The Information Products Laboratory for Emergency Response

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The three-tiered disaster management approach, *disaster planning, disaster response* and *disaster recovery*, is ripe for innovation through integrated knowledge and technology transfer efforts between university researchers, technology companies, and public sector responders. The period immediately following a disaster can be critical to preserving human life and property, and recent events have highlighted the need for system wide improvements. RIT and the University at Buffalo (UB) – The State University of New York propose a Type II partnership for innovation called the ***Information Products Laboratory for Emergency Response*** or IPLER, dedicated to innovation in disaster management.

The mission of the IPLER is to create a technology, policy and business development incubator to facilitate interaction and innovation among university researchers, private sector service and product providers, and public sector emergency response decision makers. The IPLER will develop user-directed, management products through broadened industry-user participation, focused research and development, and knowledge and technology transfer.

Intellectual Merit. RIT and UB are leading centers in remote sensing research and will build the IPLER on a foundation of state-of-the art geospatial analysis technology. Researchers at RIT have extensive experience in basic and applied remote sensing research, a history of collaboration with local emergency response and energy providers, and a special expertise in fire detection and fire behavior. UB team members bring expertise in geospatial analysis of a variety of natural and manmade disasters, including fire and floods. Both universities have strong policy components. The integrated team will apply a systems engineering approach to define user needs in disaster management, perform targeted research and development of disaster management products, and form a sustainable infrastructure for knowledge and technology transfer. The IPLER mission and objectives are designed to spur creativity and innovation in the disaster management domain.

Broader Impacts. RIT and UB will leverage their collective experience to create a vehicle to broaden the participation of all types of entities along the spectrum of disaster management. The IPLER will facilitate economic development by establishing and maintaining a continuous dialogue between the developers and providers of technologies and the people that use them in disaster response. The diffusion of technologies will improve the prevention and mitigation of disasters in the United States and lead to innovative tools for response and recovery with societal benefit. Students at RIT and UB will be actively engaged in the targeted research and will be uniquely qualified to contribute to disaster management research, development, and response. The IPLER is designed to grow and will easily incorporate new members from the academic, public, and private sectors. The outcomes of the IPLER include potentially life-saving innovations and will be broadly disseminated.

1.0 Project Description

1.1 Project Overview

1.1.1 Introduction

Planning, response, and *recovery* form the three phases of the disaster management chain. It is the time critical *response* phase during and immediately following a major emergency that is critical to human life and property. Significant investments have been made into each phase of this disaster management chain, yet floods, hurricanes, tsunamis, fires, and earthquakes still happen with uneven and non-optimal post-emergency response. This can be traced to a variety of factors related to lack of funding for planning, policy barriers, and poor access technology, to name a few.

Universities play an important role in conducting research and development (R&D) activities to find technological and policy solutions to improve all three phases of disaster management. At the same time universities train the next generation of emergency workers for the public and private sector. *Private sector companies* apply technology and provide services when disaster strikes. *Public sector agencies* are chartered to be prepared to respond to a myriad of potential natural and man-made disasters. However, this interaction between academia, the private sector and the public is far from optimal. We propose to greatly enhance the interaction between these diverse stakeholders by focusing on the inherently geospatial[1] nature of disaster management with the formation of the "*Information Products Laboratory for Emergency Response*" (IPLER).

Binghamton N.Y., the floods of 2006

In June 2006 a low pressure system moved up from the south. A blocking high pressure system over Lake Ontario stalled the system. Within a 36 hour period, over 10 inches of rain fell on Binghamton. The Susquehanna River rose rapidly causing historic flooding. New York State Gas & Electric, the local energy utility, was quickly faced with a catastrophe. The flooding caused the pilot lights on furnaces to extinguish, thus allowing houses to fill with natural gas. In several instances houses blew up. NYSEG desperately needed to map the location and extent of the flooding. Their only solution was to hire a helicopter and have a worker hang out the side with a video camera. After landing, NYSEG workers tried to manually map the flood zone onto a paper map with little success because of the poor accuracy and time involved with this approach. As part of a 2007 demonstration, RIT re-mapped the 40 mile flood zone using RIT's WASP airborne sensor and were able to provide data within one hour of collection.

The IPLER mission is to create a technology, policy, and business development incubator that will facilitate interaction among university researchers, private sector data and product providers, and public sector emergency response decision makers, built on a foundation of state-of-the-art geospatial technology. The expected outcomes of the IPLER are the development of innovative solutions for improved disaster mitigation planning, real-time response, and recovery efforts with direct

[1] "Geospatial" refers to the geographic or locational character of disasters: ***Where*** and ***what*** is happening, ***how it is changing***, and ***how temporal and spatial information*** can be used for effective planning, response, and recovery.

societal benefit. These solutions also represent significant business opportunities for private sector companies that will drive economic development. The IPLER will bring parties from across the disaster management chain to meet and collaborate.

IPLER approach and team

The IPLER will focus on understanding user needs, defining the range of possible solutions, and sharing the range of solutions with the private and public sector. This will be done by

i. initially selecting two very specific disasters (fires and floods) in which the proposal partners have proven track records, followed by
ii. broadening the participation to include industry and end-users to implement and direct the fires/floods disaster R&D, which will
iii. continue the development of IPLER infrastructure that encourages user-driven disaster product development and dissemination, and
iv. establishing a sustainable IPLER enterprise through the addition other disaster focus areas with expanded funding resources.

Rochester Institute of Technology (RIT) and the New York State University at Buffalo (UB) are proposing a Type II NSF PFI partnership to achieve the IPLER mission and objectives. RIT is a PFI graduate and was the lead institution for "The Upstate Alliance for Innovation" (Award No. 0090569, Award Amount $643,874, Period of Performance 10/1/00 – 09/30/05), a regional partnership that catalyzed collaborative efforts between academic research institutions and economic development organizations in Upstate New York. UB maintains the Multidisciplinary Center for Earthquake Engineering Research (MCEER), a national center of excellence for the discovery and development of new knowledge, tools, and technologies to help communities become more disaster resilient. MCEER has evolved its mission to include not only earthquakes, but other extreme events. RIT brings significant experience in fundamental remote sensing research and several successful prior collaborations with the private sector. UB is well versed in product development, geospatial analysis, and linking such geospatial products to policy.

The IPLER partnership allows RIT and UB to leverage their unique capabilities to foster innovation in disaster management. The universities will bring the entities responsible for disaster management together with private sector companies. The outcomes will demonstrate how existing and emerging technology can be applied to better help communities prepare, respond, and recover from disasters.

The principal investigator for the IPLER is Donald Boyd, the Vice President for Research at RIT. Dr. Boyd was the PI for the "Upstate Alliance for Innovation" and has been active in forming and growing numerous partnerships and collaborations in his role. As PI for the Upstate Alliance, he brought RIT, UB, and the University of Rochester together to engage community economic development leaders, successful entrepreneurs, and investors in a series of technology forums and retreats. The Upstate Alliance resulted in new economic development activities centered on partnerships between universities and local companies and economic development organizations. Accomplishments of the Upstate Alliance also included new university programs for innovation and entrepreneurship, the establishment of new business incubators, the development of new start ups, and increases in collaborative research with regional companies. The successes from the Upstate Alliance form an ideal platform for a partnership dedicated to fostering innovation in disaster management and emergency response. In addition to a successful history of collaboration, supporting members of the IPLER team include remote sensing researchers at RIT and geospatial analysis experts at UB:

- Dr. Tony Vodacek (RIT; co-PI) has extensive experience in basic and applied research related to fire detection and quantification of fire characteristics.
- Dr. Chris Renschler (UB; co-PI) brings to the group expertise related to geospatial analysis of disasters and the integration of resultant products in the policy domain, with a focus on flood events.
- Dr. Jan van Aardt (RIT; co-PI) focuses on remote sensing[2] of natural resources, specifically light detection and ranging (lidar), a technology that allows improved characterization of fire and flood behavior through assessment of biomass and topography, respectively.
- Dr. Jamie Winebrake (RIT; senior personnel) is researching solutions to the problem of modeling policy implications of environmental management decisions and will contribute significantly to the policy aspects of IPLER.
- Dr. Ron Eguchi (ImageCat/member of UB's MCEER initiative; senior personnel) will provide insights to the product dissemination components of the effort as an industry representative that is conversant with disaster management R&D.

<u>Why remote sensing?</u>

Remote sensing platforms, such as airborne sensors, are designed to facilitate the capture of data over large areas. Examples of information products derived from these data are:

- land cover and land use classifications defining areas of priority in disaster events and quantifying change of land cover/-use; derived from airborne and satellite imagery,
- digital elevation models (ground surfaces) for flood plain mapping and identification of challenging scenarios due to terrain restrictions; derived from radar or light detection and ranging (lidar) sensors (elevation and structural sensing), and
- multispectral infrared detection and assessment of fire and flood events through long-and short-wave infrared sensing, respectively; extracted from airborne infrared cameras.

These remotely sensed data can provide the decision maker with unique and timely information at a variety of scales, thereby significantly aiding the development of an effective response plan and mitigation of disaster events. However, real-time disaster response information is highly perishable and must be delivered quickly and reliably in a format that is readily interpretable by decision makers. This is achieved by ensuring that captured data integrates with geographical information systems (GIS) for display and spatial analysis purposes. For example, an analyst can provide a decision maker with a map that shows how much of an urban area is flooded (infrared detection), where the flood will spread (ground elevation surfaces), and if human lives and property are threatened (land cover/-use maps). This can, in principle, enable rapid high-level decision-making that leads to mitigation of disaster impacts and streamlined recovery efforts. Unfortunately, in spite of advancements in remote sensing technology, there is an alarming reluctance or inability by civil agencies in particular to make use of such information products.

Nowhere was this more evident than in the aftermath of Hurricane Katrina. According to a report from the investigating House Select Bipartisan Committee, decision makers had an "unusual

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[2] "Remote sensing" refers to observation approaches that are defined by their ability to provide non-contact, synoptic coverage of an area of interest via the sensing of reflected or emitted energy from a target surface. For example, active (e.g., airborne cameras), passive (e.g., radar sensing), and *in situ* (e.g., thermometer) sensors.

reliance on *news reports* (emphasis added) to obtain information on what was happening on the ground in the days immediately following landfall." (National Research Council, 2007). The same report stated; "the necessary investments in resources, training, and coordination are rarely given sufficient priority either by the general public or by society's leaders." Studies have shown that the lack of utilization of remote sensing in decision making applications is the result of several major barriers or gaps that exist between the remote sensing technical community and the decision making community. The inability to transform data and images into meaningful information is due to the limited understanding of how to convert measurements made from air and space into information of ecological, economic, social, infrastructure, environmental, or administrative value (National Research Council, 2001). Clearly a new paradigm for research and technology development is needed to be more responsive to the needs of the user community.

1.1.2 Approach to achieving IPLER objectives

It is in the context of these noted shortcomings that we have defined the need for the "*Information Products Laboratory for Emergency Response*" (IPLER). The identified gaps between R&D, applications, and end-user needs can only be closed through a truly integrated approach that includes all constituents in the process of technology development, while also exposing remote sensing technology experts and product providers to the process of policy and applications development. This will be achieved via four key objectives.

Objective 1: Assess the needs of the disaster management user community

We will use a systems engineering approach in this project to define user needs, establish system requirements and develop a matrix of possible solutions. The user community includes multiple local, state, federal, and private entities such as the Monroe County Office of Emergency Management, NY State Office of Homeland Security, and NY State Foundation for Science, Technology, and Innovation, and the US Forest Service (USFS). We furthermore recognize that policy can have a significant impact on how new technology is implemented into existing organizations and infrastructure. This project includes an experienced technology policy researcher, Dr. Jamie Winebrake, at the Laboratory for Environmental Computing and Decision Making (LECDM)[3] at RIT. Dr. Winebrake will serve as one of the senior personnel on the project. Like wise, MCEER has integrated policy and technology issues as a key component of their research on extreme events.

Assessment of user needs will be addressed at annual workshops, with the kick-off workshop at the core of this objective. Regular team meetings will be used to continually keep activities aligned to user needs. We will approach by collecting user inputs that are unbiased towards the proposed geospatial technologies. For example, we will determine what the user needs are for disaster management and define aspects that can be addressed by geospatial approaches.

[3] LECDM is a collaborative, multi-disciplinary research effort aimed building and using environmental models for decision-making in the public and private sectors, with a primary research theme of developing modeling and cyber-infrastructure for sustainability policy analysis. An example of a related project includes "Collaborative Research: Implications of Automotive Greenhouse Gas Policies on Material Flows - A Life Cycle Approach Integrating Engineering, Public Policy, and Market Behavior", NSF award no. 0628157

Metrics for success will include (i) positive feedback from users in terms of the ability of the R&D and industry communities to translate user needs into plans of work (actionable and implantable solutions) and (ii) specific examples of how geospatial technologies can aid each of the phases of the disaster management chain.

Objective 2: Perform user-defined, targeted R&D of disaster management products

The disaster management chain (preparedness, response, and recovery) and recognition of policy issues will form the foundation of this objective. Wildland fire and floods will be the initial application focus in Year 1, because of the frequency and extent in which they occur and because of the expertise resident within the two academic partners. This expertise is demonstrated by RIT's Wildfire Assessment Sensor Program (WASP; Popular Science, 2003; McKeown *et al.*, 2004) and UB's flood and fire mapping efforts (Womble *et al.*, 2006; McMillan *et al.*, 2007). Additional disasters will be added for investigation in Years 2 and 3.

RIT will lead the fundamental remote sensing research, innovative algorithm development, and system integration R&D for the IPLER. UB will lead the translation of data into information to directly aid the user community (Renschler, 2006a). The private sector partners will contribute to efforts at the academic institutions, including image acquisition and dissemination (DigitalGlobe, Kucera International, and Pictometry International) and algorithm implementation and product dissemination (Kucera International, Pictometry International, ImageCat). Program funding will sponsor graduate students, faculty research advisers from RIT and UB, as well as, technology transfer via the annual workshop, mini-workshops, attendance at key conferences, and direct technology implementation support to industry partners.

Metrics for success will be (i) alignment to the user needs as they were defined as part of Objective 1 and (ii) readiness-level of tools and techniques that can be transferred to industry partners for implementation at the end of the project.

Objective 3: Transfer technology and knowledge to industry and users

This objective will entail the transfer of R&D to industry partners in the form of new products and services including data collection methodologies, data processing workflows that generate information products and policy issues that may act as barriers for industry. University researchers will work closely with industry partners to ensure compatibility between research and industry workflows, while both these partners will rely on regular feedback from users in terms of product interpretability, as well as alignment to user needs. RIT and UB both have examples where they have successfully transferred technology and knowledge to industry. For example, RIT recently supported the development of a state-of-the-art airborne sensor that is currently undergoing testing with the US Army.

Successful technology and knowledge transfer will be measured by (i) the number of new products and services that the private sector companies are able to offer (ii) concrete examples where the emergency response community is able to use these new products and services.

Objective 4: Ensure IPLER sustainability through broadened participation

This objective will be achieved via successful technology transfers that directly benefit the disaster management user community and that result in products and services that result in economic benefit to the private sector partners. With a foundation of success, we intend to broaden the areas of disaster investigated and we intend to add partners that align with those new application areas. Feedback from the annual workshop, team mini-workshops and attendance at conferences and will be used to expand the focus to include a broader range of disasters, as directed by users. The industry partners need a sustained business model built not only on emergency response, but by also focusing on preparation (before disaster strikes) and long term recovery efforts.

Metrics for success will be (i) the number of new private and public sector partners supported (ii) feedback from the existing user community (iii) dissemination of developed prototype products from industry to users, and (iv) the growth in funding to the IPLER and IPLER partners.

Similar disaster management initiatives

It is noted that many components of disaster management have been addressed by many previous initiatives that are external and internal to this proposal. Examples include:

- flood forecasting efforts by the United States Geological Survey (USGS, 2004; pre-disaster),
- the NSF-funded National Center for Geographic Information and Analysis (NCGIA; Renschler, 2006b; geospatial applications),
- the MCEER Remote Sensing Institute (Womble *et al.*, 2006; reconnaissance reports) at the University at Buffalo,
- a NASA-funded real-time fire mapping program at Rochester Institute of Technology (Wildfire Assessment Sensor Program or *WASP;* McKeown *et al.*, 2004), and
- post-disaster management (9/11 and Katrina hurricane tragedies; Womble *et al.*, 2006).

Examples of similar *integrated initiatives*, on the other hand, are limited and include the "Decision Theater" (Arizona State University), and the "Risk and Vulnerability Analysis" products developed by Clark Laboratories. However, these efforts are exclusively driven by policy in the former example and do not encapsulate the entire disaster management chain. We intend to collate previous lessons learned in the IPLER, while investigating how to best bridge the gap between the needs of disaster decision makers and the often complex technical solutions that are provided by the remote sensing research and industrial communities.

In the following segment of this proposal, we highlight past and current work, including work done by members of this proposal team, in the areas of wildland fire and flood mapping.

1.1.3 Partner experience in context of fire and floods

Wildland fire mapping

Remote sensing is a key technological tool that is used to help monitor the progress of wildland fires, with sensing tools ranging from global satellite sensors to airborne sensors. Satellite sensors with kilometer spatial resolution and thermal detectors, such as the Moderate Resolution Imaging Spectrometer and the Advanced Very High Resolution Radiometer, are used for remote monitoring of fire on a global scale and have even been useful for operations in wilderness areas despite their large ground spot size (Cahoon *et al.*, 1992; Kaufman *et al.*, 1998; Li *et al.*, 2000).

Finer resolution satellite sensors such as the German Bispectral Infrared Detection platform have also provided high quality data of active fires, but at the cost of much longer repeat coverage (Wooster *et al.*, 2003). For most fire monitoring situations, fine resolution, accurate geolocation, and frequent repeat coverage are desirable (Zajkowski *et al.*, 2003). This has led to the use of airborne remote sensing, which has been used for many years in a variety of scenarios (Radke *et al.*, 2000; Ambrosia *et al.*, 2003; Zajkowski *et al.*, 2003; Li *et al.*, 2005).

Within this context, the Chester F. Carlson Center for Imaging Science at RIT has conducted a continuous research program in the monitoring of wildland fires since 2000. This work has focused on airborne remote sensing, but has included components of ground sensors, satellite remote sensing, fire propagation modeling, and synthetic image generation (e.g., Li *et al.*, 2005; Mandel *et al.*, 2007; Wang *et al.*, 2009). RIT's work considers both the science of imaging and imaging as a science tool and is based on an end-to-end understanding of remote sensing systems. The fire research has always been driven by user (fire managers) inputs. For example, a users workshop was held in 2003 in conjunction with the Wildland Fire Safety Summit conference in Missoula, MT in order to gather information on user needs and requirements, without biasing the workshop toward geospatial data or remote sensing. A distillation from unbiased workshop responses showed that fire managers want three primary capabilities at their fingertips: actionable information, rapid and reliable communications, and response resources.

Flood mapping

Remote Sensing may contribute to identifying and monitoring change in the shape and extent of major water bodies as a principal effect of flooding. A wide range of remote sensing sensors are often used to assess water extent, ranging from low resolution LANDSAT 5 TM satellite imagery to high resolution aerial imagery. However, the challenge remains to develop and transfer information along the technology-data-products continuum.

As part of UB's MCEER Special Report Series on "Engineering and Organizational Issues before, during and after Hurricane Katrina", the MCEER's Remote Sensing Institute and ImageCat released several reconnaissance reports. A report on remote sensing technologies documents the integrated implementation of available imagery at various resolutions and the VIEWS™ field reconnaissance technology produced by Image Cat (Womble *et al.*, 2006). VIEWS™ is a laptop-based data collection and visualization system, which integrates GPS-registered digital video footage, digital photographs, and observations with high-resolution satellite imagery collected before and after a disaster (such as flooding caused by surge). Amidst the chaos and uncertainty of a crisis situation, VIEWS™ is capable of streamlining the flow of information from the field to key decision- makers: The system has been used for post-disaster assessment of flood damage related to tsunamis (Great Asian Tsunami in 2005) and extreme rainfalls (Thames floods in 2007), as well as wildfires (Southern California in 2007 and 2008).

Initial project details

Fire management. The remote sensing science efforts at RIT have been concerned with providing information rather than images alone. For example, information on the fraction of targets that are flaming versus smoldering is often missing from thermal data. The use of atomic emission by potassium as a fire detection method (Vodacek *et al.*, 2002) was investigated because potassium emission is only produced in a flame (smoldering fuel is not sufficiently hot to excite the potassium). Another example is information regarding the fire perimeter and active fire line that is provided to fire managers at every morning briefing, usually through subjective, visual interpretation of thermal images. RIT has worked on automated extraction of the fire perimeter and active fire lines using digital image processing methods (Li *et al.*, 2007; Ononye *et al.*, 2007). These value-added approach require georegistered images, which led to successful research and development of near real-time (< 4 seconds) onboard georectification.

The academic team plans to integrate the collective fire and biomass (fire fuel loads) research at RIT towards developing fire information products, defined by IPLER end-users for use by the IPLER industry partners. Various researchers at the Center for Imaging Science at RIT have extensive experience in aspects of fire-related research, namely Dr. Tony Vodacek (fire detection; e.g., Vodacek *et al.*, 2002, Kremens *et al.*, 2003, Li *et al.*, 2005, Li *et al.*, 2007, Ononye *et al.*, 2007, Mandel *et al.*, 2007; Wang *et al.*, 2009), Dr. Bob Kremens (fire behavior; Kremens *et al.*, 2003; Li *et al.*, 2005), and Dr. Jan van Aardt (fire detection/forest biomass; e.g., Verbesselt *et al.*, 2006; van Aardt *et. al*., 2006a; van Aardt *et al.*, 2006b). Development of fire information products by the IPLER R&D section will occur in close collaboration with industry partners Kucera International and Pictometry International as data and product providers, and the USFS as policy partner.

Watershed analysis. Dr. Chris Renschler and his collaborators from various federal agencies (including wildfire management agencies), created and tested a user-friendly GIS interface that enables decision-makers to delineate and derive spatially distributed topographic parameters of watersheds (Renschler; 2003) during a series of projects at the National Center for Geographic Information and Analysis (NCGIA). These parameters can then be used to model the generation of surface runoff or debris flows, and the inundation of areas through floods or debris flows (Renschler, 2002), respectively. However, the successful application and implementation of a multi-geospatial hazard model at variable scales requires explicit or implicit use of some form of scaling theory, applied to the tasks of selection and transformation of appropriate data and use of results. Renschler (2003, 2005) defined this methodology and reiterated that such an approach plays a key role in controlling the efficiency of prediction results and designing appropriate scales of interest for a disaster manager's decision-making process. The extreme event modeling by the integrated Geographic Information Science group (GIScience) at the NCGIA (UB) led to the development of a Geospatial Project Management Tool (GeoProMT). GeoProMT allows multiple users to access a centralized repository of geospatial data specifically for environmental modeling. The GeoProMT and the GIS tool for analyzing watersheds combined with the airborne sensor capability at RIT, will be assessed for use in interdisciplinary flood related research projects.

1.1.4 Fostering economic and/or societal well-being

The following is a list of aspects of the proposed IPLER with direct economic and societal benefits:

- *University institutions* (RIT and UB) will further develop their disaster response research and expertise, while educating and training future product providers and decision makers. This leads to a steady stream of innovative approaches to disaster management, based on sound research, while maintaining the work force needed to address the problem.
- *Industry partners* (Kucera International, Pictometry International, DigitalGlobe, and ImageCat) benefit through the creation of addition to or expansion of a current product portfolio. Kucera International and DigitalGlobe are regarded mostly as data providers,

and outcomes of the IPLER initiative will enable them to expand their business to include directed, innovative product provision. Pictometry and ImageCat, on the other hand, already provide products, but want to develop disaster-related products that are quantitative in nature.

- *Decision makers* (Monroe County Office of Emergency Management, NY State Office of Homeland Security, and the US Forest Service) will benefit due the fact that disaster planning, response, and relief/recovery funds can be directed more appropriately, based on timely, interpretable, and accurate disaster management information products. An additional benefit will be the creation of a information product savvy workforce as a result of knowledge transfer from the IPLER initiative.

A prominent *economic development agency* (New York State Foundation for Science, Technology, and Innovation; NYSTAR) has recognized the economic contribution of the proposed effort (see "Letters of Support"). NYSTAR is a New York State governmental agency chartered with promoting technology transfer from universities to industry and stimulating economic development through consultation, policy development, infrastructure investments, and financial incentives.

Although these economic benefits are tangible, we are also confident that the IPLER will contribute to societal well-being. Examples include development of disaster plans, ensuring efficient, directed disaster response, and streamlining recovery efforts. These efforts could potentially save lives and better protect property. Imagine the impact of the following components in the cases of hurricanes Katrina and Ike:

(i) proper response plans ("How do I get my family away from danger, without an unnecessary risk to lives?"),
(ii) geospatial knowledge of disaster impacts ("Where should we concentrate our efforts?", "Are major infrastructure elements such as bridges or tunnels at risk?" or "Is my house still standing?"), and
(iii) targeted recovery efforts ("Which product providers should be mobilized where and to what extent in order to initiate recovery from a disaster?").

The IPLER will demonstrate what is possible and how technology can be effectively used. The IPLER initiative has clear economic and societal benefits that extent beyond the scope of the funding duration, as noted above. Such benefits can only be achieved through innovative approaches to the problem of disaster management. Furthermore, while the IPLER partners have major presences in upstate New York, the benefits are potentially national in scope, and may be targeted in diverse geographic regions.

1.2 Innovation Outcomes and Intellectual property

Outcomes. The mission of the IPLER is to facilitate interaction, innovation, and creativity between academic researchers, private sector companies, and emergency management decision makers. Expected outcomes from this project are:

(1) an improved understanding of how existing and emerging remote sensing technology can be applied to aid decision makers in disaster management and post disaster recovery,
(2) an improved understanding of the business opportunities for the private sector in supporting disaster management and recovery,

(3) the transfer to industry of specific remote sensing technology outcomes from University research that can aid the private sector in providing disaster management information,
(4) an understanding of the new and emerging remote sensing data collection methodologies that can lead to improved information products, and
(5) a significant step towards opening a two-way process flow between university R&D <–> industry <–> policy makers through establishment of the IPLER interface.

Item (5) above encapsulates the overarching innovative aspect of this proposal that underpins the process and economic sustainability of our efforts. Outcomes ultimately are couched in the context of a ***policy framework*** that drives requirements from decision- and policy makers to data and information providers (industry), which in turn steers university R&D and industry interaction. We propose to develop innovative methodologies that are integrated across the full disaster management chain towards building strong local, regional, and national economies and improving national well-being.

Tangible outcomes include human resource development in the form of graduate degrees, while peer-reviewed publications, conference participation, an annual onsite full-partner workshop, biannual virtual (remote) progress workshops, and a shared website constitute knowledge dissemination tools. Disaster management tools that use remotely sensed data for the rapid generation of information products that support decision makers for both natural and man-made disasters.

The scientific contribution furthermore will be innovative in that it will focus on a host of spatial and temporal scales and address needs beyond the provision of static information products. The scale and time aspects are critical because the disaster management chain and its implementation are complicated by the issue of "event scale" and the fact that most disasters are dynamic by nature, e.g., fire spreading or progression of flood movement. Further, disasters and their impacts can span from local to multi-national scales, driven by the extent and magnitude of the disaster event. Some events, e.g., tornadoes, chemical spills, or terrorist attacks may be relatively small scale, but with very acute consequences. Large-scale events, such as a hurricane or tsunami, can affect many countries with varying levels of devastation. The ability to address disasters of very different spatial and temporal scales within the context of the proposed IPLER is crucial to creating an effective response. Here the data and product dissemination abilities of the industrial partners will be brought to bear – from Pictometry International and Kucera International at local scales, to the expertise of DigitalGlobe and ImageCat for regional information products. If executed properly, such a strategy will lead to decision makers receiving timely and synoptic information of affected areas toward designing an optimal response of personnel and materials.

Intellectual property (IP). The academic partners will retain ownership of all forms of intellectual property created by their employees in the performance of this project. In accordance with their respective policies, creative acts which result in an invention, copyright, tangible research property, trademark, or other form of IP will also be commercialized for the public benefit through licensing, creating a transfer of property rights, formation of startup companies, and the publication and dissemination of project information and results.

The expected outcome of this partnership is innovation through a process that will accelerate the transfer of knowledge from the academic sector to the private and public sector. It is expected that the innovation process will lead to new forms of intellectual property and avenues for commercialization. Such technology transfer will be supported by new and existing collaborations between the partners themselves and with participating companies. The partners will follow the normal legal guidelines for determination of ownership or authorship of intellectual property. Where more than one partner is a contributor to a new invention or work of authorship, the partners who are contributors will share in that creative work with full and equal independent rights to the creative work.

Much of the technology transfer that is expected to take place will result from the facilitation activities of the partnership. The goal of the partnership is to demonstrate what is possible in emergency management applications. The partnership expects to facilitate connections between the provider and user communities that result in direct sales of existing products, novel applications of existing technologies to emergency management problems, and the development of new products and services to meet responders' needs. The project team does not foresee systemic barriers to cooperative research in this area and expects that the IPLER role of facilitator will enable the transfer of knowledge.

1.3 Management Plan

1.3.1 IPLER Management

The IPLER will be managed by the Office of the Vice President for Research at RIT under the direction of Dr. Donald L. Boyd, the IPLER project PI. R&D activities will be managed by the research experts at the respective universities. The two PIs at RIT, Drs van Aardt and Vodacek, will initially focus on wildfire disaster information products, and UB PI Dr. Chris Renschelr will initially focus on flooding information product R&D at the NCGIA/MCEER RSI at UB. The PI and co-PIs will maintain coordination through monthly status meetings. Drs. Jamie Winebrake (RIT; policy) and Ron Eguchi (ImageCat; MCEER member) will contribute in supporting roles as senior personnel. Supporting team members consisting of technology/service providers and information users will advise the IPLER on research agenda and opportunities. Letters of commitment and support have been obtained for each of the named partners. The IPLER organizational structure is shown in the Supplementary Documentation.

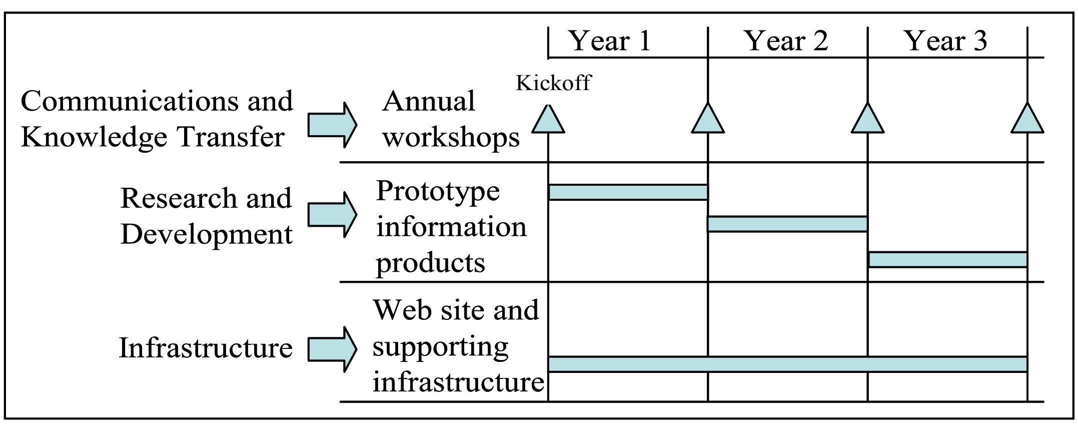


Figure 1.3.1-1: IPLER Program Schedule

The activities of IPLER will be conducted within three major sub-activities; Communications and Knowledge Transfer, Research and Development, and Infrastructure. The IPLER program will be launched with a kickoff meeting hosted by RIT (at RIT and by telecon) in which UB, private sector, and public sector representatives will define a set of notional requirements for new or improved information products that will become the focus for the research and development for that year. The selection of an information product will be based on discussion with the information users about what their needs are in light of the data and tools that are available from the commercial providers. Figure 1.3.1-1 shows the schedule for these activities.

1.3.2 Communications and Knowledge Transfer

The Communications and Knowledge Transfer activity is focused on facilitating communication of the needs and requirements of the end-users to the technology and service providers and of the technical capabilities of the providers to the users. This communication is vital to addressing many of the barriers to the greater use of remote sensing technologies for disaster management. Communications and Knowledge Transfer will be accomplished through a series of annual workshops hosted and moderated by the IPLER, beginning at RIT then alternating between RIT and UB each year thereafter. These workshops will bring together the IPLER stakeholders, academic, commercial and government to discuss topics such as:

- User problem definition and requirements including user operational requirements
- Recent research advances by the academic teams
- Commercial provider capabilities and the barriers to acceptance of their products.

Expected outcomes for each workshop includes plans for the next year's research, requirements for new disaster management information tools, and reports on key findings resulting from team discussions on requirements, research, and capabilities. Special topics of interest will be addressed via mini-workshops conducted in a virtual meeting format using telecon and video-con technology. IPLER academic team members will attend a minimum of two conferences per year. In the first year, the academic team will focus on wildfire and flood related topics. Researchers from both universities will participate fully in both conferences, as the capabilities of the two R&D partners are integrated to address the full range of needs of industry and the user community.

1.3.3 Research and Development

Research and development will be conducted by both RIT and UB/MCEER on topics relevant to the mission of the IPLER. R&D will draw upon material, data, and resources available from the commercial partners as well as at RIT and UB. Initially, the focus will be on the development and demonstration of new capabilities related to wildfire management and flooding response. Other disaster application areas will be added based on feedback from the user community. The development of new information products will be based on existing data sets available from the academic, private, and public sector partners and the use of existing or modified tools which will be adapted by researchers to the specific application. For example, imagery data sets from a major flood event from the DigitalGlobe archive will be used in conjunction with various analytical tools from ImageCat to evaluate what new or improved information products can be derived. RIT's advanced airborne sensors will provide tailored remotely sensed data in order to generate information products not readily available to the user community.

1.3.4 IPLER Infrastructure

The infrastructure for the IPLER consisting of software, processing hardware, and data collection systems will be hosted and maintained at RIT. All hardware and software will be provided at no cost to the project through the use of already existing items or provided at no cost by company partners. NSF PFI funding will be used to provide software engineering support for integration of new tools and data sets. A student will be hired to set up and maintain a program web site that will include links to relevant reports from the IPLER, sample data sets, sample information products, program news and links to IPLER partner web sites. The research and product development infrastructure will consist of software, data storage and computing hardware, and advanced airborne data collection hardware that will be provided at no cost to the NSF. Program funding will be used for software engineering support to integrate and modify (if necessary) existing software tools into an integrated workflow and to set up a data management architecture.

1.3.5 Partner Roles and Responsibilities

The IPLER team is made up of world class members that will significantly contribute to the success of the proposed PFI project. Each partner joined the IPLER team because of the potential benefits to each partner in executing their goals.

Technology and Service Providers
RIT and UB have secured the support of a diverse team of technology and service providers that represent a wide range of operational scales (regional to global) and technical capability (satellites and airborne sensors to analysis software tools). These team members have agreed to support the IPLER effort through in-kind contributions of people's time, data sets for use in the R&D activities, and existing software tools. In return, these supporting team members will benefit from IPLER research into new and improved capabilities and products as well as opportunities to interact directly with representatives from the user community to better understand the real business opportunities.

Kucera International – Private Sector Partner
- Expertise: One of world's largest private mapping operations, aerial photography, LIDAR
- Recent Relevant Work: Wildfire mapping, mapping thermal effluents from power plants
- Providing to IPLER: Imagery and LIDAR data sets, airborne data collection opportunities
- Benefit from IPLER: Better understanding of use of LIDAR for natural disasters, more effective change analysis (pre-disaster to post disaster) tools.

ImageCat Incorporated – Private Sector Partner
- Expertise: Leading provider of advanced technologies for risk and disaster management. Visualization tools, damage loss estimation, post disaster analysis tools, field analysis tools
- Recent Relevant Work: Hurricane Katrina; Indian Ocean tsunami; Northridge, Bam and Niigata earthquakes; 9/11
- Providing to IPLER: Access to analysis tools
- Benefit from IPLER: Evaluate use of high resolution thermal, multispectral, hyperspectral imagery in ImageCat tools

DigitalGlobe – Private Sector Partner
- Expertise: World's leading provider of high resolution commercial satellite imagery
- Recent Relevant Work: Hurricanes Katrina and Ike, earthquakes near Bam, Iran and Balakot, Pakistan, Indian Ocean tsunami, California wildfires, and tornadoes across the Midwest
- Providing to IPLER: High resolution satellite imagery data

- Benefit from IPLER: Further understanding of use of satellite imagery for disaster response and pre to post disaster change detection

Pictometry International – Private Sector Partner

- Expertise: Leading provider of geo-referenced aerial, oblique image libraries and software
- Relevant prior work: widely used by county GIS, planning and assessing professionals, 2008 Midwest floods, Hurricane Ike, DHS Phase II SBIR for rapid collection and dissemination of aerial imagery data
- Providing to IPLER: Pictometry product data
- Benefit from IPLER: Better understanding of how airborne LIDAR mapping, infrared imaging, and spectral analysis can be applied to aid the emergency response community

User Group Supporters

In addition to the contributing team members from industry, RIT has secured the support of a multi-faceted group of information users / consumers. The group consists of local, state, and federal agencies responsible for disaster management. Additionally, the NY State agency responsible for promoting technology transfer from academia to industry and technology development (NYSTAR) is keenly interested in participating in the IPLER project.

USFS Remote Sensing Applications Center (RSAC) – Public Sector Partner

- Expertise: Operational support for fire fighting through production of maps of wildland fire activity using satellite imagery and remote sensing technology
- Recent Relevant Work: Worked with RIT to conduct demonstrations using advanced high resolution aerial imaging capabilities for providing timely information for wildfire detection and mapping. RIT has also supported RSAC as a member of the Tactical Fire Remote Sensing Advisory Committee (TFRSAC). The TFRSAC is composed of fire management practitioners, remote sensing scientists, GIS specialists, and industry and university affiliates to formulate a tactical fire information gap analysis and prioritize development and transfer technologies related to those gaps.
- Providing to IPLER: Consultation for information product needs and requirements, feedback on IPLER research
- Benefit from IPLER: Better understanding of industry capabilities, access to new information tools and products

NYS Office of Homeland Security (OHS) – Public Sector Partner

- Expertise: responsible for the direction and coordination of a comprehensive counter-terrorism and "all hazards" prevention, preparedness, and response strategy to protect the people of New York State.
- Recent Relevant Work: OHS has invited RIT to conduct demonstrations using advanced high resolution aerial imaging capabilities for providing timely information to the New York State Police and Department of Environmental Conservation. Exercises have included the airborne mapping of a correctional facility, downtown Albany, and suspected marijuana growing sites.
- Providing to IPLER: Consultation for information product needs and requirements, feedback on IPLER research, coordination of demonstrations with state agencies
- Benefit from IPLER: Understanding of industry capabilities, access to new information tools and products

New York State Foundation for Science, Technology and Innovation (NYSTAR) – Public Sector Partner

- Expertise: NYSTAR supports technology development, innovation and commercialization leading to economic growth in New York State through partnerships, sponsored research, education, and policy.
- Recent Relevant Work: NYSTAR has sponsored RIT in several technology transfer projects including the transfer of remote sensing technology to a small local business. NYSTAR has invested over $14M at RIT for facilities to enhance technology development and transfer.
- Providing to IPLER: Consultation for information product needs and requirements, assistance in planning and implementation of programs and demonstrations, identification of funding and partnership opportunities
- Benefit from IPLER: Economic growth for upstate New York

Monroe County Office of Emergency Management (OEM) – Public Sector Partner

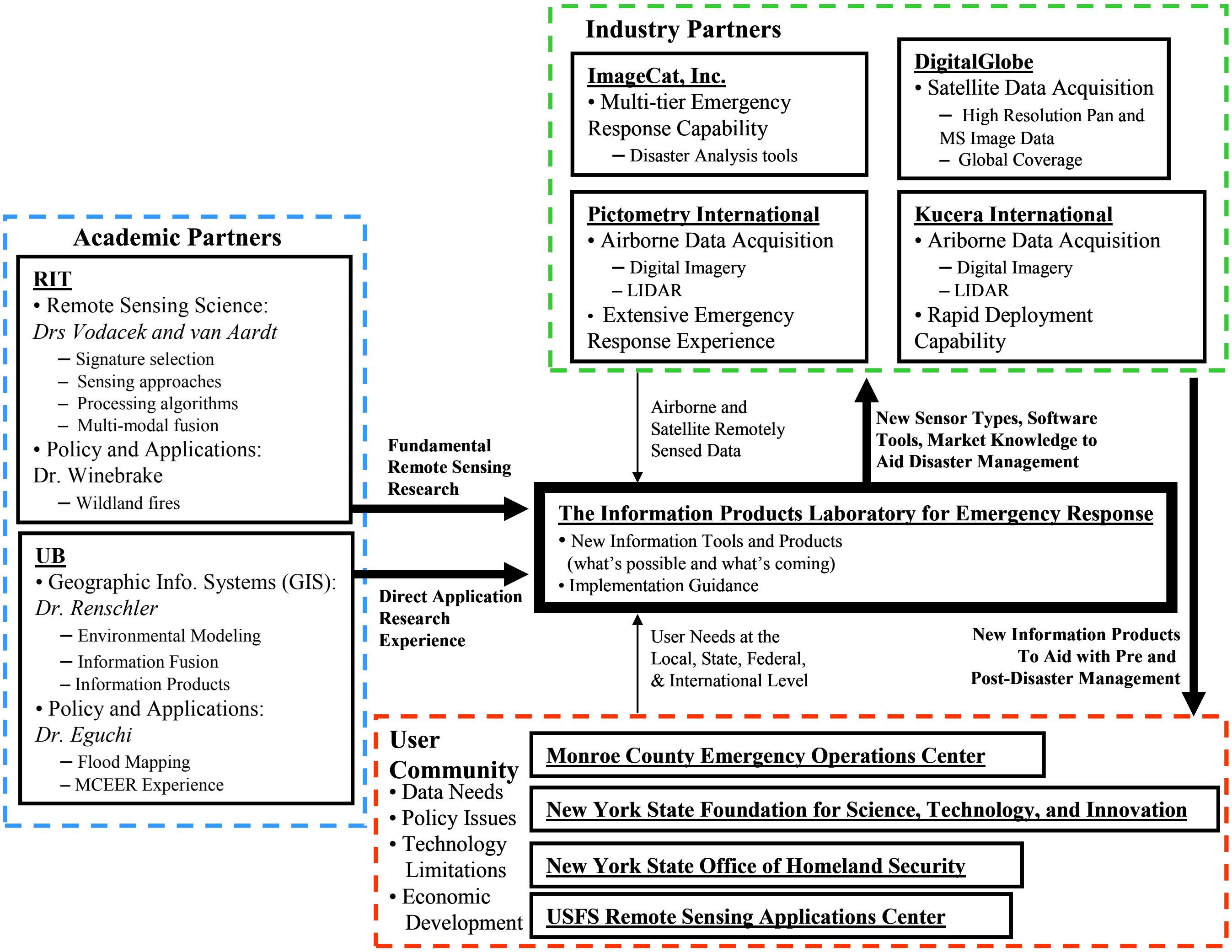
- Expertise: Maintaining and administer an integrated Emergency Management program designed to assure a safe environment through readiness, response, and recovery
- Recent Relevant Work: OEM has invited RIT to participate in several disaster exercises and demonstrations, using their advanced high resolution aerial imaging capabilities for providing timely information to their state of the art Emergency Operations Center. Exercises have included the monitoring of a simulated nuclear emergency at the nearby Robert Ginna nuclear power plant. In the demonstrations, RIT imaged and mapped areas of interest such as boat exclusion zones on Lake Ontario and evacuation routes.
- Providing to IPLER: Consultation for information on product needs and requirements, provide facilities for operational demonstrations
- Benefit from IPLER: Better understanding of industry capabilities, access to new information tools and products

Organizational/Role Diagram

The IPLER organization is illustrated below. The program consists of three types of entities, Academic Partners, Industry Partners, and the User Community. RIT and UB combine to form the academic core of the project. The complementary expertise of the two universities brings a comprehensive technical approach that includes the science and technology of remote sensing from RIT and the expertise of GIS and disaster applications from UB.

The Industry Partners bring a diverse set of skills and perspectives as providers of technology and services for the disaster management marketplace. Each partner has committed their support to the IPLER in the form of in-kind contributions from their available stock such as data sets and software tools. They will also be active participants in workshops with the academic and user communities.

The User Community partners represent local, state, and federal government agencies. These partners have also committed their support to the IPLER through active participation in workshops and as consultants in providing their valuable insight into the specific information and operational needs of their respective agencies.



IPLER Organization Chart

Proposed Resource Plan for Sustainability

The Information Products Laboratory for Emergency Response (IPLER) will be sustained in the long run through funding by participating entities (both technology providers and information users), partnerships with entities not already part of the IPLER, and new grants requiring IPLER capabilities.

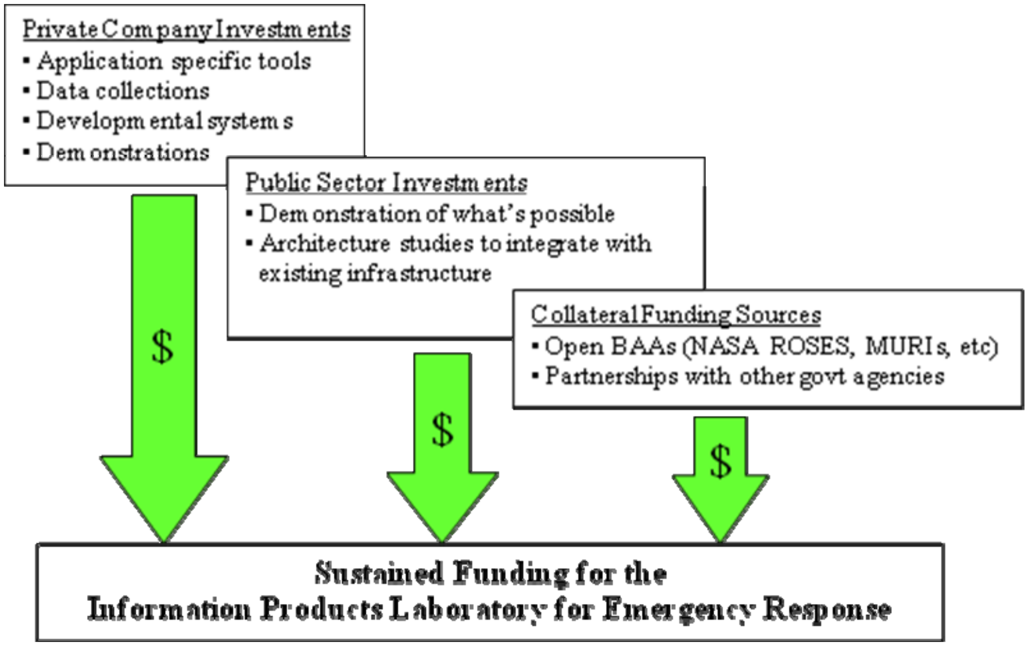
The IPLER will make extensive use of existing infrastructure such as data storage servers, computing resources, and experienced personnel capable of processing remotely sensed data and generating information products. The IPLER will operate as a laboratory within the RIT Chester F. Carlson Center for Imaging Science, but will be a resource for the entire emergency response community.

The strategy for maintaining the sustainability of the IPLER consists of
1) Relevancy - interaction with users ensures research satisfies their needs and interests
2) Quality - experienced investigators understand the problem and deliver results
3) Awareness - workshops and web site maintain visibility of IPLER to potential new partners

Growth of the IPLER enterprise is predicated on delivering high quality research results that, because of end user participation in the development process, are relevant and therefore have real marketable value. Awareness about the work of IPLER will be brought about through open workshops, publications, and attendance at conferences. This awareness will lead to additional opportunities for funded research and demonstration projects. We have found that the IPLER will provide an important resource not readily available to the public and private sector. Remote sensing data collection companies typically do not have an R&D arm that can explore the development of new data products that would be valuable to the emergency response community. The public sector emergency response community may not always know what technology solutions are currently or soon to be available. Filling this knowledge gap will aid the emergency response community while providing expanded business opportunities for companies.

We have identified three broad categories of funding (see the figure below) to sustain and grow the IPLER. Private sector companies are interested in funding the development of application specific tool and system capabilities that will provide them a competitive advantage. The public sector (local, state, and federal agencies) wants to fund developments that will assist them in fulfilling their specific mission while aiding the academic programs and enhancing the capability of the private sector. Collateral funding sources from agencies chartered to aid general research can be tailored to support the mission of the IPLER.

RIT has successfully implemented this model related to its wildland fire research. The core funding for the research came from a multiyear NASA grant to investigate fire phenomenology and detection. This led to a second multiyear NASA grant that resulted in the development of an advanced airborne fire mapping sensor called the Wildfire Airborne Sensor Platform (WASP). RIT has supported multiple airborne data collections for companies who used the resulting data as part of their research into possible new sensors. Finally, RIT has received multiple direct research contracts with the US Forest Service in support of multiple research projects related to fire mapping.



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December 12, 2008

Dr. Donald L. Boyd
Rochester Institute of Technology
Office of the Vice President of Research
141 Lomb Memorial Drive
Rochester, NY 14623-5608

RE: Partnership for Innovation

Dear Dr. Boyd,

DigitalGlobe is pleased to provide you with a letter of commitment to becoming a partner with the Rochester Institute of Technology (RIT) on its Partnership for Innovation (PFI) proposal to the National Science Foundation.

DigitalGlobe is the world's leading supplier of high resolution commercial imagery captured by our state-of-the-art satellite systems. When widespread tragedy strikes from natural disaster, it is often impossible to assess the extent of damages on the ground. DigitalGlobe imagery has been instrumental to agency relief efforts around the globe, including those for Hurricanes Katrina and Ike; earthquakes near Bam, Iran and Balakot, Pakistan; the Indian Ocean tsunami; as well as seasonal events like California wildfires and tornadoes across the Midwest. DigitalGlobe imagery has been used to support initial disaster response efforts as well as ongoing support for rebuilding and insurance claims.

It is anticipated that the proposed project with RIT and the University of Buffalo (UB) will provide DigitalGlobe with an important resource to further investigate how our satellite imagery can be used to respond to natural disasters. Of particular interest is the use of overhead imagery both before and after disaster strikes, to establish more effective change detection analysis. As part of our commitment to this project, DigitalGlobe is prepared to provide imagery from our vast data archive to the RIT/UB academic team to aid in its research. In return, we look forward to the technology transfer opportunities from the academic team that will enable DigitalGlobe to provide new products and services to the global emergency response community.

Should this project be awarded, scope of support and rights to results shall be negotiated prior to commencement of the project. DigitalGlobe looks forward to a productive and successful partnership with RIT and the Partnership for Innovation. Please direct any correspondence regarding this partnership opportunity to Mr. Vic Leonard.

Respectfully,

Dr. Walter S. Scott
Executive Vice President and Chief Technical Officer
DigitalGlobe, Inc.

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