract: Cybersecurity principles for Wireless Sensor Networks (WSN), including current threats, mitigation solutions and methodologies will be explored. Discussion will center on the challenges inherent with protecting sensor based operating technology (OT), inflight data movement, data aggregation and collection nodes, and broader WSN's using today's solutions and approaches. We will also focus on orthogonal approaches that build and maintain dynamic trusted environments in WSN's. The approaches will be addressed at three levels: (1) device authentication and authorization, (2) device and content confidentiality and (3) data integrity within the broader constraint of availability.

Background:

Mr. Ken Morris is an innovative cyber technologist and entrepreneur with deep expertise in cybersecurity, specifically focused on ICS, OT, IoT and endpoint environments. Following years as an executive with med-tech companies Boston Scientific and Guidant Corporation, Ken founded and led a number of successful companies—from an award winning strategic advisory firm, The Apercu Group, which provided strategic insight to Fortune 250 companies to KnectIQ, which brings orthogonal secrets and endpoint management cybersecurity solutions to bear on the most challenging endpoint ecosystems. Ken serves on multiple boards and frequently presents to international groups on data privacy, cryptography, cybersecurity and M2M authentication. Ken earned his Juris Doctorate with honors from Mitchell Hamline University School of Law and his undergraduate degree from Willamette University

Passive Wireless Sensing Technology (PWST) - From Research to Reality

Joe Iannotti
Iannotti@ge.com
(518) 387-6889

GE Global Research Center
Senior Principal Engineer
RF Microsystems and Sensing

Abstract: This talk will discuss some benefits of passive wireless sensing for harsh industrial applications. The talk will discuss the attractive attributes passive wireless sensors afford as well as talk about the challenges of maturing the technological and manufacturing readiness of the technology for specific industrial applications. **The Purpose** of the talk is to inform the audience of some areas where GE sees benefits from the utilization of passive wireless sensors as well as discuss the challenges and costs associated with maturing and demonstrating the robustness of system level solutions for industrial applications. Additionally we will discuss the challenges in defining and standing up a robust supply chain for long term passive wireless sensing system supply for industrial applications. **The Objectives** of the talk is to help the audience appreciate the various facets of developing and instantiating a new sensing solution for industrial applications. This includes the value proposition for various types of sensor solutions supporting, instrumentation, condition-based monitoring, and control applications and the challenges associated within each application area.

Background:

Mr. Joe Iannotti is currently a Senior Principal Engineer at GE Global Research Center in upstate New York where he has been working for the past 18 years. Prior to joining GE Joe worked for 14 years as a design engineer and engineering manager focusing on RF surveillance and Electronic Warfare systems.

While at GE Joe has participated in and led numerous multi-disciplinary efforts that have successfully transitioned into product realization. These include the development of electro-optic hardware for military avionics, improved design methods for MRI phased array surface coils and receiver systems, high power RF MEMS switch for MRI systems and most recently a Passive Torque Sensing system utilizing RF SAW strain sensing. Currently Joe is leading a government funded effort exploring the applicability of additive manufacturing to aid in the affordability of industrial passive wireless sensing.

Joe's 30 plus years of engineering experience combined with experience in forming and leading multi-disciplinary teams and his expertise in electro-magnetic modeling, RF circuit design and electronic integration methods helped tremendously in realizing the Passive Torque Measurement system.

Earlier this year Joe was awarded the 2018 GE Idelchik Award for Outstanding Technical Achievement for his work in leading the 3 year effort in completing the RF SAW Torque Sensing maturation program. Joe currently has 30 patents in the areas of RF and electro-optics, RF packaging and RF circuits and systems.

Joe's current areas of interest include proliferation of RF SAW passive sensing as well as architectures, hardware and integration methods for affordable robust passive sensing solutions as well as phased array systems for sensing and communications.

Vapor Intrusion and Groundwater Sensor Needs

Thomas A. Greene, P.E.
tom@AppliedEngineeringUSA.com
952-939-9095
Applied Engineering, Inc.
Founder and CEO
Wayzata, Minnesota

Abstract: Vapor intrusion is an urgent EPA human health concern where low-level, potentially carcinogenic, contaminants migrate through soil and into occupied buildings. Mitigation involves creating negative pressure beneath the basement floor to prevent vapors from entering the building. Economical sensors are needed to monitor pressure differentials between ambient indoor air and sub-slap air to +/- 0.25 pascals. Economical sensors are also needed to detect ambient indoor air containing perchloroethylene (PCE) to 20 ug/m3 and trichloroethylene (TCE) to 3 ug/m3. Also of interest are benzene, 1,3,5-trimethylbenzene and 2,4,6-trimethylbenzene.

Monitoring of contaminated groundwater is an ongoing EPA health concern. Initial investigations cost thousands of dollars to drill temporary soil borings to collect one-time water samples. The borings are sealed per health code requirements the same-day. To significantly increase the benefit of these temporary borings, permanent sensors are needed to be inserted into the borings prior to sealing to continuously detect contaminants; and to a lesser extent, to detect groundwater flow direction, groundwater elevation, ph, and / or temperature. Primary contaminants of concern are benzene (10 ug/L), PCE (7 ug/L), and TCE (30 ug/L). Sensors need to be able to withstand vehicular traffic running over the sealed borings.

Background:

Tom Greene is CEO of Applied Engineering, Inc. and a professional engineer licensed in the state of Minnesota providing environmental consulting services related to the investigation, cleanup and regulatory compliance associated with underground contamination since 1989; licensed monitoring well contractor; 8 years experience in the service station industry as a resale engineer for Mobil Oil Corp; 5 years experience as a Civil Engineer for the U.S. federal government; 1976 Engineering Graduate from the United States Air Force Academy.

Printed Wireless Sensors for Structural Health Monitoring

Ramaswamy Nagarajan
Ramaswamy_Nagarajan@uml.edu
+1-978-934-3454

Department of Plastics Engineering
University of Massachusetts Lowell
Lowell, MA 01854, USA

Abstract: Passive wireless detection of crack and strains in absence of clear line of sight is of prime importance for numerous applications. Wireless structural health monitoring systems based on the printable passive sensors have been developed. The first type of sensor was designed specifically to remotely detect cracks. These low-cost passive sensors are based on inductor-conductor (LC) circuits printed using low temperature-processable conductive silver inks. These sensors can be interrogated using RF. The formation of a crack on the substrate (with the printed sensor) causes the characteristic RF response of the sensor to be significantly modified. This provides the opportunity for wireless crack detection. Our research has also shown that the interrogation range of these sensors could be improved substantially by integration with an RFID system. The possibility of utilizing this novel wireless crack sensing strategy in specific applications such as detection of cracks on body armor has also been explored. The second type of sensor was designed specifically for detecting strain/displacement wirelessly. This sensor comprises a pair of printed LC circuits mounted on a substrate of interest. When the substrate is deformed, the shift in the characteristic resonance frequency is proportional to the strain of the substrate. Therefore, these sensors can be used to monitor the strain/deformation in the absence of a clear line of sight. These sensors can be printed on a variety of substrates to monitor cracks or mounted on components/structures to monitor strain/ displacement wirelessly.

Background:

Ramaswamy Nagarajan is a Professor of Plastics Engineering and the co-director of the HEROES (Harnessing Emerging Research Opportunities to Empower Soldiers) initiative at the University of Massachusetts Lowell. He has a combination of science and engineering background with bachelor degrees in chemistry and rubber technology and a doctoral degree in polymer science from the University Massachusetts. His research interest is in the development of “greener”/sustainable routes to advanced functional materials (polymers, additives and surfactants), development of sensors for detection of explosives, contaminants in water and soil as well as wireless sensors for remote structural health surveillance. Working at the interface of science and engineering his research group has been involved in translating fundamental research into engineering applications for advancing technology in new and emerging areas. He is the Co-editor of Journal of Renewable Materials and has published 55 papers in peer-reviewed journals and holds 18 U. S. patents.

Passive Wireless Strain Measurement Using an Antenna Sensor

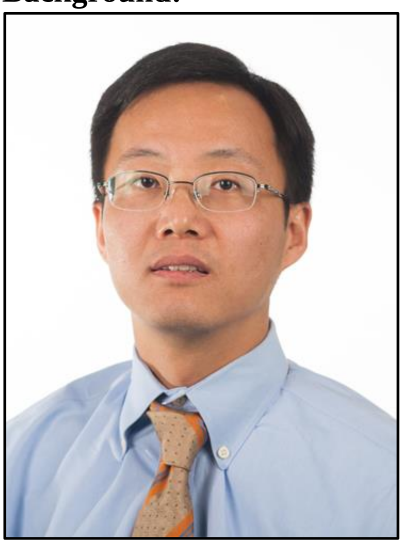
Yang Wang
yang.wang@ce.gatech.edu
Tel: (404)894-1851

Associate Professor
School of Civil and Environmental Engineering
Georgia Institute of Technology

Live Demonstration at 3:15pm – 3:40pm on Wednesday 12/12, S7-C Passive RFID

Abstract: A passive antenna sensor has been developed to wirelessly measure strain on a base structure. Bonded to the surface of a base structure, the antenna sensor deforms when the structure is under strain, causing the antenna's electromagnetic resonance frequency to change. This resonance frequency change can be wirelessly identified by an interrogation device and used to estimate the strain. In this demo, an emulated crack device is used to apply tensile strain on the antenna sensor. The crack testing device consists of three rigid aluminum plates, i.e. a base plate, a rotating top plate, and a fixed bottom plate. The fixed bottom plate is fastened to the base plate by four corner bolts. The rotating top plate is attached to the base plate by one bolt at the bottom right corner, which acts as the rotation axis. By rotating a control screw, the rotation of the top plate opens a gap between the top and bottom plates, which generates tensile strain on the antenna sensor. As strain increases, the resonance frequency change of the passive antenna sensor is wirelessly interrogated.

Background:



Dr. Yang Wang is an Associate Professor in Civil and Environmental Engineering at the Georgia Institute of Technology, where he also holds an adjunct position in Electrical and Computer Engineering. Prior to joining Georgia Tech, Dr. Wang received a Ph.D. degree in Civil Engineering and an M.S. degree in Electrical Engineering at Stanford University in 2007. His research interests include structural health monitoring, wireless and mobile sensors, structural system identification, model updating, and decentralized structural control. Dr. Wang serves as an Associate Editor for the *Structural Health Monitoring* journal and the *ASCE (American Society of Civil Engineers) Journal of Bridge Engineering*. He received an NSF Early Faculty Career Development (CAREER) Award in 2012 and a Young Investigator Award from the Air Force Office of Scientific Research (AFOSR) in 2013. In 2017, Dr. Wang received the Achenbach Medal; he was also an air force summer faculty fellow.

Miniature Batteryless Wireless Sensors

J.-C. Chiao
jcchiaouta@gmail.com
817-272-1337

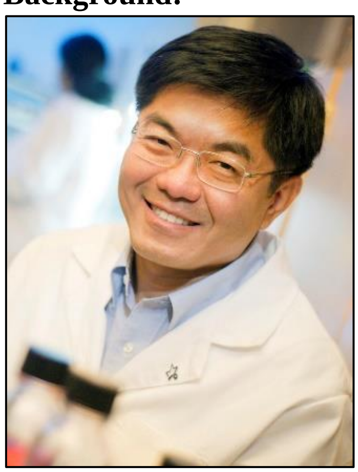
Electrical Engineering
University of Texas at Arlington
http://www.uta.edu/faculty/jcchiao/

Abstract: Mobile technologies have changed our life style significantly. Low-power electronics and miniature antennas have enabled radio frequency identification (RFID) devices for wide uses in logistics. Integrated with low-power sensing mechanisms, their functionalities empower Internet of Things, remotely-deployed, wearable and implantable sensors with network level complexity and intelligence. Quantitative and continuous documentation of physical and chemical parameters present better assessment of conditions and provide possibility of adaptive solutions and closed-loop management.

This presentation discusses the development of several batteryless wireless micro sensors and their system operation with wireless communication and energy transfer. Many are originally designed for medical applications as batteryless, wireless implants with enhancement in miniaturization and functionalization. Owing to flexible substrates and the elimination of bulky batteries, they can be implemented via endoscopic procedures without painful surgeries. These sensors are based on simple electrical and electrochemical sensing mechanisms so they can be fabricated and integrated with available semiconductor processes. Beyond clinical uses, they are readily to extend applications for monitoring environment, manufacturing and industrial processes, machine and material conditions, as well as many emerging activities.

Several examples for sensing impedance, pH, strain, dielectrics and chemicals with the batteryless and wireless methods will be presented. Some have been demonstrated in clinical and realistic settings showing feasibility for closed-loop management and capability of remote operation. These examples aim to inspire new system application ideas to address the implementation and cost challenges, and enable intelligent management of complex systems.

Background:



Dr. J.-C. Chiao is Greene professor and Garrett professor of Electrical Engineering at University of Texas – Arlington. He received his PhD at Caltech and was with Bellcore, University of Hawaii-Manoa and Chorum Technologies before he joined UT-Arlington in 2002.
Dr. Chiao has published more than 260 peer-reviewed papers and received 12 patents. He received the 2011 O'Donnell Award in Engineering presented by The Academy of Medicine, Engineering and Science of Texas. He received the Tech Titan Technology Innovator Award; Lockheed Martin Aeronautics Excellence in Engineering Teaching Award; Research in Medicine milestone award by Heroes of Healthcare; IEEE MTT Distinguished Microwave Lecturer; IEEE Region 5 Outstanding Engineering Educator and individual Achievement awards. Currently, he is an IEEE Sensors Council Distinguished Lecturer and serving as the Editor-in-Chief for Journal of Electromagnetics, RF and Microwaves in Medicine and Biology. His webpage is at http://www.uta.edu/faculty/jcchiao/

Opportunities for PWS in Aerospace Quality Bolted Assemblies

Geoffrey Grove
GeoffG@PilgrimAero.com
(401) 274-4090 x323

Pilgrim Aerospace Fasteners
President & CEO
Providence, Rhode Island

Tao Wei

Department of Electrical Engineering

Otto Greggory

Department of Chemical Engineering
University of Rhode Island
Kingston, Rhode Island 02881

Abstract: The goal of this research was to develop a cost effective RFID tag and antenna system for aerospace nuts and bolts. Specifically, we wanted to determine the feasibility of embedding radio frequency identification (RFID) tags into average-sized nuts and bolts that are used by the US Air Force, US Navy and commercial aerospace customers. The premise here was to integrate RFID tags into existing bolt and fastener designs that are compatible with current manufacturing techniques. A successful demonstration of RFID tags for identification and inventory purposes could lead to major breakthroughs in the aerospace industry by providing a fast and reliable solution for anti-counterfeiting, sorting, post-disaster identification and inventory control. Currently, the main limitation in employing commercially available RFID tags for this purpose is that the patch antenna used for off-the-shelf RFID tags is that they are too large for the average aerospace fastener. To overcome this limitation, the bolt itself was used as the antenna in our RFID tag design, making the RFID tag highly integrated, yet compact enough to function within the confines of the bolt (environment). Fundamental engineering parameters were used to simulate performance of the "bolt antenna" after integration with an off-the-shelf RF chip. The following benchmarks were used to achieve a functioning device:

- Selection of suitable off the shelf RFID scanners, chips, and tags; Develop customized electronics and software to interface with the off-the-shelf RFID scanner, and acquire data in real-time.
- Performance of commercially available RFID tags attached to different types of bolts was investigated.
- RFID tags were integrated with RFID chip and the "bolt antenna" and tested.
- Embedded RFID chip and "bolt antenna" were integrated to attain peak performance in terms of reading distance, signal-to-noise ratio, etc.

Background:

Mr. Geoffrey Grove is the President & CEO of Pilgrim Aerospace Fasteners, formerly known as Pilgrim Screw Corporation. Pilgrim Screw was established in 1932 by Geoff's grandfather Fred Sahakian. Founded as a jewelry findings manufacturer, it grew quickly into screw manufacturing. By 2000, the focus of the company was completely on the aerospace & defense industries.

Geoff received a Bachelor of Science degree in Management from Clarkson University. He serves as Technical Advisor from his company to AIA's National Aerospace Standards Committee.

Internal Radio-Frequency Instrumentation System (IRIS): RFID-Enabled Wireless Vehicle Instrumentation

Raymond S. Wagner, Ph.D.
raymond.s.wagner@nasa.gov
281-244-2428

NASA Johnson Space Center
Houston, TX

Abstract: Wireless instrumentation has long been sought for spaceflight applications, but practical implementations capable of providing the utility of wired sensors have proven elusive. The power needed to drive transmitters/receivers in traditional "active" wireless sensor radios requires either frequent battery replacement or prohibitive duty cycling. This prevents installing such sensors early in a vehicle's integration and treating them as always-on throughout its operation. "Passive" solutions such as radio frequency identification (RFID) techniques provide an appealing alternative, though most common RFID sensing approaches such as surface acoustic wave (SAW) RFID do not lend themselves easily to integrating arbitrary suites of sensors and sensor processors. In this talk we detail the design, fabrication, and evaluation of the Internal Radio-frequency Instrumentation System (IRIS), an RFID-enabled instrumentation solution that integrates an EPC Global Class 1 Generation 2 interface with processor-based wireless sensors. IRIS thermocouple sensors can operate in a low-power hibernation state with instantaneous over-the-air wakeup for nearly a decade on a small (255 mAh) coin cell battery. In their active state, they can acquire and stream 10 Hz data for more than 200 days. This allows wireless sensors to be installed and powered on early in vehicle integration and continue to operate after launch through a lengthy mission, opening the vehicle design trade space to wireless sensing in a meaningful and unprecedented way.

Background:

Raymond Wagner leads the wireless sensor network research and development program in the Avionic Systems Division at NASA-Johnson Space Center, and he is involved in related programs for development of wireless communications systems for vehicle, habitat, and surface operations. He earned a Ph.D. in electrical engineering in 2007 as an NSF Graduate Research Fellow at Rice University in Houston, Texas with a thesis concerning distributed data processing algorithms for wireless sensor networks. His research interests include RFID, passive and active wireless sensor networks, low-power embedded computing, and distributed signal processing, and he is active in standards development for international space agencies within the Consultative Committee for Space Data systems.

High Surface Area Nanostructured Films for Surface Acoustic Wave (SAW) Sensors

Tolga Aytug
aytugt@ornl.gov
865-574-6271

Senior Research Staff Member
Oak Ridge National Laboratory
Oak Ridge, TN 37830

Abstract: A key health monitoring task for power transformers includes monitoring the concentrations of certain gasses dissolved in the transformer oil, including H_2, methane (CH_4), acetylene (C_2H_2), ethylene (C_2H_4), ethane (C_2H_6), carbon monoxide (CO), and carbon dioxide (CO_2). High level concentration of these gases indicate decomposition of the transformer oil due to various fault types associated with, but not limited to, thermal or electrical issues (e.g.,oil decomposition due to high temperatures – methane and ethylene), partial discharges (hydrogen), and arcing (acetylene). In this work a dissolved gas analysis (DGA) system is being developed which utilizes surface acoustic wave (SAW) sensors incorporating unique nanostructured thin film assemblies, as high surface area scaffolds and selective sensing chemistries for the detection of gasses in the transformer's insulating oil. Our initial efforts concentrated on detection of methane, due to its common occurrence during a fault; and the fabricated SAW sensors operating at 250 MHz exhibited a 1-5 kHz frequency shift when exposed to 100% methane. However, to maximize the sensitivity, SAW devices are currently being designed to operate at 915 MHz and the results will be discussed.

Background:

Dr. Tolga Aytug, is a senior research staff member of the Chemical Sciences Division at the Oak Ridge National Laboratory (ORNL) and an Adjunct Assistant Professor at the Department of Physics and Astronomy, at The University of Tennessee, Knoxville TN. He is also a Distinguished UT-Battelle Inventor at ORNL. He received his PhD in Physics from the University of Kansas, KS. He is well experienced in the processing of advanced materials using both physical and chemical vapor deposition, and chemical solution approaches as well as advanced materials characterization and microstructure-property correlations for process optimization. His primary research interests are fabrication and characterization of thin film heterostructures, thermodynamic and kinetic effects on phase nucleation and structure formation, analysis of electromagnetic properties of materials, unique approaches for superhydrophobic coatings, development of novel nanostructured photovoltaic materials and gas sensors, radiation resistant nanocomposite dielectrics for next generation nuclear reactors, and scalable approaches for the production of highly conductive metal composites. He has authored and co-authored over 100 publications. He has given numerous invited presentations in national and international conferences and has written two book chapters. He has 14 issued and 9 more pending US patents. He has received numerous awards of excellence including 2007, 2010, 2012, 2014, and 2015 R&D100 Awards; 2008, 2010, 2017 National Federal Laboratory Consortia Excellence in Technology Transfer Awards; 2007 Southeast Federal Laboratory Consortia Award; 2008, 2009, 2014, and 2017 Oak Ridge National Laboratory Significant Event Awards; and 2014 ORNL Research Accomplishment Award; and 2006 and 2017 ORNL Excellence in Technology Transfer Awards.

Fabrication of Printed Passive Wireless Surface Acoustic Wave Sensors by Aerosol Jet System

Marissa E. Morales-Rodriguez
moralesme@ornl.gov
865-576-2625

R & D Staff
Oak Ridge National Laboratory
Tennessee, USA 37831

Abstract: Advancements in additive manufacturing techniques, printed electronics, and nanomaterials have made it possible for the cost-effective fabrication of sensors and systems. Low-cost sensors for continuous and real time monitoring of physical and chemical parameters will directly impact the energy-efficiency, safety, and manufacturing challenges of diverse technology sectors. In this paper, we present the design, printing, and characterization of a two-port surface acoustic wave (SAW) integrated on $LiNbO_3$ substrate. The aerosol jet printer was used for direct-writing of interdigitated transducers for SAW devices with center frequency in the range of 40-87 MHz. The linear response of a temperature sensor based on the SAW design shows promise for direct-writing of environmental sensors on low-temperature substrates.

Background:

Dr. Marissa E. Morales-Rodríguez was born in San Juan, Puerto Rico. She received B.S. and M.S. degrees from the Department of Chemistry of the University of Puerto Rico at Mayagüez, and Ph.D degree in energy science and engineering with entrepreneurship track from the Bredesen Center for interdisciplinary Research and Graduate Education at the University of Tennessee Knoxville.

Morales-Rodríguez is a R&D scientist with 8+ years of experience working on multidisciplinary teams of scientists and engineers to develop new sensing techniques with applications in the energy industry, environmental monitoring and homeland security. Her research focus is in the integration of additive manufacturing to develop low cost cyber sensors for energy delivery systems, technology development and commercialization. She is the author/coauthor of over 10 publications and 1 patent.

She serves as the Director-Elect for the International Society of Automation (ISA) Test and Measurement Division (1500+ members) and a member of IEEE and the American Chemical Society since 2016.

Direct Digital Manufacturing for next Generation Electrically Functional RF Structures

Kenneth Church
khc@sciperio.com
407-275-4720

nScrypt, Inc
Chairman and CEO
Orlando, Florida

Abstract: Direct Digital Manufacturing is a combination of 3D printing, printed electronics, precision milling and pick and place on a single platform. The integration of these processes allows for diverse multi-materials and features for RF applications. RF devices have fabricated using the 3D printing approach and passive antennas specifically have proven effective and efficient. The issue with using 3D printing for RF devices is at the higher frequencies and when smoothness, edge definition and good conductivity matters. 3D printing using thermoplastics leads to rough surfaces by RF standards. Printing conductive materials on the rough surfaces presents rough edges. In addition to the features, the conductive materials need to be low temperature processed materials to be compatible with the polymer materials extruded from 3D printing. This talk will provide an overview of some of the materials, overview of process and device demonstrations using the DDM approach for RF applications.

Background:

Dr. Church is the Chairman and CEO of nScrypt, Inc. nScrypt is a capital equipment company that sells micro-dispensing platforms for 3D applications. nScrypt is a spin off from Sciperio, Inc. which Dr. Church founded in 1996. Sciperio Inc. is a research company for advanced innovation. His work with nScrypt and Sciperio has been in a wide range of technical areas to include 3D printing, electronics, antennas, tissue engineering, water and sensors. He and his team have been pioneers in 3D printed electronics and including for RF applications. Funding for these efforts have come from a variety of private and government entities. Dr. Church has managed numerous R&D projects funded by the Defense Advanced Research Projects Agency (DARPA), the National Science Foundation (NSF), the U.S. Air Force, the U.S. Navy, the U.S. Army, the Department of Justice, Missile Defense Agency (MDA), National Institutes of Health (NIH) and various private institutions. He has more than 75 publications, over 100 technical presentations and more than a dozen patents or patents pending.

Laser Assisted Deposition for Metals, Ceramics and Polymers

Hervé Javice
hjavice@i-o-tech.com
+972-54-309-4985

Michael Zenou
mzenou@i-o-tech.com
+972-54-261-3636

Co-founders of I-O Tech in the high-tech-park of the Hebrew University of Jerusalem

Abstract: Additive manufacturing users are searching for a multi-material technology that can produce objects using a wide range of materials and delivering full functionalities. To this effect, a single printer has to deposit different types of materials at the voxel level. The first attempt came from inkjet based systems printing plastic materials at high resolution, in multi-color. However, multi-jet systems work best with low viscosity materials. As a result, higher viscosity metal slurries, ceramic pastes or advanced organic material are in need of a nozzle-free digital technology.

In this presentation, we will demonstrate how an innovative laser-assisted deposition system can **process multiple high-viscosity materials simultaneously at high-resolution**. This new technology opens the way to new advanced applications and the fabrication of innovative materials and metamaterials. The system will work with many materials currently on the market and will also leave great freedom to innovate to both material engineers and chemists: they will be able to create products with significantly better properties than those achievable with current 3D printing technologies.

Learning Objectives:

- Discover laser assisted deposition, a new additive manufacturing technology
- Evaluate how laser-assisted deposition can add value in manufacturing
- Understand both the potential and the limitations of the technology
- Think of new functional products that can be created

Background:

Herve Javice, co-founder & CEO, IO TECH
Photon Jet, 3D printing, co-*founder & director*; Atlas Capital, $4B fund of hedge funds, *board member*; European Corporate Equity Derivative business, Credit Suisse, *director*; Master, ESCP Europe; MBA, Harvard University.

Michael Zenou, co-founder & CTO, IO TECH. Expert in laser assisted deposition; Orbotech, *lead researcher*, designed first-in-kind copper laser-printer; Israel Nuclear Research Center, *researcher*; Electro-optics Engineer, JCT; PhD in Physics, Hebrew University of Jerusalem

Additive Manufacturing of Multilayer and Non-planar Electronics

Simon Fried
simon@nano-di.com
(650) 209-2866

Nano Dimension USA
President
https://www.nano-di.com/

Abstract: This talk will introduce the systems, materials and processes developed at Nano Dimension for additive manufacturing of electrical circuits, sensors and antennas. The use of precision 3D printing and functional inks ushers in capabilities that allow for fully additive processes to create complex multilayered electrical circuits including the full range of traditional interconnects such as blind or buried vias. Additive manufacturing also allows for new geometries and applications to be considered, ones that traditional manufacturing processes cannot make. **The Purpose** of talk is to introduce an approach taken to create a multi-material additive manufacturing process for electronics. **The Objectives** of the talk is inform and then challenge the audience to consider the implications and applications of an emerging additive manufacturing process.

Nano Dimension has developed inks, software, hardware and processes all with the purpose of using high definition inkjet printing to precisely 3D print complex multi-layer circuits. Using both conductive and dielectric inks the approach allows for rapid testing of ideas, enhanced secrecy during in-house development and a much more agile way of making PCBs, antennas, sensors as well as other types of electromechanical parts.

Background:

Mr. Simon Fried is the President of Nano Dimension USA and a co-founder of Nano Dimension Technologies. In this capacity Simon has overseen product management, beta programs, marketing and business development. This has placed him at the forefront of the challenges and opportunities presented by 3D printing electronics.

Prior to his work at Nano Dimension Simon spent several years as a strategy consultant and also founded a project consultancy as well as a single malt whiskey distillery. Previously Simon worked as an academic researcher at Oxford University applying behavioral economics to the psychology of risk and judgement.

In-Space Manufacturing (ISM) Project with an emphasis on Printed Electronics

Niki Werkheiser
Niki.werkheiser@nasa.gov
256-544-8406

NASA ISM Project, Manager
Marshall Space Flight Center (MSFC)
Huntsville, AL.

Abstract: NASA's In-Space Manufacturing (ISM) project seeks to identify, design, and implement on-demand, sustainable manufacturing solutions for fabrication, maintenance, and repair for future exploration missions. The ability to produce parts and components on-demand during missions has the potential to significantly reduce mission logistics mass, increase reliability, and mitigate risk. Current logistics operations for low earth orbit (LEO) systems, such as the ISS, rely on regular resupply missions from Earth. The ability to manufacture parts in space rather than launch them from Earth represents a fundamental shift in the current risk and logistics paradigm for human spaceflight, but one that is necessary to enable sustainable exploration missions. Given the historical incidence rates for failure of electronic components and subsystems on ISS[14], it is anticipated that a manufacturing capability for electronics will be needed to fabricate, assemble, and repair electronic parts on the long-duration missions. To date, ISM has focused on materials development activities (including development of processes for printing of metallic inks and optimization of polymer substrate printing) while concurrently identifying high-value applications through a number of functional demonstration parts, including a range of printed sensors. In Space Manufacturing Multi Material Fabrication is combining the latest leading-edge technologies in 3D printing, materials development, sensing, and flexible electronics to develop new fabrication materials and processes. Many of these new materials and processes are also being integrated into ground-based manufacturing systems to reduce cost and weight, improve functional characteristics of materials, and allow new application spaces to be developed. ISM has a capability development roadmap which incorporates next-generation materials and equipment advances to further improve our capability to manufacture the items needed for deep space exploration missions.

Background:

Ms. Niki Werkheiser is the NASA Manager for In-space Manufacturing (ISM). In this role, Niki is responsible for developing the on-demand manufacturing, repair, and recycling technologies required for sustainable, long-duration space missions. The ISM portfolio includes the 3D Printing Technology Demonstration payload on the International Space Station, which made history by being the first 3D Printer to manufacture parts in space, as well as in-space recycling, repair, printable electronics, and more. The project heavily leverages these rapidly-evolving commercial technologies here on earth for adaptation to the space environment. Ms. Werkheiser spent the majority of her career in NASA's Space Shuttle and International Space Station Programs Payload Offices where she designed, developed, integrated, and operated multiple NASA payloads. Ms. Werkheiser has a M.S. with an emphasis in Gravitational and Space Biology, as well as a B.S. in Biology and a B.A. in Russian Studies from the University of Alabama in Huntsville.

Direct Write of Non-Planar and 3D Sensors and Antenna using Optomec's Aerosol Jet Technology

Bryan Germann
bgermann@optomec.com
+1-651-200-6515

Aerosol Jet Product Manager
Optomec
2575 University Ave W Suite 135
St. Paul, MN 55114

Abstract: Printed electronics enable traditional electronic structures such as circuits, sensors, antenna and more to be manufactured additively onto existing and non-traditional substrates using metal and polymer-based inks and pastes. Most printed electronics techniques allow for 2D planar geometries to be realized with a variety of functional material sets. In contrast to current techniques, Optomec's Aerosol Jet Technology enables complex, multilayered and high performance printed electronic structures to be added to non-planar and fully three-dimensional substrates with complex surface features. Aerosol Jet is a non-contact material jetting technology with a varied material capability enabling the deposition of thin films ranging from 100 nm and up in open atmosphere and printed features as small as 10µm have been achieved. This novel printing technology is beingen widely used by both researchers and manufacturers providing novel methods of printing strain gages, gas sensors, high frequency micro-strip antenna, and fully 3D phased array antenna structures. Examples of various printed structures will be highlighted in this presentation.

Background:

Mr. Bryan Germann is responsible for Aerosol Jet product management as as well as strategic customer projects centered around volume production scale-up. Prior to joining Optomec, Bryan held the position of Senior Engineer at GE Power responsible for integrating Aerosol Jet technology for a production application printing high temperature ceramic sensor on gas turbine blades. Bryan has 13 published patents and holds a B.S. and M.S. in Mechanical Engineering from University of South Carolina.

Graphene Based Materials for Passive Wireless Sensing

Panos Datskos
Panos.Datskos@nrel.gov
303-384-7024

National Renewable Energy Laboratory
Mechanical & Thermal Eng. Sciences
National Wind Technology Center

Abstract: This talk will discuss graphene-based materials and their use in 3D printing and additive manufacturing with applications to sensors. Graphene is flat, one atom thick sheet of hexagonally-arranged carbon atoms and possesses superior material properties. The electron mobility (for a high quality) one atom thick sheet of graphene is > 10^5 cm^2 V^{-1} s^{-1}, its electrical resistivity is ~ $3x10^{-8}$ Ω m, the thermal conductivity is > 2,000 W m^{-1} K^{-1},the material strength is 19 GPa and has 2 - 3% optical absorption. There are different types of graphene related materials beyond the single carbon atom thick sheet. For example, in bilayer graphene the stacking order and orientation have a profound effect on optical and electronic properties. To date, there are a number of efforts focused on the development of graphene which can be produced by different fabrication methods. Each method can produce different quality and forms of graphene which are suitable for a variety of different device applications. Although, chemical vapor deposition (CVD) techniques can produce high quality graphene in large quantities. However, mechanically exfoliated graphene platelets, graphene flakes, graphene nanoribbons and 3D graphene structures are suitable for additive manufacturing and 3D printing.

During this talk a review will be provided of on-going graphene efforts and potential application to sensors and devices. Taking advantage of the electrical, thermal and mechanical properties of graphene based composite materials can lead to advances in sensor technology, wireless transmission, energy storage and packaging.

Background:

Dr. Panos Datskos is a Senior Research Advisor at the National Renewable Energy Laboratory (NREL). He is also a Professor at the University of Tennessee Knoxville, and an Adjunct Professor at Marquette University. At NREL he is responsible for providing scientific direction for wind manufacturing and renewable energy resilience research activities. During his tenure at ORNL he led R&D programs covering a broad range of science and technologies in nanomanufacturing, nanomaterials, MEMS and micro sensors at Oak Ridge National Laboratory. He has over 25 years of experience in scientific research and development that involve the physics of nanomaterials, micro and nanomechanical (MEMS/NEMS) systems, micro-mechanical physical and chemical sensors, the physics of electron transport and ionization in gases and liquids. His current research interests focus on nanostructured surfaces, MEMS and NEMS and involve the development of physical and chemical MEMS/NEMS sensors using microcantilevers, microcalorimetric spectroscopy, and uncooled MEMS infrared (IR) detectors. He has demonstrated leadership strengths and has led multi-disciplinary research teams, and managed research teams consisting of senior and junior technical staff, postdoctoral fellows, graduate and undergraduate students. He has received a 2000 Discover award, and seven coveted R&D 100 Awards, which is given to the 100 best technologies of the year. He has 103 open literature publications, and 127 conference proceedings and presentations, 17 issued U.S. patents and 3 pending patents applications.

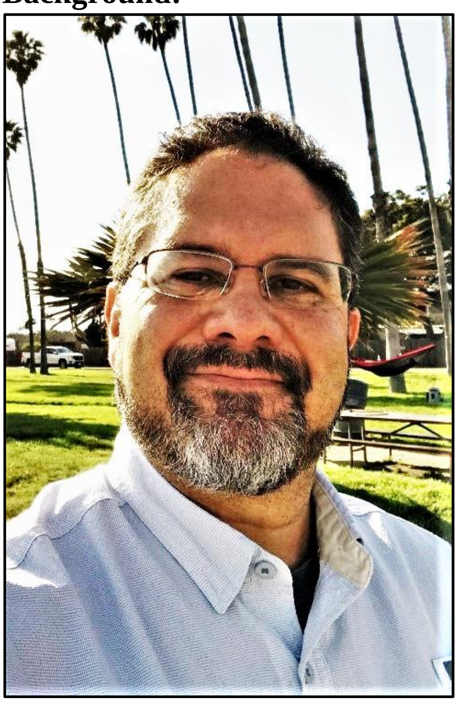
Fast, highly accurate, full-FEM Surface Acoustic Wave (SAW) simulation

Balam A. Willemsen
bwillemsen@resonant.com
805-701-0876 (cell)

Resonant, Inc.
Director, Software Engineering
Goleta, CA

Abstract: Highly accurate Finite Element Simulation of electroacoustic devices is highly desirable for the design and optimization of Surface Acoustic Wave (SAW) devices such as duplexers for commercial radio frequency and microwave devices. Over the past several years, we have developed a series of full Finite Element Analysis (FEM) tools using a hierarchical cascading approach that allows us to make these kinds of simulations very rapidly (< ~1 second per frequency point) on engineering workstation hardware. In practice when developing high-performance filters and duplexers for the cellular telephone market, many concurrent simulations are required as complex designs may include dozens of different SAW resonators to achieve a desired filtering response. In this presentation we will summarize the application of these tools to a variety of Surface Acoustic Wave devices including resonators and acoustically coupled resonator filters (CRF), sensors and a recently introduced class of bulk acoustic wave devices we call XBAR. We will also discuss how we leverage commercially available cloud computing infrastructure to handle large numbers of concurrent simulation. The web based cloud framework we have developed for his tool provides a generic framework for enabling scalability of these computationally intensive tools.

Background:



Dr. Balam A. Willemsen received the B.S. degree in physics from the University of Delaware, Newark, in 1988, and the M.S. and Ph.D. degrees in physics from Northeastern University, Boston, MA, in 1991 and 1996, respectively. From 1996 to 2010, he was employed by Superconductor Technologies Inc., Santa Barbara, CA in a wide variety of engineering and management positions. From 2011-2013 he worked at Ambient Inc., Newton MA. Since 2013 he has been employed at Resonant Inc., Santa Barbara CA most recently as Director of Software Engineering. He has authored over 40 peer-reviewed publications and is named inventor on over 30 issued U.S. Patents. His past research interests have included fundamental measurements of microwave surface impedance in HTSs and associated nonlinearities, vortex dynamics in layered superconductors, quantum chaos, electronic tunability of high-Q microwave circuits, development of novel cryogenic resonant structures, and the development of sensors for smart grid applications. His current professional interests lie in design automation and computer assisted engineering of Surface Acoustic Wave (SAW) devices.

Multiple Subcarrier Multiple Access: A Frequency Efficient, Concurrent Wireless Access Method for Backscatter Sensors

Yuki SATO
sat3@keio.jp
+81-3-3516-0620

Graduate School of Media and Governance
Keio University
5322 Endo, Fujisawa, 252-0882, JAPAN

Abstract: Backscatter communication enables wireless structural health monitoring with tiny, low cost batteryless LSI sensors. One of the challenge of backscatter communication is the concurrent data collection from multiple sensors. Existing multiple access methods such as FDMA, TDMA and CDMA, can surely achieve concurrency but demand additional performance and functionality, such as channel filter, burst transmission and transmission power control, which are difficult to be accommodated with an LSI sensor. In Multiple Subcarrier Multiple Access (MSMA), each backscatter is allocated a dedicated subcarrier to modulate sensor data realizing a pseudo FDMA. The inherent mutual interference among subcarriers and their harmonics are rejected at the receiver by sequentially producing harmonic replicas. The interference rejection allows dense subcarrier frequency allocations. Since the interference rejection is done in the waveform level, we can use either analog and digital modulations. We evaluated the interference rejection processing gain and the concurrency of MSMA in controlled propagation environment using SMA cables and indoor and outdoor propagation environment to reveal that we can achieve about 7 dB processing gain and practically zero synchronization error. The prototype backscatter sensor used in the experiments comprises of discrete electric parts including Atmel SAML MCU and Intel MAX CPLD, not LSI at this moment. The software receiver is developed with LabVIEW communications with USRP 2952R. The interference rejection performance depends on carrier to interference power ratio (CIR) which differs from subcarrier channel assignment. Since the channel assignment is a permutation problem, $O(n!)$ where n is the number of sensors, the brute force optimization is not practicable in many sensor settings. We developed a heuristics channel assignment method based on a newly introduced "contamination power" to achieve equivalent communication capacity yet requiring $O(n^2)$ examinations.

Background:

Dr. Yuki SATO has received his B.A. M.A. and Ph.D. degrees in 2012, 2013 and 2017 from Keio University, Japan, respectively. He has joined Auto-ID Laboratory Japan and started research activities on RFID and its information systems in 2009. He has received the best poster award in the 3rd International Conference on the Internet of Things, 2012. He was a postdoctoral academic visitor in Department of Communications and Networking of Aalto University, Finland, from 2017 to 2018 with Erasmus Mundus TEAM scholarship. He is now a project research associate in Graduate School of Media and Governance, Keio University. His research interests include automatic identification technologies, their information systems, RFID and wireless communications. He is also working with national and international standardization communities in the related area.

Recent Achievements in Wireless Sensing Technology in the Laboratory for Electrical Instrumentation at IMTEK - University of Freiburg

Prof Dr. Leo M. Reindl
Reindl@imtek.uni-freiburg.de
+49-761-203-7221

Head, Laboratory for Electrical Instrumentation
Department of Microsystems Engineering (IMTEK)
University of Freiburg, Germany

Abstract: The measurement technologies of the future are being enabled at IMTEK Laboratory for Electrical Instrumentation. This presentation discusses research in alternative power supply and energy-saving techniques for wireless sensors and actuator systems. In all cases, preserving the system features is essential. Concepts for alternative power supply, such as using local energy sources (Micro Energy Harvesting) from light, RF fields, local or temporal thermal gradients, or mechanical vibrations, is discussed in detail. An energy-saving wireless wake up receiver is presented which operates on a current requirement as low as 3 micro A. To increase readout range, methods are examined to eliminate the rectifier stage using (1) a passive frequency modulating device to shift the read out signal to a side band, or (2) a resonator with a high quality factor (e.g. a SAW, BAW, or a dielectric resonator) to store the energy until all environmental echoes are fade away. Examples of how this laboratory research is being applied include sensors for "Industry 4.0" (use of cyber-physical systems), indoor position sensors, inductively transmitted power to implants and high temperature wireless sensors.
IMTEK Laboratory for Electrical Instrumentation grows and multiplies experts in (1) Wireless sensors with passive Surface Acoustic Wave Components, (2) Materials for Surface Acoustic Wave Components, (3) Wireless data communication for autonomous Microsystems, (4) Energy-autonomous Microsystems, (5) Sensor Actuator Interfaces, (6) Signal processing, (7) Systems on Chip, (8) Fail-safe systems, particularly for civil protection in cases of disaster, (9) Wake Up Strategies for WSNs, and (10) Indoor Localization.

Background:

Dr. Leonhard Reindl received the Dipl. Phys. degree from the Technical University of Munich, Germany in 1985 and the Dr. sc. techn. degree from the University of Technology Vienna, Austria in 1997. Working in the surface acoustics wave group of the Siemens Corporate Technology Division in Munich, he contributed to the development of SAW convolvers, dispersive, tapped and reflective delay lines. His primary interest was in the development and application of SAW ID-tag and wireless passive SAW sensor systems. Dr. Reindl was guest professor for spread spectrum technologies and sensor techniques at the University of Linz, Austria and Professor for communication and microwave techniques at the Institute of Electrical Information Technology at the Clausthal University of Technology. In May 2003 he accepted a full professorship in the Laboratory for Electrical Instrumentation at the Department of Microsystems Engineering (IMTEK), University of Freiburg, Germany.
Leonhard Reindl is senior member of the IEEE and the German VDE. He serves as Editor-in-Chief for the Section 'Sensor Networks' of the open access journal Sensors. He also serves in key positions with the IEEE Frequency Control Symposium, IEEE Ultrasonic Symposium, Eurosensors and of the German Biannual Symposium "Sensoren und Messsysteme" and the European Security Research and Innovation Forum ESRIF.

One-on-one Sessions

The One-on-One session facilitates private discussions between those Users with potential needs for wireless technologies and the Providers of those technologies and capabilities.

Technology Providers will sign up for 10-minute time slots on a board near the registration desk ahead of the Thursday pm One-on-One Session.

PWST One-on-One Signups

			Session Start Times ->	10:50	11:00	11:10	11:20	11:30	11:40	11:50
1	S1-C1	Torres	NASA Eng & Safety Center/PWST							
2	S1-C2	Doyle	AFRL-Space Tech							
3	S1-C3	Toscano	NASA AMES - Human Systems Instr							
4	S1-D2	Willoner	Savannah River Nuclear Solutions							
5	S1-D3	Gleason	GLSEQ - Nuclear Pwr Plant Instr.							
6	S1-D4	King	NASA/MSFC-Nuclear Pwr in space							
7	S2-C1	Waldersen	NASA ARMD - flight test PWST							
8	S2-D1	Christopher	Calspan Flight Test							
9	S2-D3	Hough	TMI Orion Data Loggers							
10	S3-C1	Johnson	Northrup-Grumman-Orbital-ATK							
11	S3-C2	Sebald	ArianeGroup							
12	S3-C3	Barber	Boeing - SLS/XP30							
13	S3-C4	Soto	Sensatek							
14	S4-C1	Rines	Zodiac Systems - WAIC Req							
15	S4-C2	Gibson	Ametek/VTI - Large scalle test Instr							
16	S4-C3	Smith	Boeing - Wireless/Comm A/C							
17	S4-C4	Petermann	Luthansa Technik							
18	S4-D1	Nyholt	American Petroleum Institute							
19	S4-D2	Ohodnicki	DOE/NETL - Sensing Fossil Fuels							
20	S4-D3	Lafferty	Scientific Technical Services							
21	S4-D4	Panfil	AON Risk Solutions - Waste Collection							
22	S5-C3	Griffin	DARPA Near-Zero Power							
23	S5-D1	Kuruganti	DOE/ORNL - Bldg Sensors							
24	S5-D2	Lopez	Elect Pwr Research Institute							
25	S5-D3	Morris	KnectIQ - Secure Comm							
26	S5-D4	Ianotti	GE Global Research							
27	S5-D5	Greene	Applied Engineering , Inc							
28	S7-C1	Werkheiser	NASA/MSFC - In-Space Manufacturing							
29	S7-D1	Willemsen	Resonant - FastFEM for SAW							
30	WiSEE	Rojas	Embry-Riddle University							
31	WiSEE	Wilkerson	NASA/MSFC - Wireless R&D							

Panel for 3D Printing and Additive Manufacturing Applications for Passive Wireless Sensors

"How can 3D Printing and Additive Manufacturing expand applications for Passive Wireless Sensor Technologies?"

Scope: Passive Wireless Sensor and other Wireless Avionics Applications: Antennas, Sensors, Batteries, EMI/EMC/Radiation Shielding (electronics box cover, individual thin/light-weight shields, connector covers, wire shielding), wire traces and shielding, Re-Use, InSitu Design & Fab, InSitu Inspection/Verification, Connectors and Shielding.

1:00-2:30pm - Energy & Infrastructure Applications-Moderator:DOE/ORNL/Tim McIntyre
2:30-2:45pm - coffee break
2:45-4:15pm - Aerospace & Remote Applications – Moderator: NASA/MSFC/Curtis Hill

Schedule:
(both panels)

10 min Moderator Introduction to Topic, Questions and Panel members
40 min Panelist Talking Points
20 min Panel Discussion
20 min Audience Contributions and Q&A
5 min Moderator Summary – Panel Secretary will assist throughout the event

Tim McIntyre is a senior research staff member and Energy & Environmental Sensors Program Manager in the Electrical and Electronic Systems Research Division at Oak Ridge National Laboratory (ORNL). Tim's research activities at ORNL span >25 years and include nano-technology, optical and physical sensors, sensor networks, wireless communications, energy harvesting, and most recently, zero-power sensors. Tim's work has produced 19 inventions disclosures, resulting in 7 patents and >50 publications, proceedings and invited talks. Tim also served as the Department of Energy Liaison to the National Academy of Sciences' seminal report on industrial wireless sensor technology for energy efficient process control.

Mr. Curtis Hill is a Subject Matter Expert Sr. Materials Engineer at NASA Marshall Space Flight Center in Huntsville, AL. He is leading the technical development of advanced materials and processes for In Space Manufacturing (ISM) applications. Curtis has developed a number of advanced functional materials and processes for NASA, with numerous awarded and pending patents. His research has included the development of high-performance dielectric materials for ultracapacitors and supercapacitors for energy storage and battery replacement, as well as for printed ultracapacitors. His current work for In Space Manufacturing includes the development and implementation of a new range of passive sensors for RIFD sensing on the International Space Station and new completely flexible sensors/platforms for astronaut crew health monitoring.

Panel for 3D Printing Additive Manufacturing Applications for Passive Wireless Sensors

Invited Panelists:

	Energy and Infrastructure Applications				Aerospace and Remote Ops Applications			
	Moderator: DOE/ORNL/Tim McIntyre				Moderator: NASA/MSFC/Curtis Hill			
	Secretary: NREL/Panos Datskos Panos.Datskos@NREL.gov				Secretary: Harding Univ/ Charles Wu wu@harding.edu			
Panelist	**Last**	**First**	**Org**	**Discipline**	**Last**	**First**	**Org**	**Discipline**
User 1	Kuruganti	Teja	DOE/ORNL	Buildings	Smith	Robert	Boeing	Aerospace
User 2	Ianotti	Joe	GE Global	Energy/All GE	Johnson	Mont	Orbital/ATK	Aerospace
PWS 1	Carranza	Susana	Makel	Int sensor/ant	Malocha	Don	UCF	PSAW
PWS 2	Morales	Marissa	DOE/ORNL	PSAW	Hanson	Andrew	NIAR	Functional HW
3D/AM	Brogan	Jeff	Mesoscribe	Mesoplasma	Church	Ken	nScrypt	Direct Digital
3D/AM	Germann	Bryan	Optomec	A-jet/LENS	Tabor	Chris	USAF/AFRL	3D Print R&D
Materials	Drye	Thomas	Techner	Materials	Estrada	David	Boise State	Materials
RF	Pour	Maria	UAH	RF/Antenna	Abedi	Ali	Univ Maine	RF/Wireless
	Key Metrics to consider for Panel 1				**Key Metrics to consider for Panel 2**			
	User Needs – High Volume, Near Term payback				User Needs-Critical Aerospace, Unique Environments			
	Niche Applications: not able to be met otherwise				Niche Applications: not able to be met otherwise			
	Take advantage of COTS & IOT devices(eg phones)				Take advantage of DOD or Industry Investments			
	OEM breakthrough technologies vs applications				OEM breakthrough technologies vs applications			
	TRL – years to maturity in field				TRL – years to flight test			

Consider how to take advantage of

- WiSEE2018 & PWST Workshop relevant presentations
- NASA Printed Electronics Workshop – April 3 & 4, 2018 - Niki Werkheiser (MSFC)
- Printed Electronics USA, Santa Clara, Nov. 14-15: https://www.idtechex.com/printed-electronics-usa/show/en/
- Defense Manufacturing Conference, Nashville, TN. Dec 3-6: http://www.dmcmeeting.com/

Dr. Charles Wu was born and raised in Taichung, Taiwan. He came to Texas to purse higher education at age of 21. He completed his BS, MS and Ph.D. degrees all in Electrical Engineering, and all from University of Texas at Arlington, in 1995, 1996 and 2000, respectively. Currently, he served as Associate Professor of Engineering and faculty advisor of student branch of IEEE at Harding University. He is a member of IEEE, ASEE, AIAA and SPIE and actively involved in scientific research.

Contact:
Phone: 501-279-5118
Email: wu@harding.edu

Panel for
"Passive Wireless Sensor Applications for WAIC Consideration"

Thursday, Dec 13, Room D, 1:00PM – 2:30PM

Panel Purpose: Evaluate applications based on passive wireless sensors and how they best fit into WAIC architecture

Panel suggested topic questions:

1. What do you envision as potential use cases for passive wireless sensors on new and retrofit commercial aircraft? (Results to be applied in the assessment of WAIC system safety impacts)

2. What constraints does WAIC available spectrum (4.2.-4.4 GHz) impose on passive wireless sensors and what are the architectural and installation considerations that should be taken into account to make best use of the available spectrum?

3. System integrators will be responsible for WAIC spectrum allocation. Can passive wireless sensors be made configurable for spectrum allocation and power to match available spectrum?

4. Commercial aircraft present a significantly broader intrusion attack surface than military or space implementations of passive wireless sensors. Have mitigation approaches been considered to deal with intentional or unintentional disruption of passive wireless sensor communications?

Moderator/Organizer: **Steven Rines, Zodiac** - See Presentation S3-C1 "Wireless Avionics Intra-aircraft Communications Requirements for RTCA & ICAO Consideration"

Email your Input to: Steven.Rines@zii.aero

Background:

Steven Rines is Chair of the RTCA SC-236 Wireless Avionics Intra-Communications (WAIC) Committee and SWG-2 leader for WAIC Architectures and Network Services. Steve is an active member of AVSI, having previously led the effort to open the 60 GHz wireless band for use on aircraft. Steve worked for VT Miltope as Systems Architect for wireless networks and as a Chief Engineer on the Connexion by Boeing satellite broadband system project specializing in wireless connectivity –all subsequent to retiring after 30 years from Rockwell-Collins as Manager of European Special Engineering projects.

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