Draper Laboratory

Call for Abstracts (CFA)

University Research & Development (URAD) Program

Draper Fiscal Year 2011 (DFY11)

CFA Issued: February 26, 2010

Abstracts Due: March 12, 2010

Period of Performance: July 3, 2010 – June 25, 2011

Abstracts sought in the following areas:

Precision Navigation & Timing
Strategic & Space Guidance, Navigation & Control Systems
Tactical Guidance, Navigation & Control Systems
Miniature, Low-Power Systems
Autonomous Systems
Information & Decision Systems
Complex Reliable Systems
Biomedical & Chemical Systems
Secure Networks & Communications
Advanced / Future Technology
Strategic Systems
Special Operations
Tactical Systems
Space Systems
Biomedical Systems
Geospatial Systems
Energy Solutions

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Introduction

The primary mission of the Charles Stark Draper Laboratory, Inc (Draper) is to solve our nation's hardest problems. To accomplish this mission, we maintain a strong commitment to advanced research and development, which helps us to bring new technical solutions to our customers. Another aspect of our mission is to support advanced technical education. Draper's Internal Research & Development (IRAD) program is used to develop the technologies and capabilities that best position Draper to compete for future sponsored work. Our University Research and Development (URAD) program is a specific subset of our overall IRAD program, and is designed to bring University researchers and Draper developers together to explore new areas of technology advancement. URAD funding to University teams is intended to serve a variety of possible outcomes:

(a) Exploring the feasibility of a new technology concept for possible further development at Draper, at the University, or by some team of Draper and University;
(b) Maturing a particular technology or concept sufficiently to enable capture of external sponsor funds for further development or implementation by the Draper-University team;
(c) Engaging skills, capabilities, or technologies at the University which partner synergistically with Draper skills within the context of a larger program of internal and external development.

New this year

Those familiar with the Draper URAD program will note several changes this year.

1) Abstract-only submission: This year only a basic abstract will be required for the initial selection process. Full, formal cost proposals will only be needed after a research concept has been selected for award. This is intended to simplify the process.
2) Potential for multiple-year awards: Starting this year, we will consider selecting projects for award that are known to be multi-year projects. In cases where a multi-year commitment is made, there will be key milestones, "gates" or "decision points" used at key points in the schedule to approve the next increment of funding. Therefore those projects selected for a multi-year award will have to design their project for incremental funding and prepare the final formal proposal accordingly.
3) Discussions with Draper staff required: Prior to submitting an abstract to this call, PIs must contact the Draper point of contact listed in the relevant topic area to discuss the potential project and to develop initial alignment with Draper near- and long-term goals and objectives. This is intended to provide you an opportunity to check if your project idea is well aligned with Draper interests, so you can choose not to prepare an abstract if there does not appear to be good alignment.
4) New Terms and Conditions: We are moving to a simpler set of Terms & Conditions (T&Cs) for the contracts that result from an award in order to streamline the process.

Scope of URAD Program

Anticipated Competition

Abstracts that are selected for award must meet the specific needs of Draper's business, technology and R&D programs, which are in a constant state of evolution. **It is imperative that potential PIs review the attached list of project topic areas, and engage the Point of Contact for that area to discuss possible project topics.**

URAD Awards are Contracts, Not Grants

Note that funded URAD projects are implemented as *contracts*, not as *grants*, and have contractual milestones, deliverables, and a statement of work. If you or your organization is not willing to work within this framework, then the Draper URAD program is not the right venue for your idea.

Abstract Schedule and Selection Process

We plan the following schedule, which Draper reserves the right to change if necessary.

- Abstracts due to Draper: **March 12, 2010**
- Draper final selections & presidential approval: week of April 16, 2010
- Notifications sent to PIs: week of April 19, 2010
- Formal proposals due for projects selected for award: June 1, 2010

Program Implementation Schedule

Those projects selected for funding should work with the following preliminary schedule to establish their schedules and implementation plans:

- Award notifications to proposers: week of April 19, 2010
- Request for detailed plans and final budget sent to awardees: May 10, 2010
- Detailed plans and final proposed budget due to Draper: June 1, 2010
- Contract negotiations: June 1 – June 26, 2010
- Earliest project start: July 5, 2010
- Kickoff review to be held at Draper: July or August 2010
- Mid-year review at Draper: December 2010 or January 2011
- Final review at Draper: May or June, 2011.

Note that the mid-year reviews are scheduled so as to allow feedback into the development of the CFA for DFY12. Delaying the mid-year review past early January can therefore reduce the possible impact of your project on the upcoming CFA.

Minimum Project Requirements

All projects selected for award will include, at a minimum, a Kickoff, Mid-year, and Final review at Draper. Deliverables will include, at a minimum, the presentation material from the three reviews and a Final Report. These deliverables will be due to Draper no later than 1 week after the reviews (presentations) and three weeks after completion of the project (final report).

Abstract Preparation Guidelines

All abstracts must be submitted using the Draper CFA DFY11 Form. This form will be available on our public web site (www.draper.com). Expectations are that PIs have engaged the appropriate Draper Point of Contact for the relevant topic area in preliminary discussions, so that the abstract submitted should be relatively brief, providing a summary of the project concept, a description of the potential impact, an estimated budget and schedule, and a list of expected outcomes. Detailed guidelines for completing the abstract submission form are provided below.

Section A: Identification

Principal Investigator (PI),: Provide the full name and title of the Principal Investigator, lead researcher, or proposer for this abstract. Provide the name of the home university and department, including US Mail address, telephone number, and email address.
Co-Investigator(s) & Affiliation(s): Identify any major collaborations or co-investigators for this abstract. For each Co-I, provide full name and title, home university and department, US mail and email address, and telephone number. Also provide a brief (several words – up to one sentence) description of their role or contribution.
Continuation/Evolution of prior funded Project? (Y/N): If this abstract is a continuation or natural evolution of a currently-funded project, indicate Y (yes) and provide the title of the current project. If this is a new, stand-alone proposal, indicate N (no).
Proposal Title: Provide a descriptive title of your proposal; limit 256 characters.
Topic Area(s) – indicate up to 2: Identify the specific topic area(s) from the list that is most relevant to this abstract. Up to 2 different areas can be identified. The choices are:

- Precision Navigation and Timing;
- Tactical Systems Guidance, Navigation & Control;
- Strategic/Space Systems Guidance, Navigation, & Control;
- Miniature Low-Power Systems;
- Autonomous Systems;
- Information & Decision Systems;
- Complex Reliable Systems;
- Biomedical & Chemical Systems;
- Secure Networks & Communications;
- Strategic Systems Business Area;
- Tactical Systems Business Area;
- Space Systems Business Area;
- Biomedical Business Area;
- Special Operations Business Area;
- Geospatial Solutions Business Area;
- Energy Solutions Business Area; and
- Advanced / Future Technology

Person(s) at Draper with whom this abstract has been discussed: Indicate the names of those at Draper with whom the abstract was pre-reviewed / discussed. These individuals will be asked to comment on / review your abstract.

Section B: Abstract Overview

Abstract Summary: The abstract must contain a summary of the project not more than one page in length. It should be a self-contained description of the activity that would result if the project were funded. The summary should be written in the third person and include a statement of objectives and methods to be employed. It must clearly address in separate statements (within the one-page summary):

- the intellectual merit of the project; and
- the broader impacts[1] resulting from the project.

It should be informative to other persons working in the same or related fields and, insofar as possible, understandable to a scientifically or technically literate lay reader. Abstracts that do not separately address both merit review criteria within the one-page Project Summary may be considered non-compliant and rejected without further review.

Problem being addressed: Provide a short (up to ½ page) description of the specific problem that will be addressed.

Competitive assessment: Provide a short (up to ½ page) assessment of the uniqueness of the project, and identify competitive approaches or solutions, indicating relative merits of each (Why is your project "better" than the others?).

Approach: Provide a short (up to ½ page) description of the approach to be used to implement the project. Describe methods to be used, elements to be evaluated, figures of merit and performance / success criteria, specific tasks and activities.

Schedule: Provide a brief schedule that outlines the tasks, major milestones, and deliverables for the project. This can be provided as a bulleted list.

Deliverables: Provide a list of all deliverables to Draper (see "Minimum Requirements", above) and provide a date when each deliverable will be provided to Draper.

Risks: Describe any known risks.

Section C: Estimated Budget /Scope

Personnel: Provide an indication of the number and type of personnel that would be involved in and paid for by the project, the %level of coverage expected by the project by year, and the rough costs for each. An example is provided in the template form.

Indirect/Non-Labor: Provide a rough estimate for the all indirect costs associated with the project. Materials & Services should include a description of what is included (e.g. test articles; machining; consumables). Travel should include travel costs for trips to Draper for the required reviews, and for any other travel pertinent to the project. NOTE that Draper does NOT pay for conference travel. Use "Other" to capture categories unique to your project/home institution; be sure to itemize all elements. A few examples are provided in the template form.

Contributions: Indicate any contributions (from the home organization or other source) that will augment this research. Cost-sharing is not required. Examples can include students working for credit rather than monetary pay; use of major capital equipment without charge to the project; or inclusion of pre-existing components (or components generated in a

[1] Examples of broader impacts include (among others): developing the next generation of U.S. Science, Technical, Engineering and Math (STEM) workforce; broadening participation of underrepresented groups; advancing discovery and understanding while promoting, teaching, training and learning; and benefits to society.

parallel effort) as part of the deliverables to Draper. List or describe any items included here. A few examples are provided in the template form.

Abstract Preparation Checklist

Failure to meet any of the following requirements may result in the abstract being considered noncompliant and rejected without further review. If you need copies of any of the required forms, please visit the Draper public web site at www.draper.com.

1) Use the provided Abstract Submission Form and complete all sections of the form. Follow the Abstract Preparation Guidelines provided above to complete the form. This form must be submitted as a Microsoft Word document via email sent to the Draper Office of Education at ed@draper.com.
2) Complete the Self-Identification form. Individuals who do not wish to provide the personal information are still required to submit a form, and should check the box indicating their desire to decline providing that information.
3) Estimated cost data in the form of a not-to-exceed estimate is required. Formal cost data and proposal submission from your home institution is not required by Draper at this time; a final formal proposal will be required only for those projects selected for award.
4) Submit the two forms, the Abstract Submission Form and the Self-Identification form, via email to ed@draper.com **no later than March 12, 2010**. Hardcopy submissions will not be accepted. PDF or other formats for the electronic forms will not be accepted unless also accompanied by the Microsoft Word format forms.
5) Any appendices or attachments must be submitted in electronic form with the submission email and the total of all appendices or additional attachments to any one abstract cannot exceed 5MB in size.

Draper Fiscal Year 2011 (DFY11) URAD Project Topic Areas

Project abstracts are sought for our Technical Capability areas, Business Area Thrusts and Advanced/Future Technology Areas. Technical Capability areas generally seek concepts for advanced technology that may be 3-5 years or more from the maturity level needed to seek customer funding for further development. Business Area Thrusts are generally seeking concepts for technologies and concepts with a shorter timeframe to maturity. Advanced/Future Technology Areas are those that we believe may be significant at Draper in the 5- to 10-year timeframe. Descriptions of the various topic areas sought are provided below. When you have identified a possible match for your concept, and **prior to abstract submittal, you must contact the individual named for that topic area** to preview your concept and determine whether further refinement or development of the concept is needed or encouraged prior to abstract submission. Discussions with the individuals named may result in decisions to pursue other avenues of collaboration and joint work rather than abstract submission to this URAD call.

Technical Capability Areas

Precision Navigation & Timing

Points of Contact:
Stephen P. Smith, 617.258.1953, ssmith@draper.com
Stan Shanfield, 617.258.3392, sshanfield@draper.com

The Precision Navigation & Timing Technical Capability at Draper includes the conceptualization through detailed design and prototyping of systems that provide measurements used to determine the attitude and position of a platform. This can include the mechanical structure that houses the instruments and sensors as well as the instruments themselves, plus auxiliary sensors that may aid GN&C, such as high precision clock and clock technology, stellar sightings, and GPS enhancements. The instruments / sensors may be mechanical, MEMS, Electro-Optical, or, in the future, Cold Atom. Any additional hardware or software required to complete the system is also included, such as, gimbals, motors, electronics, and local control algorithms and logic. Applications can include measurements on or near the Earth's surface, or in space; and can also include advanced gravimetry concepts.

Abstracts are sought in the areas of revolutionary concepts for instruments, clocks, and sensors which enable significant improvement in accuracy and/or reduction in size and cost.

Strategic & Space GN&C Systems

Point of Contact: Leena Singh, 617.258.1766, lsingh@draper.com

The Strategic and Space GN&C Systems Technical Capability addresses the system architecture, algorithms and software needs that are specific for strategic and space GN&C systems. There are several items that comprise this capability, including: ascent systems, entry systems, missiles, spacecraft on-orbit control, and autonomous rendezvous and docking, to name a few. Specific sensor and measurement technologies required to implement algorithms or solutions in this area will be drawn from the Precision Navigation and Timing capability described above.

Abstracts are sought in the following areas:

- Model-Based GN&C System Design, Traceability and V&V
  - Concepts for efficient (reduced cost) implementation of safety-critical software using model-based development for auto-code generation and V&V
  - Development of verifiable, model-based mission-critical flight software and algorithm concepts to capture mission and systems requirements and specs
  - Model-based design to support V&V of closed-loop integrated performance assessments of complex inter-connected systems

- Model-Based GN&C Algorithms Design
  - Model-based GN&C algorithms for high-fidelity, drift-invariant, robust, high-performance in-space operations e.g. high-precision multi-sensor pointing & tracking, rendezvous, prox-ops etc.
  - Advanced modeling, mission-planning and onboard GN&C algorithm and targeting concepts for precision re-entry vehicle and strike systems that are robust to system and environmental disturbances such as winds, thermal effects, ablation effects
  - Novel actuation and control methods for precise engagement, pointing and tracking missions with spacecraft or very high-altitude vehicle formations
  - Design of precision model-based algorithms for extremely high sensitivity navigation sensing and estimation for gravimetric and gradiometric assessments

- Mechanization and Miniaturization of GN&C Components and Systems
  - New or alternative integrated navigation solution concepts that preserve accuracy and performance with reduced dependence on external information E.g. architectures that utilize gimbal mechanization, baseball stitch motion, EM-log, depth, sonar, GPS & exotic sensors (e.g. gravity gradiometric) with IMUs for next-generation strategic measurement systems
  - Concepts to improve the navigation/Fire Control System/ Missile interface for improved design and performance. Extremely small chip-scale satellite systems for low-detectability, with stealthy battlefield penetration and wide-area coverage. Concepts to analyze the launch, deployment, release and probabilistic track generation during re-entry. Assessments of possible applications and marketability of such light-weight, small size satellite-on-chip concepts.

Tactical GN&C Systems

Points of contact:
For vision-aided nav: Greg Andrews, 617.258.1479, gandrews@draper.com
Peter Sherman, 617.258.2580, psherman@draper.com

The Tactical Guidance, Navigation, and Control (GN&C) Technical Capability includes sensor architectures, algorithms, and systems technology enabling tactical operations in areas where GPS signals are challenged or fully denied. The focus here is on multi-sensor fusion techniques and component technologies that provide precise and highly reliable engagement, navigation, and targeting functions in a compact low power package.

Abstracts are sought for:

- Navigation, geo-location, and body attitude determination employing multi-sensor fusion of poorly modeled measurements using non-traditional filtering techniques. Component technologies of interest are vision-based and collaborative navigation with a focus on robust, low size-weight-power (SWAP) mobile processing. Supported environments include indoor, urban, underground, and undersea.
- Systems providing prompt, precision, non-magnetic pointing for target geo-location using image-based target tracking and low noise drift stabilized inertial sensors. Robust secure sensor-to-shooter communication links. Strategies for real-time moving target identification, tracking, and prosecution. Highly integrated target laser designator (TLD) systems.
- Precision airborne mission planning and delivery via novel sensing and GN&C algorithms with application to munitions, autonomous air vehicles, and guided parafoils. Sensors, algorithms, and avionics systems supporting precision guided air-drop of supplies and weapons onto fixed drop zones as well as moving platforms.
- Antisubmarine warfare (ASW) countermeasures – novel sensors and systems to defeat ASW techniques or to enable stealth submarine activity.

Miniature Low-Power Systems

Point of Contact: Elliot Ranger, 617.258.1026, eranger@draper.com

The design, development, prototyping and, in some cases, low-rate production of miniature, low-power, electro-mechanical systems is an established business area for Draper. This capability includes system conceptualization and design methods for addressing demanding customer requirements, and draws upon miniature electronics packaging technology (e.g., Draper's multi-chip-module MCM packaging technology), low-power electronics design principles, and MEMS/NEMS sensor technology. Many applications also require communications (e.g., antennas, RF circuitry, analog/digital electronics) and signal processing technology.

Abstracts are sought for projects that can be implemented and demonstrated in a 3 to 5 year time horizon and that will dramatically reduce the size (thickness or volume) and power of a component and/or system; and that can provide discriminating capabilities for our customers. Currently the main drivers for overall system size are batteries (power source), antennas, and sensors. We are working to improve overall energy efficiency and algorithm efficiency to enable longer mission durations or smaller batteries (power sources). We are seeking technologies to enable the design and fabrication of complex, miniaturized electronics systems. These enabling technologies include:

- packaging heterogeneous devices (MEMS sensors, batteries, discrete components) in our multi-chip modules;
- new, miniature sensors and optics;
- intelligent, power-efficient algorithm processing such as multi-core embedded processing;
- ultra-low power GPS and navigation processing;
- ultra-low power audio and video compression and processing techniques; and
- robust, sensor data exfiltration, data fusion and information exploitation.

Autonomous Systems

Points of Contact:
Mark Abramson, 617.258.4271, mabramson@draper.com
Mike Ricard, 617.258.3019, mricard@draper.com

The Autonomous Systems Technical Capability encompasses a broad set of technologies to address problems in closed-loop decision making for commanding, controlling, estimating and predicting of the state of a broad class of assets ranging from teams of heterogeneous autonomous vehicles to tasking, analysis and dissemination of information.

Abstracts are sought in the following areas:
Autonomous Vehicle Mission Management: Novel algorithms and approaches for a variety of on-board mission management activities (which include tasking and planning, situation awareness, and situation assessment). This includes planning and control algorithms that incorporate tactics, that can maintain dynamic posture management to increase situational awareness while minimizing signature, and that can infer adversarial intent. This area also includes approaches that facilitate multi-vehicle operations and shared situational awareness; and novel approaches to facilitate operator tasking of and interaction with autonomous vehicles including human guided post-mission analysis. Also sought are algorithms or other concepts to make autonomous vehicles more robust to unanticipated mission conditions, unstructured and highly dynamic environments, to improve overall mission reliability, and to minimize the development and test effort required to achieve assurance of mission performance.

Complex Reliable Systems

Point of Contact: Rob Hammett, 617.258.2494, rhammett@draper.com

The Complex Reliable Systems capability addresses the development of system, software and hardware solutions for applications where sophisticated control and a high degree of reliability are needed, such as manned space flight systems, Unmanned Autonomous Vehicles (UAV's), and biomedical systems. This capability is also concerned with designing and building extremely complex systems such as squadrons of cooperating UAV's or the control of large electrical power grids. Capabilities that Draper brings to this field include reliable and fault tolerant system conceptualization, avionics design and analysis, and reliable computing.

Abstracts are sought in the following areas:

- System concept exploration: Methodologies and technologies for system concept exploration, analysis of alternatives, visualization to support decision making and architecting solutions for realizing complex and highly reliable designs that are applicable across Draper's business areas. The emphasis should be on concept design decision aids using preliminary and limited information rather than optimization techniques, but methods such as Multi-Disciplinary Design Optimization (MDO) and Pareto frontiers are applicable.
- System engineering for complex systems: Advanced methods and processes for transforming system concepts into operational systems are being sought. Methods that insure that these systems will perform reliably while also reducing system development cost and schedule are of interest. Processes and tools that can be used to capture the complete system definition: the system architecture, system and

subsystem performance requirements, functions, system concept of operation, design assumptions, and interface requirements for use over the entire design and usage life cycle are being sought after. Extensions to this capture system that allow for analysis of the design, automatic consistency checking and the ability to export test vectors for use in system V&V are also of interest. The design capture system should be fully integrated with model-based design and verification tools. It should help manage design complexity and facilitate making design decisions for the decomposition of the system into appropriate subsystems, modules, work packages, WBS elements, etc to allow for efficient development, project management and rapid system integration. The capture system should scale to address the design of both an individual system as well as complex, systems of systems.

- Robust software: Advanced methods for developing highly reliable embedded, real-time software and/or for making the software more robust to residual design errors are being sought. Methods that can be used to analyze software requirements, designs or coding to identify potential errors or predict software reliability are of interest. Concepts for features that can be added to the system to make it tolerant of residual software defects (including those resulting from incomplete or incorrect requirements or operating the system in unanticipated ways) are being sought.
- Advanced reliable systems and computing: Technology is being sought to develop the next generation of extremely reliable, fault-tolerant real-time embedded controls suitable for safety-critical systems. These systems must operate without functional interruption despite individual component failures, space radiation Single Event Upset (SEU) and Electro-Magnetic Interference (EMI) effects. They must be robust to system utilization that can't be fully defined or tested during system development. They may need to operate for extended periods without opportunity for repairs. They must degrade gracefully where appropriate. They will need the ability to be updated and extended during the systems lifetime, not necessarily by the same people that developed the system initially. These systems will of necessity need redundant components, but these must be used sparingly to minimize system Size, Weight and Power (SWaP) and cost with power being the major concern for many systems. These advanced systems should use standardized, non-development hardware and software where ever possible to control development costs and to facilitate the introduction of improved technology as it becomes available. The inclusion of wireless technology should be assumed as part of these future systems

Biomedical & Chemical Systems

Points of Contact:
Biomedical focus: Jim Comolli, 617.258.4232, jcomolli@draper.com
Chemical Systems focus: Shirley Hoenigman, 617.258.1939, shoenigman@draper.com

The Biomedical & Chemical Systems capability area is a developing capability that addresses new business areas in clinical and military medicine and chemical/biological defense. The primary goal is to capitalize on the in-house engineering expertise and skills of Draper to develop practical solutions to the critical needs of our sponsors. The focus of Draper's research and development is currently microfabricated medical devices, cellularized scaffolds, sensor systems, biomedical informatics including signal processing and image analysis, and medical

device/instrumentation development. We are seeking proposals where the university investigator is willing to work closely with Draper staff to push technology development and/or address identified sponsor needs. Proposals are being sought in the following areas:

- Physiological Sensing: Sensors of physiological signals or related technologies for creating robust, integrated detection and diagnostic systems. Potential applications are for non-contact, wearable, or implantable devices for soldier assessment, triage, or medical diagnostics and monitoring. Protein or metabolic biomarkers associated with physiological parameters, or innovative and robust methods to monitor these biomarkers, are also desired. Also of interest is research or technologies aimed at associating physiological status with cognitive state for medical diagnostic purposes.
- Chemical and Biological Threat Detection: Biological agent sensors for environmental monitoring and alert, with demonstrated detection performance, including figures of merit for sensitivity, selectivity, precision, and analysis time. Seeking proposals for transitioning sensor systems from the laboratory into portable, fieldable systems. Ideas for performance verification testing and system modifications are of interest.
- Biological Threat Decontamination: Innovative materials, methods, and systems for decontamination of chemical and biological agents from individuals, equipment, or fixed sites.
- Miniaturized Medical Device Technologies: Technologies that enable the miniaturization of medical diagnostic/monitoring systems or therapeutic devices for high-throughput, wearable, or implantable applications. This includes energy efficient technologies, biocompatibility enhancements, electronics packaging, sensors and optics, communications, and low power algorithm processing and data management. Projects that can integrate with our miniature low-power systems capability (described above) for medical and military applications are of particular interest.
- Mechanotransductive Cell Biology: Research into cell types that respond to mechanical drivers for cell differentiation and organization into tissue and tissue-like structures. The goal is a collaborative project between academic cell biologists and Draper microfabrication engineers to create novel devices and technologies for therapeutic or pharmaceutical screening applications.

Information & Decision Systems:

Points of contact:
Laura Major, 617.258.3432, lmajor@draper.com
John Irvine, 617.258.4957, jirvine@draper.com

We define Information & Decision Systems as the collection of those technologies that advance the transformation of data into information through human and/or machine systems to enable enhanced decision making; this includes aspects of human-machine collaboration, task sharing, and augmented cognition to improve human-intense information processing in combat intelligence analysis and/or imagery analysis situations.

Abstracts are sought in the following areas:

- **Visual and Predictive Analytics:** Technologies that have the ability to assist people in predicting future outcomes based on large, disparate, diverse and sparse data sets. Techniques should combine human expert decision making with algorithms and analytic capabilities. Analytic technologies may include fusion, data mining, pattern detection, forecasting and predictive

models. Human understanding of the models and analysis should be supported by immersive interaction and visual analytics. Applications of interest include close-in sensing, cyber security, defense informatics, geospatial information and climate monitoring.

- **Human, Social, Culture, and Behavior Modeling:** Computational modeling and interaction for understanding and successful navigation of the human terrain for the purpose of influencing populations at the strategic, operational and tactical levels to assist decision makers (intelligence analysts, operations analysts, operations planners and wargamers). Approaches should support understanding group relationships and socio-cultural data. A multidisciplinary approach is needed to incorporate theories of culture and cognition from the social sciences with technology development. The models and tools must provide sufficient transparency and interaction for decision makers to effectively use and trust them. Quantification, propagation and representation of uncertainty should be addressed as part of the solution.
- **Human Understanding:** Models and algorithmic techniques for estimating a person's current physical, psychological and emotional state and predicting their future behavior based on physical or behavioral observables or other external data sources. The approach may include evaluation and experimentation to provide the data needed to support biomarker discovery, assist in model design and development and validate methods. The aim is to develop models and algorithmic techniques that can support robust remote collection systems, predictive warfighter effectiveness, and adaptive human-computer interaction.
- **Data-intensive discovery**: Novel techniques and algorithms are sought for dramatic improvement in situational awareness and the creation of actionable knowledge given the enormous existing body of persistent data and overwhelming flood of real-time streaming data available across a variety of applications. Of particular interest are applications that develop knowledge about individuals and society. Relevant areas of research include graph analytics, game theory, human guided algorithms, semi-supervised learning, semantics, prediction, and optimization. Models of interest include physical, mathematical, and social science models, and especially their integration.

Secure Networks & Communications:

Points of contact:
Communications: Robert Tingley, 617.258.1279, rtingley@draper.com
Networks: Jim Zagami, 617.258.4883, jzagami@draper.com

The Secure Communications and Networks capability enables the reliable and efficient transport of data through and across challenging field environments. Within these environments the propagation and interference characteristics are both unknown a priori and rapidly varying with time. Environments of interest include the low power satellite channel, powerlines, underwater and underground, and free space optical. Networks of interest include both commercial and governmental local, metropolitan and wide-area networks.

Abstracts are sought in the following areas:

- Methods and techniques to exploit existing wide area communications and networking infrastructure for the purposes of detection, disruption and data transport. Of particular interest are techniques to access commercial networks employing customary security measures and protocols.

- Methods and techniques to detect and characterize intrusion and utilization of secure communication networks. Of particular interest are techniques applicable to standards-based networks.
- Integrated sensing and communication architectures, achieving superior performance by means of symbiotic design. Of particular interest are communication systems associated with a guidance, navigation and control (GN&C) architecture.
- Communication methods and system architectures that achieve high overall energy efficiency. Of specific importance are systems optimized in terms of energy required to transport each data bit over a specified channel.
- Communication methods and systems for operation in challenging environments, such as powerlines, underground, and underwater.
- Communication and distributed sensor networks that depend on and/or take advantage of guidance, navigation, and control (GN&C) technologies
- Energy efficient cognitive radio techniques and approaches
- Methods and techniques for providing robustness at the network layer in order to enable practical realization and ensure resiliency to inaccurate models, adversarial attacks, and other unpredicted state perturbations
- Spectrum/ power efficiency through advanced point of sensor processing
- Interference and Jamming mitigation for SWaP constrained platforms
- MIMO antenna design and signal processing for urban and indoor UAV operations
- RF signature reduction, beyond traditional LPD/LPI; exploitation of ambient RF activity to mask transmission and operate undetected

Advanced/Future Technology Concepts

Points of contact:
Mike Matranga, mmatranga@draper.com, 617.258.2781
Tony Kourepenis, tonyk@draper.com, 617.258.3229

Draper is considering future work in a variety of technology areas that we expect will be important in the 5- to 10-year timeframe. Abstracts are sought in the following areas:

- Advanced, non-inertial sensors for navigation; including RF, acoustic, signals of opportunity, and other modalities
- Advanced cryptography
- Advanced materials; including polymer electronics

Business Area Thrusts

Strategic Systems Business Area

Point of contact: Roy Setterlund, rsetterlund@draper.com, 617.258.4200

Strategic Systems support a variety of needs, including our current work for the Trident Life Extension project for the US Navy. We seek concepts to support future technologies to enable strapdown strategic boost guidance systems, Prompt Global Strike, re-entry guidance, g- and rad-hard components and systems; as well as novel technologies or concepts for accurate long term underwater navigation.

Tactical Systems Business Area

Point of contact: Neil Adams, nadams@draper.com, 617.258.2411

Our Tactical Systems business area is seeking ideas to support soldier systems, munitions & precision weapons, missile defense, maritime systems, and command & control (C2) systems. Specifically, ideas for:

- Soldier systems:
  - Parafoil related systems concepts for a) sensors and/or algorithms providing robustness to winds for long-range standoff (glide ratios > 4) and/or precision (<10m) airdrop missions; b) low-cost and clandestine delivery methods in mountainous or urban terrain
  - Technology (sensors and processing) to perform standoff detection of conventional and/or nuclear explosives and concepts to address counter-insurgency and IED threats
  - Very low cost (<$1K) navigation solutions in GPS challenged/denied environments. Pedometer-based and human motion modeling techniques, velocimeters and other aiding technologies.
  - Novel North-finding capabilities involving, inertial, magnetic, celestial, and GPS techniques and combinations thereof.
  - Concepts to enhance soldier performance; physiological monitoring, advanced appliances to maintain effectiveness under adverse conditions, power sources, traumatic brain injury (TBI) avoidance/mitigation, and cognitive load assessment.
- Munitions & precision weapons:
  - Novel terminal sensor technologies that enable precision munitions to operate at long stand-off distances and engage moving targets.
  - Low cost, low power, high launch acceleration survivable (>50kG) GN&C electronics that include small, anti-jam/spoof approaches for spinning projectiles
  - Low-cost wave-front simulation test capabilities for multi-antenna projectile systems.
  - Novel GN&C concepts that enable precision engagement under complete GPS denial, e.g., optimization and combined use of geo-spatial, celestial, radar, digital terrain and elevation data (DTED), inertial and other navigation technologies, combined with encrypted communications for platform re-tasking.
  - Systems and GN&C design concepts and trades for man-portable, weaponized UAVs that provide soft target lethality in hard to access locations.
- Missile defense: Concepts which extend enhanced ground test (EGT) methods to interceptors with closed-loop seekers
- Maritime systems:
  - Technologies and concepts to support tactical undersea missions: a) fish-net mitigation; b) covert navigation (100 hour / .01% distance travelled / 10W / large depths); c) multiple manipulators in a shared volume; ultra-high reliability operations
  - Fusion concepts for underwater obstacle/threat detection and avoidance based on active imaging. Novel non-acoustic sensing and exploitation (gravity, magnetic, etc) for remote anti-submarine warfare (ASW) applications and exploitation of automatic identification system (AIS) signals for improved ASW.
- Command & Control (C2) systems:
  - Closed loop planning and control for automated decision support of complex operations. Technologies and concepts must facilitate collaboration of human decision makers and

decision support algorithms, and ensure robust planning under uncertainty. Domains of interest include: transportation and logistics; air, ground, sea battle management; IED defeat; consequence management; airspace management, deconfliction and control, and intelligence, surveillance and reconnaissance (ISR) tasking

- Concepts for seamless migration of existing systems into net-centric, state of the art architecture, Info assurance especially rapid accreditation.

Special Operations Business Area

Point of contact: Greg Cardinale, greg@draper.com, 617.258.4614

This area focuses on technologies for ultra-miniaturized systems and novel sensor concepts. To further miniaturize and expand uses of electronic systems, we seek proposals in technology areas such as tiny, thin and flexible antennas, ultra-low power consumption architectures, micro-scale energy sources, and "smart packaging" (i.e., packaging with functionality). Sensor topics of interest include, but are not limited to, quantum sensing, non-invasive biometric sensing, and passive (near zero power) sensors. We also seek new concepts for modeling and evaluating social measures of influence.

Energy Solutions Business Area

Point of contact: Len Polizzotto, lpolizzotto@draper.com, 617.258.4624

Draper is leveraging its strengths in sensing and instrumentation, decision and control, architectures for complex systems, and vanishingly small systems to develop world class capabilities to address critical needs in our Nation's energy generation, transmission, and distribution infrastructure. Specific areas of interest include process control for power generation, grid management and control, integration of renewable resources, and decision and planning for energy generation, transmission, and distribution. Proposals are being sought for:

- Carbon capture, sequestration, and/or reconversion. New technologies or concepts for separating CO2 from exhaust gas mixtures, e.g. coal power plant exhaust stacks, that impose less of a burden on the cost of electricity than the current state-of-the-art amines. In addition, technologies to sequester CO2 in places other than underground or to convert CO2 into a more benign or even beneficial substance such as formic acid or methane.
- Direct carbon fuel cells. These are fuel cells that are based on the electrochemical reaction of carbon with oxygen. Such fuel cells exist but only on a very small scale such as milliWatts. In addition, batch fuel supply and ash accumulation prevent continuous, sustained operation. We are looking for solutions to scale these fuel cells to useful power levels and to allow them to operate continuously.
- System level approaches for real time evaluation of the dynamic state and security level of general power distribution systems from available data. Of particular interest are methods for evaluating decentralized grid topologies (i.e., clusters of micro-grids).
- System level tools and methodologies for evaluating power grid design concepts. These tools should address the broad range of pertinent issues from grid security to economic and environmental concerns. These tools should permit system level trade studies to be performed to investigate such questions as what kind of sensing, levels of control, and on-grid storage are required? What communications architecture is necessary? How does the current grid architecture facilitate or impede transition to the next generation grid?

Biomedical Systems Business Area

Point of contact: Dale Larson, dale.larson@draper.com, 617.258.4583

The Biomedical Systems business area has a near-term focus on Compact, Integrated Miniaturized Sensing Systems (CIMSS) to bring solutions to our customers. These customers include both military and civilian medicine. Abstracts are sought for projects that address our target markets including the returning soldier, chem-bio defense and sensor systems, and smart sensors. In civilian markets there is an added emphasis on reducing health care costs.

Space Systems Business Area

Point of contact: Seamus Tuohy, stuohy@draper.com, 617.258.1407

Space Systems supports robotic and human space exploration as well as military space applications. We seek concepts and advanced technologies supporting a human outpost on the moon, robotic precision landing on planets and small bodies (moons, asteroids), precision pointing both toward and away from Earth, and advanced Earth and planetary science instruments. In addition, we seek concepts and technical advancements in the development and use of small, low-power, functionally integrated systems for the mission applications listed with particular needs for space qualified or the advancement of space qualification of said systems.

Geospatial Systems Business Area

Point of contact: Heidi Perry, hperry@draper.com, 617.258.2472

This area is primarily focused on applying novel information extraction and reporting technologies and techniques to the collection, analysis, fusion, visualization, and understanding of timely, reliable geospatial information for critical decision-making by intelligence analysts as well as warfighters. An important factor for consideration is the development of tools and techniques that optimize both experiential and reflective cognition modes of performance to either a specific task or class of tasks. Proposers should demonstrate a familiarity with the warfighter or analyst workflow and provide quantitative estimates of performance enhancement. Interests also extend to adding new visualization tools and software applications that leverage existing geospatial data sources and contribute to improved cognition.