Wireless Sensor Needs Defined by SBIR Topics

Dec 5-6, 2010 JANNAF Wireless Sensors Workshop

NASA/JSC/EV/George Studor

- **SBIR Process, Roles and Opportunities**
- **NASA SBIR**
- **Other Agency Subtopics**
- **Conclusions**

SBIR Homepage: **http://www.sbir.gov/**
Links to all SBIR Homepages: **http://www.win-sbir.com/related.html**
SBIR Schedules by Agency: **http://www.win-sbir.com/schedule.html**
DOD SBIR Resource Center **http://www.dodsbir.net/**
DOD SBIR Topic Search: www.dodsbir.net/Topics/
NASA SBIR Homepage: **http://sbir.gsfc.nasa.gov/SBIR/SBIR.html**
NASA SBIR Org: http://sbir.gsfc.nasa.gov/SBIR/pgminfo.htm#office
NASA TechSource: Searchable Technologies: **http://sbir.nasa.gov/technologies**
https://ehb8.gsfc.nasa.gov/sbir/public/technologySearch/searchAction.do?requestFrom=NASASBIRHome
NASA Technology Search: **http://sbir.gsfc.nasa.gov/sbirweb/advancedsearch.jsp**
NASA Abstract Search: **http://sbir.gsfc.nasa.gov/SBIR/abstractarch.htm**
NASA SBIR Fall Conference: **Nov 8-10, Oklahoma City, OK** **http://www.sbirok.org/**
NASA SBIR Awards: **http://sbir.nasa.gov/SBIR/awards.htm**

Small Business Innovation Research (SBIR) Program

- 1982 Small Business Innovation Development Act
  - Agencies with $100M in extramural research
  - Competitively awards funding to small businesses
  - Focus on meeting governments' requirements for technology
- Annual funding ~$2.5B (venture industry $1.7B)
- Link to all SBIR Sites: http://www.acq.osd.mil/osbp/
- Participating Agencies or Departments:
  - DOD(Army, Navy, Air Force)
  - Chem & Bio Defense
  - DARPA
  - Defense Logistics Agency
  - Defense Micro-Electronics Activity(DMEA)
  - Defense Threat Reduction Agency(DTRA)
  - Missile Defense Agency(MDA)
  - National Geospacial Intelligence Agency(NGA)
  - US Special Operations Command(SOCOM)
  - Environmental Protection Agency

  Dep of Education
  Dep of Energy
  Health & Human Services
  - NIH, CDC, FDA

  Dep of Transportation
  NASA
  National Science Foundation
  Dept of Commerce (NIST)
  Dep of Agriculture
  Dep of Homeland Security

Note: The SBIR Phase I threshold has been increased from $100,000 to <u>$150,000</u> and the Phase II threshold has increased from $750,000 to <u>$1,000,000.</u>
Per notice posted to http://www.acq.osd.mil/osbp/sbir/solicitations/index.htm

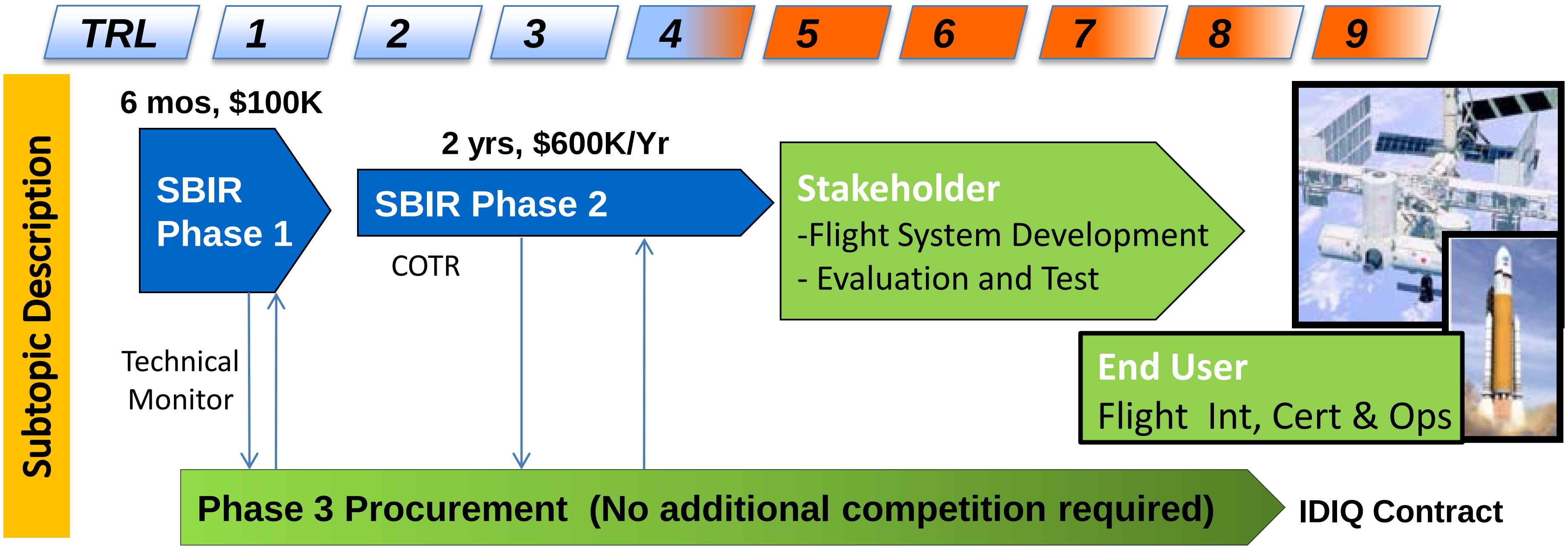
What qualifies as a small business?

- Organized for-profit U.S. small business (500 or fewer employees)
- At least 51% U.S. owned and independently operated
- Small business located in the U.S.
- P.I.'s primary employment with small business during the project

Who can partner with a small business for SBIR?

- Another small business
- University
- Large business

SBIR Big Picture



Phase 1 Technical Monitor

- Technology Vision
- Stakeholder Contacts
- Kick-off Telecon/Visit if possible
- Discuss progress informally
- Increase personal awareness of other development activities.
- Plug company into opportunities of exposure for stakeholders

Phase 2 COTR

- More involved, has more accountability than Phs I Tech Monitor
- More detailed review of deliverables and schedule
- Schedule and Technical Progress report to Contracting Officer
- Accept deliverables
- Facilitate testing of prototype with potential stakeholder
- Prepare for end of year or discretionary $ purchase of system or application test for evaluation and feedback of early prototype
- Plan for next step after delivery with stakeholder

Opportunities to Benefit from the SBIR Process

- **<u>Proposal Evaluator:</u>**
  - Can understand the details of the proposal, their company, other contacts, stakeholders and applications.
  - Insight from just one reviewer can really change the Subtopic Manager’s ranking
  - Can decide if want to volunteer as a Tech Monitor(Phase 1) or COTR for Phase II
- **<u>Technical Monitor(Phase I) or COTR(Phase II):</u>**
  - Tech Monitor in Phase 2 has earliest access to the Final Report and Phase 2 proposal
  - Tech Monitor in Phase 1 may have a better opportunity to be COTR in Phase II
  - SBIR office wants to see the evaluation of the Phase 1 Tech Monitor for the Phase II proposals
  - Provides the Quad Chart that “sells” the proposal in the ranking process.
- **<u>Participating Subtopic Manager:</u>**
  - Can see all proposals as soon as they are in the system – SBIR Electronic Handbook.
  - Start figuring out who would be good candidates for reviewing each relevant proposal.
  - Provide the Sub-Topic manager with reviewer names and justification.
  - Time to read all the proposals, Topic Manager is caught up in more of the administrative work
- **<u>Subtopic Manager:</u>**
  - Most insight, most work, most influence on priorities, most headaches
  - Be involved with the process first, participating subtopic manager preferred
  - Be a part of several groups that include technology experts in the field(s) and the potential applications
- **<u>SBIR Intra and Inter Agency “Scrounge”</u>**
  - Phase I or II projects – contact company and the COTR
  - Subtopic Solicitations – work with the subtopic manager
  - Other SBIR Forums and Reviews (eg. NASA SBIR forum, Navy annual SBIR Opportunity Forum)

Opportunities to Benefit from the SBIR Process

- **Work with the NASA Center Technology Infusion Managers**
  - **These folks job is to find avenues to commercialize what has been developed under SBIR.**

- **Be a Stakeholder or End User:**
  - **Work with SBIR Topic and Subtopic Managers to define the Subtopic Description and/or create new subtopics.**

  - **Work with proposing small businesses and/or universities(STTR) in being a part of their proposal.**

  - **Work with the already funded Phase 1 or Phase 2 projects**

  - **Partner with other Stakeholders/End Users to evaluate the options and select the best fit of past/present SBIR**

Subtopic Proposal Review & Ranking Process

- **Identify and Assign Evaluators**
  - Subtopic & Participating Subtopic Managers Review proposal abstracts ASAP to identify potential reviewers
  - Get agreement from reviewers to commit to review schedule and have no conflict of interest
  - Need at least two reviewers per proposal
  - Register and Assign Reviewers in the SBIR "Electronic Handbook"

Criteria(Subjective):
- Recognized expert in either technology or stakeholder application side and programatics
-Has a bonified interest, but is not overly vested and no conflict of interest(there is a form)
- Track record of objective and thorough SBIR proposal evaluation
- Time available/permission to participate
- EHB shows other SBIR evals he/she is committed to.

- **Subtopic Evaluation and Scoring**
  - Individual scoring meets criteria(85% rule,15pt spread)
  - Consistent with subtopic description and priorities
  - Consistent across all proposals - with help of participating subtopic managers
  - Subtopic manager sign off/quality check, sign eval

Criteria(EHB required plus justification paragraph):
- Scientific/technical merit and feasibility (50%)
- Experience, qualifications and facilities (25%)
- Effectiveness of the proposed work plan (25%)
- Commercial merit and feasibility (NASA/non-NASA)
- Resources and Commitments consistent with plan
- Recommend or Not Recommend

- **Subtopic Ranking**
  - Technical Monitors/COTRs identified and agree to prepare Quad Chart Summaries
  - Quad Charts evaluated and updated for consistency, very short presentation format, subtopic ranking, etc
  - Ranking and Quad Checked, entered into system

Criteria(Subjective):
- Volunteer, Experience, Vision, Understanding, Time
- COTR not required until announcement of award
- Objective & Considerate wording – proposers see it
- Other knowledge/**application to Funded Projects**
- Quad chart briefing in 1 to 5 minutes, graphics

NASA SBIR/STTR Organization

http://sbir.gsfc.nasa.gov/SBIR/pgminfo.htm#office

NASA SBIR/STTR Program Management Office

- Prog Exec/Selecting Official – NASA/HQ/Carl Ray
- Program Manager – AMES/Dr. Gary C. Jahns
- Technology Infusion Manager – AMES/Dr. Ryszard (Rich) Pisarski

SBIR Mission Directorate Administrative Centers:

- SOMD - ARC/Mr. Luis Mederos
- ARMD - GRC/Ms. Gynelle C. Steele
- SMD - JPL/Indrani Graczyk
- ESMD - LaRC/Robert L. Yang

Technology Infusion Managers - Replaces the old Center SBIR Office at Each Center:

AMES - Kim Hines	KSC - Joni Richards
GRC - Dean Bitler	LaRC - Kimberly Graupner
GSFC - Stephen Rinehart	DFRC – Ron Young
JPL - Carol Lewis	SSC - James Bryant
JSC - Kathryn Packard	MSFC - Lynn Garrison

SBIR 2009 Phase 2 Recommendations by Mission Directorate(MD)

Mission Directorate	Subtopics	Proposals Received		Proposals Recommended/Ranked by MD		Recommended by PMO	
		Count	Percent	Count	Percent	Count	Percent
Aeronautics Research	28	73	21%	45	18%	43	20%
Exploration Systems	37	110	32%	96	38%	71	33%
Science	43	122	36%	84	33%	75	35%
Space Operations	19	39	11%	30	12%	24	11%
Total	127	342	100%	253	100%	215	100%

63% of the Phase 2 Proposals were recommended!

http://sbir.nasa.gov/SBIR/sbir2009/phase2/awards/2009press.html -Oct. 18, 2010

FY09 DOD SBIR Annual Report

http://www.dodsbir.net/annualreport/annrpt.html

DoD Component	SBIR Budget	# Topics	# Ph I proposals	# Ph I awards	# Ph II awards
Army	265,653,000	204	3,449	334	226
Navy	332,871,000	224	3,555	414	208
Air Force	331,831,000	184	2,359	598	245
DARPA	70,426,000	45	947	288	72
DTRA	8,076,000	12	198	12	7
MDA	111,418,000	40	584	150	86
SOCOM	10,206,000	5	95	14	5
CBD	13,220,000	10	192	31	9
OSD	74,522,000	61	932	161	56
DLA	3,229,750	1	63	9	5
DMEA	907,000	3	60	6	1
NGA	499,049	0	0	0	2
All DoD	**1,222,858,799**	**789**	**12,434**	**2,017**	**922**

Example: SBIR/STTR 2009 Phase 2 Project Search

http://sbir.nasa.gov/technologies

http://sbir.gsfc.nasa.gov/sbirweb/advancedsearch.jsp

Note: At approximately $1.3M for each 2 year project… there is a lot being invested..

Note: Other agencies not listed: DOT, NIH, National labs, etc.…

Agency	Sensors	Networks	RFID	Avionics	Radio	Antennas	Total
Air Force	15	7	3	10	12	17	64
Army	12	11	9	0	8	17	57
CBD	1	1	1	0	0	0	3
DARPA	5	5	2	3	1	10	26
DHS	11	4	4	0	0	0	19
DOE	19	2	0	0	0	0	21
MDA	5	2	0	11	2	3	23
NASA	31	11	5	9	7	6	69
Navy	20	8	2	10	18	23	81
NIST	4	0	0	0	0	0	4
NSF	17	2	7	0	2	4	32
OSD	3	2	0	0	1	2	8
SOCOM	0	1	0	0	1	2	4
Total	143	56	33	43	52	84	

NASA SBIR Topics:

A1 - Aviation Safety
A2 - Fundamental Aeronautics
A3 - Airspace Systems
A4 - Aeronautics Test Technologies
A5 - Integrated System Research Project (ISRP)
O1 - Space Communications
O2 - Space Transportation
O3 - Processing and Operations
O4 - Navigation
S1 - Sensors, Detectors and Instruments
S2 - Advanced Telescope Systems
S3 - Spacecraft and Platform Subsystems
S4 - Low-Cost Small Spacecraft and Technologies
S5 - Robotic Exploration Technologies
S6 - Information Technologies

X1 - In Situ Resource Utilization
X2 - Advanced Propulsion
X3 - Life Support and Habitation Systems
X4 - Extra-Vehicular Activity Technology
X5 - Lightweight Spacecraft Materials and Structures
X6 - Autonomous Systems and Avionics
X7 - Human-Robotic Systems
X8 - High-Efficiency Space Power Systems
X9 - Entry, Descent, and Landing (EDL) Technology
X10 - Cryogenic Propellant Storage and Transfer
X11 - Exploration Crew Health Capabilities
X12 - Exploration Medical Capability
X13 - Behavioral Health and Performance
X14 - Space Human Factors and Food Systems
X15 - Space Radiation
X16 - Inflight Biological Sample Preservation and Analysis

X5.01 Subtopic Summary

X5.01 Composite Structures - Practical Monitoring and NDE for Composite Structures - SBIR 2009 Phase 1/2

Lead Center: JSC - EV/George Studor, Nathan Wells

Participating Center(s): ARC/ Ed Martinez, , LaRC /Bill Winfree, MSFC/Jimmy Miller

Orion backshell, Aries Payload fairing, and Lander struts and composite pressure vessel option, COPV and composite tankage and Habitat modules are only a few of the many weight-reducing applications for composites that need efficient and modular systems to accomplish monitoring and NDE for them to be practical. This subtopic seeks the development of technologies to detect, locate and characterize indications of a failure far enough ahead that routine actions can be taken to rectify the situation. Perform monitoring such that models can be built of event behaviors and structural response condition can be determined. Monitoring and/or NDE changes can be made with minimum cost/operations.

Performance Goals/Metrics:

Provide impending system failure indications with sufficient time to take action to reduce the risk of catastrophic failure;

- Increase the number of sensor locations per pound of monitoring weight by 50%;
- Decrease the system monitoring electronics weight by 50%;
- Decrease total wiring required for monitoring by 50%;
- Decrease the time to plan and install monitoring by 50%;
- Decrease the overall life-cycle cost per sensor by 50%;
- Decrease total data rate required from the sensor data acquisition location by 50%;
- Decrease time to perform NDE inspections by 50%;
- Decrease the expected cost of instrumentation changes/upgrades by 50%.

Technologies sought include: smart sensors, wireless passive sensors, flexible sensors for highly curved surfaces, direct-write film sensors, real-time compact NDE imagers for damage inspection, highly accurate defect and tool position determination.

Applications include: Advanced composite structures such as cryo-tanks, large area composites such as launch vehicle fairings, habitable volumes, hard to access/inspect composite members, as well as metallic pressurized structures of all kinds. Interior as well as exterior measurements of the pressure vessel are needed.

This subtopic is also a subtopic for the "Low-Cost and Reliable Access to Space (LCRATS)" topic.
Proposals to this subtopic may gain additional consideration to the extent that they effectively address the LCRATS topic (See topic O5 under the Space Operations Mission Directorate).

X5.04 Spaceflight Structural Sensor Systems and NDE - SBIR 2010 Phase 1

Lead Center: LaRC/Eric Burke, JSC/George Studor
Participating Center(s)/Participating Subtopic Managers:
LaRC /ARC/ Ed Martinez (IVHM/TPS), MSFC/Jimmy Miller(HLV),
JSC/Richard Barton(Wireless); JSC/Nathan Wells (GFE Flight Cert and Operations)

As the use of various lightweight structures and materials continues to grow for existing and transformational spaceflight applications, the need is growing for the use of practical modular structural sensors and Non-Destructive Evaluation (NDE) sensor systems for use during spaceflight missions. The subtopic will address these two areas, for which proposals to either area will be considered equally:

Spaceflight Structural Sensor Systems

Technologies sought include: modular/low mass-volume systems, stand-alone smart sensor systems that provide answers as close to the sensor as practical, Surface Acoustic Wave (SAW)-based sensors, passive wireless sensor-tags, flexible sensors for highly curved surfaces and direct-write film sensors. These systems allow for additions or changes in instrumentation late in the design/development process and enable relocation or upgrade on orbit. They reduce the complexities of standard wires and connectors and enable sensing functions in locations not normally accessible with previous technologies. They allow NASA to gain insight into performance and safety of NASA vehicles as well as commercial launchers, vehicles and payloads supporting NASA missions.

X5.04 Spaceflight Structural Sensor Systems and NDE - SBIR 2010 Phase 1

Mission Application Areas (Interior or Exterior):

(1) Add-on in-space modular sensors for:

- Commercial human-rated transportation systems
- Composite Overwrapped Pressure Vessels (COPVs) and other pressure-vessels
- International Space Station (ISS) habitable modules and exterior structure
- Inflatable habitat modules

(2) Built-in flight monitoring systems for:

- New COPV and other pressure vessels
- New manned and unmanned spacecraft
- New propulsion system tankage and transfer systems
- New heavy-lift vehicles: fairings, transition sections, engines, Thermal Protection Systems (TPS), tanks
- New transformational habitats and structures like inflatables

(3) Mobile sensor interrogation systems - robotic, wireless network or interrogation which can:

- Program and download data from smart systems without wires
- Acquire active/passive sensor-tag data
- Determine real-time position/orientation for other sensors or tools

Performance Goals/Metrics:

- Ability to establish new functionality in one of the 3 areas above, and:
- Increase number of sensor locations per pound of monitoring weight by 50%
- Decrease the system monitoring electronics weight by 50%
- Decrease total wiring required for monitoring by 50%
- Decrease the time to plan and install monitoring by 50%
- Decrease the overall life-cycle cost per sensor by 50%
- Decrease total data rate required from sensor data acquisition location by 50%
- Decrease the expected cost of instrumentation changes/upgrades by 50%

T7.01 Wireless SAW Sensor Arrays
Lead Center: KSC
Topic Manager: Robert Youngquist

Wireless surface acoustic wave (SAW) sensor arrays may have significant application in the ground processing of future spacecraft. These sensors do not require an embedded power source; instead they are powered by an RF interrogation pulse. Consequently, they have the promise of being essentially maintenance free, allowing them to be installed in normally inaccessible areas and provide environmental information for many years. In addition, as opposed to microprocessor-based transponders, SAW devices can be designed to operate from cryogenic temperatures up to about 1000 degrees C. These characteristics have resulted in interest in this technology, not only for ground processing, but recently from both the NASA research and flight centers.

The Kennedy Space Center has been supporting the development of wireless SAW sensor arrays through prior STTR activities. A new communication system has been demonstrated, namely Orthogonal Frequency Coding, that allows access to an array of SAW sensors, each with its own unique identifier. Also specific sensors have been developed to measure temperature, cryogenic level, humidity, and hydrogen under prior year funding. These are all of interest, but further development in other types of wireless SAW sensors is desired. This call requests proposals for wireless SAW sensors that can monitor, for example, pressure, strain, near-by impacts/structural acoustic events, acceleration, proximity, magnetic field, current, electric field, and hypergols (monomethyl-hydrazine or nitrogen tetroxide). This list is not exclusive and other sensors may also be of interest as well. In addition, alternative communication or multiplexing concepts are of interest, and enabling technologies, such as antenna design for SAW sensors, are welcome.

Applications for these sensors are diverse. When a vehicle is moved to the pad on a mobile launch platform strain sensors and accelerometers monitor the vehicle’s sway, pressure sensors could be placed under sprayed on foam insulation to ensure bonding integrity up to launch, moisture sensors could be used to determine if water has migrated into inaccessible areas. Electric field sensors might help with lightening warnings, chemical sensors can improve safety, and magnetic field or current sensors can monitor valve performance.

The goal is to maximize the ability to acquire information on these and other parameters while minimizing the need for cabling, maintenance, and operator labor. Wireless SAW sensor arrays appear to promote this goal.

Let's Search other Subtopic Descriptions
….and see what we find in a few minutes…

www.dodsbir.net/Topics/

Army

Proposals Accepted: December 13, 2010 - January 12, 2011
Program: SBIR
Topic Number: A11-004 (Army)
Title: **An External Pressure Data System for Rotors and Wings**
Research & Technical Areas: Air Platform
Topic Author:

Francis X. Caradonna, Phone: 650-604-5902, Fax: 650-604-5173, caradonna@merlin.arc.nasa.gov
Jacob Wilson, Phone: 650-604-2893, Fax: 650-604-5173, jwilson@merlin.arc.nasa.gov

Objective: It is required to develop and demonstrate an easily-appliable and easily-useable transducer array system for the acquisition of pressure time-histories and chordwise spatial distributions, for use on air-vehicle surfaces, especially rotors and wings.

Description: Rotorcraft fly under a huge variety of conditions, a number of which entail unpredictable airloads. As a result, the development or modification of rotorcraft is often delayed by the occurrence of unforeseen and sometimes dangerous flight anomalies, of unclear cause. Understanding these conditions is difficult without the ability to easily acquire diagnostic data that identifies aerodynamic loading sources (mainly surface pressures) – especially on wings and rotors. Similar needs also exist with wind-tunnel testing, where a major (and often prohibitive) source of cost is in the pressure instrumentation of models. The point of this solicitation is to eliminate the cost and difficulty of such measurements by developing an externally appliable pressure measurement strip with the ability to acquire and store large data quantities and to receive, respond-to and record wireless command and time-synchronization signals, thus eliminating the need for costly slipring and cabling assemblies.

Army

Proposals Accepted:	December 13, 2010 - January 12, 2011
Program:	SBIR
Topic Number:	A11-007 (Army)
Title:	**Wireless Power Transfer**
Research & Technical Areas:	Information Systems, Ground/Sea Vehicles, Electronics

Topic Author: Eric Beckel, Phone: 973.724.5024, Email: eric.beckel@us.army.mil

Acquisition Program: PEO Missiles and Space

The technology within this topic is restricted under the International Traffic in Arms Regulation (ITAR), which controls the export and import of defense-related material and services. Offerors must disclose any proposed use of foreign nationals, their country of origin, and what tasks each would accomplish in the statement of work in accordance with section 3.5.b.(7) of the solicitation.

Objective: Design, develop and demonstrate a wireless power transfer device capable of charging battery operated systems at moderate distances.

Description: Today's warfighter is reliant on small battery operated devices for communication, enemy detection, and battlefield management. As such, these devices must be recharged on a regular basis to ensure sustained operation. Current charging technologies require the device to be plugged into a charging station via a wired connection. This wired power connection requirement decreases the battlefield flexibility due to limited number of units that can be charged at one time. Additionally, the wired power connectivity increases the logistical footprint and operation complexity. Recently, advances in power transfer technology have been demonstrated that may allow batteries and other electrical systems to be charged and powered wirelessly. Researchers at Massachusetts Institute of Technology describe a method of transmitting power wirelessly through the use of resonant coils coupled magnetically. These researchers were able to power a 60W light bulb wirelessly from over 2 meters away. However, efficiency of this method was only 40%.

Army

Proposals Accepted: December 13, 2010 - January 12, 2011

Program: SBIR

Topic Number: A11-028 (Army)

Title: **Asynchronous Network Signal Sensing and Classification Techniques**

Research & Technical Areas: Information Systems, Electronics

Topic Author: Mr. Metin Ahiskali, Phone: 443-861-0521, Email: metin.ahiskali@us.army.mil
Dr. Wei Su, Phone: 443-861-0525, Email: wei.su@us.army.mil

Acquisition Program: The technology within this topic is restricted under the International Traffic in Arms Regulation (ITAR), which controls the export and import of defense-related material and services. Offerors must disclose any proposed use of foreign nationals, their country of origin, and what tasks each would accomplish in the statement of work in accordance with section 3.5.b.(7) of the solicitation.

Objective: Develop a low-cost sensor network that can perform signal sensing and automatic modulation classification (AMC) of weak signals that normally cannot be detected with traditional single sensor methods.

Description: With the emergence of software-defined radios (SDR) and cognitive radios (CR), hostile communication devices have the capability to transmit in low power, change the transmitting frequency, as well as modify the modulation format on-the-fly. To face this new challenge in a non-cooperative transmission environment (i.e., no handshake between the transmitter and receiver), an RF interceptor must sense and extract weak signals then blindly classify them. The objective of this research is to leverage the new or existing wireless sensor networks to achieve a technological breakthrough in signal sensing and automatic modulation classification (AMC) of weak signals that cannot be detected using traditional single sensor methods. Multiple, low-cost sensors are linked to a master sensor, where data fusion is implemented to artificially boost the signal-to-noise ratio (SNR) of weak signals, as well as eliminate channel distortion.

Army

Proposals Accepted: December 13, 2010 - January 12, 2011

Program: SBIR

Topic Number: A11-015 (Army)

Title: **Direct Sensing of Micro Unmanned Aerial Vehicle Lift**

Research & Technical Areas: Air Platform

Topic Author: Dr. Ed Measure, Phone: 575-678-3307, Fax: 575-678-3385, Email: ed.measure@us.army.mil

Acquisition Program:

Objective: Better dynamic measurements of lift are needed for small and micro Unmanned Aerial Systems (UAS) that maneuver in a highly cluttered near surface environment.

Description: Insects and quite likely birds are elaborately instrumented for flight. The sensors they use seem to more directly measure lift than conventional airspeed indicators. Lift depends on circulation about the wing, or more directly, upon the integrated Lamb vector over the whole surface (the Lamb vector is the vector cross product of the vorticity and the velocity). The tiny hairs or settae with which insects fliers are equipped may well measure something very similar to the above. In concert with simple neural based closed-loop systems these provide the very precise control over lift that is required for precise maneuver in gusty winds in cluttered environments. The very small and micro Unmanned Aerial Systems that aim to operate in similar environments will require control with equivalent precision. Biologically inspired measurement of wing circulation or the Lamb vector could potentially provide the sensing and control paradigms needed for more effective implementation of their flight control.

Army

Proposals Accepted:	December 13, 2010 - January 12, 2011
Program:	SBIR
Topic Number:	A11-019 (Army)
Title:	**Plasmonic Nanosensors for Chemical Warfare Agents**
Research & Technical Areas:	Chemical/Bio Defense, Sensors

Topic Author: James Parker, Phone: 919-549-4293, Fax: 919-549-4310, Email: James.kenneth.parker@us.army.mil

Objective: To develop the fundamental knowledge which is required to build a prototype sensor based on the phenomenon of localized surface plasmon resonance (LSPR) for real-time detection of chemical warfare agents (CWA) at ultralow concentrations.

Description: The U.S. Army has a need for small, portable sensors for the real-time detection of ultralow concentrations of chemical warfare agents. These sensors may be used to support chemical demilitarization efforts and provide for force protection in battlefield environments. Recent developments in the study of LSPR in metallic nanodots have shown a possible path toward greatly improved sensitivity of putative optical sensors based on metal nanoparticle arrays. LSPR, a phenomenon which occurs when light incident on metal nanoparticles induces the conduction electrons to oscillate collectively with a resonant frequency, causes nanoparticles to absorb and scatter light with an extremely high intensity. Research has shown that when molecules adsorb onto a plasmonic nanoparticle, the local electromagnetic fields around the particle can enhance the Raman scattering by as much as 1015 for a single molecule. This phenomenon, known as surface-enhanced Raman scattering (SERS), results in a highly specific and sensitive method for molecular identification. The electromagnetic enhancement in SERS results from Raman excitation and emission coupling with the nanoparticle LSPR modes. Because LSPR is tunable by changing the size and shape of the nanoparticle, sensors based on LSPR phenomenon would be ideal candidates for a complementary molecular identification platform with SERS. The objective of this SBIR effort is to develop fundamental knowledge which is required to allow for the construction of highly sensitive and selective sensors which would be able to detect a specific chemical warfare agent simulant at a vapor-phase concentration equal to or less than 0.0001 mg/m3 in a response time of less than one minute.

Chem & Bio Defense

Proposals Accepted: December 13, 2010 - January 12, 2011
Program: SBIR
Topic Number: CBD11-103 (CBD)
Title: **Improved M8 Chemical Agent Detector Paper for Facilities Monitoring**
Research & Technical Areas: Chemical/Bio Defense

Topic Author: James O. Jensen , Phone: (410) 436-5665 , Fax: (410) 436-1120 , Email: jim.jensen@us.army.mil
Janet Jensen, Phone: (410) 436-5836 , Fax: (410) 436-1120 , Email: janet.jensen@us.army.mil

Acquisition Program:

Objective: Develop improved inexpensive monitoring strips for detecting liquid chemical agents. Develop improved robustness and ease and speed of detection, without materially increasing system cost, for the monitoring of potential liquid chemical warfare (CW) contamination of fixed-site facilities.

Description: M8 Chemical Agent Detector Paper consists of a 10 cm x 6.5 cm booklet of removable sheets of detector paper packaged in a polyethylene bag used by the U.S. military to detect G- and V-nerve and H-blister agents in the field under combat conditions. …. (3) Examine methods for self-reporting that allow of low-power automatic communication of any positive interaction of the new test strips. (4) Examine development of self-reporting smart materials and other methods of transduction and communication that could lead to remote detection capabilities using the chosen material. Low cost, low-power, or no-power solutions are sought.

Air Force

AF10-BT03 - Innovative Approaches to On-Demand Cloud Computing over Ad-Hoc Wireless Networks
Government Managing Office: AFO
Government Sponsoring Office: AFO
Technology Areas: Information Systems Technology

Objective: Develop techniques, algorithms, protocols and architectures to enable on-demand cloud computing across varied tactical platforms utilizing distributed ad-hoc wireless networks.
Description: Platforms of the current generation employ monolithic, stove-piped computer architectures. These platforms have reduced effectiveness due to a lack of scalable, tactical wireless networks to support collaboration between platforms. Moreover, each platform attempts to perform its mission isolated from other platforms, unable to leverage resources from other platforms to solve war fighting problems. Innovative techniques, algorithms, protocols and architectures are sought to enable cloud computing across varied platforms. Cloud computing uses programming models, such as MapReduce, and associated implementation for processing and generating large datasets. Users specify the computation in terms of a map and a reduce function and the underlying runtime system automatically parallelizes the computation across large-scale clusters of machines, handles machine failures, and schedules inter-machine communication to make efficient use of networks and disks. ….

Cloud computing concepts and protocols should be able to:
- Support scaling of collaborative applications from 10 to at least 100 local nodes with no degradation in performance, with further capacity through tiered multiple local node groups through backbone networks;
- Seamlessly scale while specific node-to-node communications bandwidth varies by at least three orders of magnitude (e.g. 10 kbps to 10 Mbps) over just a few seconds;
- Support local collaborative applications with timeliness requirements of a few milliseconds (with allowance for increasing latency with number of hops and distance).

Air Force

AF10-BT10 Mission Prioritized Lossless Data Compression

Government Managing Office: AFO
Government Sponsoring Office: AFO
Technology Areas: Information Systems Technology

Objective: Investigate new capabilities for mission prioritized data acquisition, compression and reduced bandwidth representation for efficient and effective telemetry and processing of test and evaluation data

Description: The test and evaluation (T&E) mission in complex test facilities such as wind tunnels, flight tests or anechoic chambers results in large amounts of data collection, transmission and transfer due to the numbers and complexity of sensors. Restrictions and limitations on human capacity to review large amounts of data and on transmission bandwidth can adversely impact the ability to collect and process all pertinent sensed information in a timely and accurate manner.

Discovery of fast and efficient methods to assist engineers in identifying which data is critical to review during or after a test is crucial for assessing flight/test safety, test hardware integrity, and achievement of test objectives. Often, a terabyte or more of data is collected during a test, which must be examined in a prioritized way to make timely programmatic decisions.

In addition, current practices employ data compression techniques on single sensor data sources without regard to intended use of the data or to correlations between co-located or nearly co-located sensors. New research indicates it may be possible to combine low-rate sampling with computational power for efficient and accurate signal acquisition, referred to as compressive sampling or compressed sensing. Furthermore, advances in computational abilities and algorithms now allow for consideration of compression and fusion of data to greatly reduce required transmission bandwidths, particularly when the compression is accomplished to optimize the inference requirement of the mission. For bandwidth reduction methods that employ data fusion via algorithmic and computational approaches, intelligent use of metadata and/or knowledge of user requirements combined with cognitive communication processes can also advance existing capabilities.
Contributions are sought to significantly advance the through-put and efficiency of collection of large amounts of useful data through novel, mission prioritized data acquisition and compression capabilities, without loss of signal integrity.

Potential topics for consideration include, but are not limited to, the following:
- Algorithm development or improvement allowing for user-defined prioritization of lossless data compression or extraction
- Computational methods that assist in mission prioritized data collection, transmission or transfer
- Development of machine learning methods to reduce total data collection
- Investigation into compressed sensing techniques applicable for very large data collections

Air Force

AF103-155 Passive, Wireless Sensors for Extreme Turbine Conditions
Government Managing Office: Materials & Manufacturing
Government Sponsoring Office: Materials & Manufacturing
Technology Areas: Materials / Processes

Objective: Develop and demonstrate improved wireless sensor materials and concepts that can be used for >2,300°F applications.

Description: The Air Force Research Laboratory (AFRL) is seeking new and novel sensor capabilities that will enable the measurement of system environmental conditions as an input parameter to life prediction models of critical engine components and for the detection of in situ damage. Engine health monitoring (EHM) sensor capabilities are needed to monitor the health of aircraft structures, avionics, turbine engines and other subsystems[1]. To be of value for long-term EHM applications, the sensors need to have self- calibration capability, high reliability, fast response, low sensor drift, and high accuracy. … wireless temperature measurements on a low-pressure turbine blade is the primary target of this effort.

Phase I: Demonstrate a passive, wireless high-temperature device at a minimum of 2,300°F (1,260°C) in a laboratory environment.

Phase II: Demonstrate and test mature materials and sensor electronics. Demonstrate accurate temperature measurements using RF wireless sensors conformally fabricated onto actual commercially available low-pressure turbine blade at temperatures of at least 2,300°F.

Phase III and Dual Use Applications:
Military Application: Wireless, passive high-temperature sensors, and minimal sensor drift coupled with reliable attachment methodologies is a pervasive technology that can be used in high-temperature military systems.

Air Force

AF103-214: Real-Time Health Monitoring for Solid Rocket Motors

Government Managing Office: Propulsion West

Government Sponsoring Office: AFNWC

Technology Areas: Sensors, Electronics, and Electronic Warfare

Objective: Development of innovative systems to allow real-time health monitoring of solid rocket motors assessing both the current and future state.

Description: The current methodology for monitoring the health of solid rocket motors (SRMs) is to launch or dissect a few missiles a year looking for anomalies. The current system not only expends limited, and oftentimes expensive assets, it also presents two opposing risks: first, there is the risk of failing to detect defects in a population due to statistical sampling; second, a single flawed motor could lead to the destruction of an entire SRM fleet. A new monitoring system, which could be embedded into future systems or a non-invasive technique for monitoring the current system, has the potential payoff to "save as much as 50% in costs over a 50-year life cycle."2 Non-invasive techniques are currently used during the manufacturing process (e.g. computed tomography, ultrasound, and eddy current) for quality control purposes. However, they are rarely used in a fielded system to attempt to monitor the overall health of the system due to the time-consuming nature and cost of transporting the motor back to the Depot. Embedded or non-invasive sensors outfitted on an SRM have the potential to analyze both the mechanical and chemical state. Aging studies have shown that certain chemical reactions in combination with diffusion of species through the propellant-liner-insulator bondline have led to premature failures. Chemical aging models have improved significantly but in order to take full advantage of them real-time motor data is needed. Innovations are sought to gather critical data without affecting the integrity of the asset. Research areas may include but are not limited to chemical sensors, improved/miniaturized non-destructive techniques, embedded/external sensors with wireless/wired communication. These capabilities will enable the real-time health management of SRMs and the accurate prediction of usable lifetime. Creative solutions that address the topic and have a strong backing in engineering principles; previous research and development; scientific literature; and cost analysis are highly sought after.

Phase I: Demonstrate feasibility of an innovative technology that can acquire information to determine the current and future state of a SRMs health. The solution will improve monitoring of the current and future system over current capabilities and evaluate the technology for its affordability/usability.

Phase II: Develop and fabricate an initial brass board/prototype to accomplish the aforementioned goals. Validate and verify the technology on a sub-scale SRM or analog, at a minimum, in environments relevant to a deployed asset. This effort shall clearly resolve the link between actual measurement and the state of the SRM and detail the performance and cost payoff of this technology.

Phase III Dual Use Applications:

Military Application: Current and future ballistic missile and space launch applications, supporting the prediction of service life for all SRMs.

Commercial Application: Space-launch, successful identification of a degraded SRM could potentially avoid a catastrophe saving millions of dollars worth of commercial payload equipment.

Air Force

AF103-201 Wireless Sensor Network powered by Energy Harvesting Solution Network
Government Managing Office: Propulsion
Government Sponsoring Office: Joint Strike Fighter
Technology Areas: Sensors, Electronics, and Electronic Warfare
Objective: Develop wireless sensor devices powered by energy harvesting technologies from vibratory and thermal gradient energy sources and/or Radio Frequency (RF) in a distributed control system

Description: USAF is currently developing a distributed engine control system (DCS) to eliminate Full Authority Digital Engine controls (FADEC) cooling requirement and mitigate obsolescence, and improve reliability and robustness. The typical minimum operating rage for introduction into a FADEC and sensors require an operating range of -55 to 125 degrees Celsius. However, it is desired to extend this range up to 225 degrees Celsius. Ideally, a sensor capable of a wider operating range would be desirable as the move to mount electronics on the core of the engine becomes a feature discriminator. DCS offers modularity, improved control system prognostics, and fault tolerance, along with reducing the impact of hardware obsolescence. Distributed control (DC) is the Air Force strategy that enables flexible multiple control nodes while potentially reducing the system's installed cost. In the DCS of the future, networked sensor and actuator-based solutions will be used for controls and engine health management. Wireless technology may be applied increasingly in control systems to reduce weight and cost and provide extensibility to existing systems without having to carry out significant modifications.
Wireless networks can bring control systems additional advantages, such as flexibility and feasibility of network deployment at low costs, while it also raises some new challenges. This has been enabled by the availability, particularly in recent years, of sensors that are smaller, cheaper, and intelligent. These sensors are equipped with wireless interfaces which may communicate with one another to form an adaptable network.

A typical engine environment is around 177 °C. It is expected that energy solution can provide a typical voltage output is ~ 5V @ DeltaT = 60 °C, and the Power Output = 80mW @ DeltaT = 60 °C. A minimum of 300 microWatt is desired for the wireless sensors. While these technologies can harvest useful energy, they share the common problem of being reliant on ambient sources generally beyond their control. Solar requires light, vibration requires motion, and thermal requires a heat source. Radio frequency energy may also be harvested from the environment adequately to provide a power store for a wireless sensor network .

AF103-201 Wireless Sensor Network powered by Energy Harvesting Solution Network (Continued)

A wireless power solution based on RF energy transfer overcomes this lack of controllability because power can be replenished when desired. Various techniques can be used for RF energy transfer, the most simple being an inductively coupled system, which works at radio frequencies. The RF is received by an antenna and converted into a rectified signal which can power sensor(s) and/or low power electronic circuits. The impact for wireless sensors is profound. Instead of design and operational constraints for maximizing battery life, devices can be recharged with energy repeatedly and perpetually, enabling greater functionality and more frequent use. Wireless data acquisition system design requires the ability to extract usable amounts of electrical energy from vibratory and thermal gradient energy sources and / or RF energy transfer techniques. This is a critical technology as the use of wire supplied power supply negates any advantage of the wireless approach. Isolated electronic devices must be able to be self – sustainable and “harvest” (and to some extent store) sufficient power with which to operate. WSN will be able to transmit senor data to the FADEC on a periodic basis.

Phase I: Develop requirements and plan for a multiple source (vibratory, thermal, and/or RF) wireless sensors powered by energy harvesting solution which enables a wireless sensor network to be implemented within a distributed control system.

Phase II: Fabricate and test a prototype of the smart wireless distributed sensor node powered by energy harvesting system and Demonstrate the feasibility of a WSN powered by an energy harvesting technique on a control system bench. Packaging and protection should be considered for EMI, lightning, and temperature.

Phase III Dual Use Applications:
Military Application: The device must be able to be incorporated into a FADEC to be transitioned to commercial production for dual use applications.
Commercial Application: This technology has wide applicability to commercial gas turbine engines for aircraft and also for improving performance and maintainability of industrial gas turbine engines in remote areas.

Air Force

AF08-BT01 Autonomous Nonbattery Wireless Strain Gage for Structural Health Testing and Monitoring in Extreme Environments

Government Managing Office: AFO

Government Sponsoring Office: AFO

Technology Areas: Air Platforms

Objective: Develop a passive, conformal RF device capable of sensing and transmitting wide bandwidth strain or structural health monitoring data at service temperatures ranging from -60C to +300C.

Description: This topic seeks novel concepts for a passive, conformal sensor that can transmit high-bandwidth data from extreme environments at temperatures ranging from -60C to +300C and accelerations levels up to 56600g. The sensor should be easily installed with no permanent changes to the component or surface upon which it is installed. The sensor must be sufficiently small and conformal to avoid disrupting aerodynamic flows. Situations arise with structural testing or structural health monitoring of aerospace components operating in extreme environments (jet engine fan and compressor blades, aircraft propellers, helicopter blades, transmission parts) where a passive sensor capable of transmitting high-bandwidth sensor data is needed. A common method of structural testing or structural health monitoring is to install sensors and wire them to a data collection system. For example, strain and shear are sensed with this technique. However, wired sensors are generally limited to temperate environments and stationary structures. In more difficult test environments, either a wired sensor cannot be installed or the sensor and its wires are expensive to install and short-lived. Further, powering a sensor with batteries is usually impractical and sometimes impossible, so a passive sensor is necessary. Bulky wireless data relay devices are available to condition and transmit sensor data, but they cannot be used in harsh environments, extreme temperatures, tight spaces, or fast-moving structures, and the sensors still need to be wired to the data relay.

Phase I: Determine technical feasibility and an approach for the RF device. Feasibility must be addressed for operating temperature, strain sensing, high-rate data transmission, operation of multiple sensors on the same test article, and sensor size.

Phase II: Fabricate and demonstrate the operation of a number of passive, conformal RF devices on a high speed, high temperature aerospace component. The operating environment includes temperatures up to 300C and acceleration forces up to 56600g.

Air Force

AF093-070 Miniaturized Satellite Development for Responsive Space Missions

Government Managing Office: Space Vehicles

Government Sponsoring Office: Space & Missile Systems Center

Technology Areas: Space Platforms

Objective: Develop satellite technologies that increase capability, reliability, and responsiveness while reducing size. The goal of this solicitation is to develop smaller satellite components and satellites with capabilities of current larger satellites through the use of miniaturization technologies.

Description: The Department of Defense (DoD) is actively pursuing the capability to assemble and launch a satellite within days, or even hours, of a battlefield commander''s notification. This capability is essential to meet the operational needs for a variety of responsive space missions. Enabling technologies to achieve this goal for Operationally Responsive Space (ORS) is miniaturization of the various satellite systems and components while increasing capability by a minimum of 40%. Smaller satellites are easier to store, integrate, and launch. In addition, smaller satellites are generally less expensive and can be easily duplicated to support multiple mission needs; defining the objective of this solicitation.

The ORS Office is pursuing the development of miniaturized satellite systems to include, but not limited to: standardized payload configurations, compact sensors, compact bus systems, miniaturized communication components, and flexible operations schemes. It is necessary to investigate creative solutions to avoid the need to develop custom hardware, software, and interfaces. The ORS Office will also consider novel modification endeavors to existing commercial-off-the-shelf (COTS) components to meet the needs of this solicitation.

Phase I: Design, fabricate, and test a proof-of-concept or feasibility design for your proposed satellite miniaturization technology. Utilize test results to identify key technical challenges, develop a mitigation strategy, and to develop the Phase II program plan.

Phase II: Design, fabricate, and test a prototype-level concept that achieves the functional and interface specifications of the ORS Officeï¿½s mission areas. Develop and demonstrate a 10x cost reduction for small satellite fabrication, assembly, and checkout through the use of miniaturization technology.

Navy
SBIR 2010.1

N101-095 TITLE: Distributed Sensor Network for Structural Health Monitoring of Ships

Subtopic Manager: ONR - Mrs. Tracy Frost - tracy.frost1@navy.mil

TECHNOLOGY AREAS: Air Platform, Ground/Sea Vehicles, Materials/Processes

OBJECTIVE: To develop a distributed network of sensors for load monitoring of ship structures. The target attributes of the system are outlined below, but in general the system should be reliable and durable in a sea environment, capable of monitoring a minimum span of 400 ft, the sensors should have a small footprint so as to be cost effective and non-intrusive, with good dynamic range and sensitive, reconfigurable, adaptive and scalable up to 500 sensors, with good frequency response. Other attributes include EMI resistance and have minimal wiring and maintenance requirements (no batteries, no switches).

DESCRIPTION: A highly reliable, non-intrusive system for monitoring loads in Naval structures (ships and submarines) as well as next generation weapon systems is critically needed. Strain monitoring is a proven method for assessing the performance of a structure and for determining the remaining fatigue life left on the structure. However, present strain monitoring systems suffer from various limitations. The sensors need two or four wire leads to pick up the signal, the sensors and wire leads have to be heavily shielded to minimize EMI, each sensor needs a pre-amplifier and signal conditioner nearby, and two more wire leads are required for each amplifier as well as powering. These limitations make current technologies intrusive, cumbersome, heavy, susceptible to EMI, overly complicated and with many failure points. New and promising technologies are being sought that might address these issues. Techniques that use fiber optic sensors or wireless MEMS sensor nodes are two examples that could offer the opportunity to overcome all these limitations. Overall objectives for this program are simplicity, reliability, scalability and affordability.

N101-095 TITLE:
Distributed Sensor Network for Structural Health Monitoring of Ships (Continued)

PHASE I: During the phase I the contractor will demonstrate the ability to monitor strains in a loaded aluminum or steel panel by using the advanced distributed sensor concept. The system will have a minimum of 50 sensors and monitor a large aluminum or steel cantilever with a proof mass producing a 10 Hz resonance. The software development component for the Phase I will be limited to data acquisition and display of the strain data in a pictorial manner. Some of the target system parameters are: system reliability (this includes the sensor, the signal and the attachment method = 10 years in a sea environment); small footprint size (= 1 cm2), weight (= 1 gram), and cost (cents); large dynamic range (=± 5,000 microstrain); with good sensitive (1 microstrain or better); good frequency response (up top a 200 Hz); large range (around 400 feet); minimum maintenance requirements (no batteries, no switches).

PHASE II: During the Phase II the contractor will develop all the necessary components for a standalone unit capable of monitoring 500 sensors for loads monitoring. The system will be dynamically reconfigurable, adaptive, have a small foot print and be capable of self diagnosing. By dynamically reconfigurable it is meant that the system should be able to reconfigure itself so as to monitor a fraction of the 500 sensors with higher fidelity when appropriate. By adaptive it is meant that as the region of interest shifts from one location to another, the system should be capable of quickly adapting to that new circumstance. By stand alone it is meant that the system will collect, analyze, compress and store the entire strain state and strain history of the ship hull for a specified period of time. By self diagnosing it is meant that the system can identify those sensors that are providing faulty information so that they can be removed. One of the main components of this effort during the Phase II will be software development. The software should be able to adjust the sampling rates in response to the structural behavior, compress or reduce the massive amounts of data to a meaningful set of parameters, be able to reconstruct the strain history from that set, store and display the data.

Conclusion

- JANNAF Organizations have many common needs for wireless sensors as demonstrated by SBIR solicitations.
- Other SBIR/STTR participating agencies can be expected to have common needs as expressed in their solicitations.
- Many millions $ are being invested in SBIR/STTR technology projects that also have common outcomes.

- Long need seems to be for a multi-agency group to look at overlapping wireless sensor needs and technology projects.
- Perhaps a first step is to start pathfinder activity kicked off in a multi-agency supported Passive Wireless Sensor Workshop.