VACCINE

Visual Analytics for Command, Control and Interoperability Environments
A U.S. Department of Homeland Security
Science and Technology Center of Excellence

VACCINE ANNUAL REPORT – YEAR 5
JULY 1, 2013 – JUNE 30, 2014

Cooperative Agreement No. 2009-ST-061-CI0001

PURDUE UNIVERSITY

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U.S. Department of Homeland Security

Homeland Security University Programs
Today's Research & Education, Tomorrow's Security

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I. Summary

Overview

Established in July of 2009, the Visual Analytics for Command, Control, and Interoperability Environments Center (VACCINE), along with its co-lead, Rutgers University, has served as the Department of Homeland Security's (DHS) Center of Excellence in Visual and Data Analytics. VACCINE's mission continues to focus on creating methods, tools, and applications to analyze and manage vast amounts of information for all mission areas of homeland security in the most efficient manner. VACCINE accomplishes its mission through an integrated program of research, education, and outreach, spanning the disciplines of visualization and computer graphics, engineering, computer science, geographic information systems, cognitive psychology, information technology, and emergency management and public safety. VACCINE is an international center with the overall management handled by Purdue University. The education/MSI mission is directed by Purdue University with partners Jackson State University, Florida International University, and Morgan State University providing critical input. VACCINE currently has three official MSI partners, Morgan State University, Florida International University, and Jackson State University, with interest recently express by Bethune-Cookman University of joining the team. The VACCINE team is currently comprised of the following 27 entities with the associated Principal Investigator listed for each school:

University	*PI*
Arizona State University	Dr. Ross Maciejewski
Carleton University, CA	Dr. Jim Davies
Dalhousie University, CA	Dr. Kirstie Hawkey
Florida International University (MSI)	Dr. Shu-Ching Chen
Georgia Institute of Technology	Dr. John Stasko
University of Maryland	Dr. Niklas Elmqvist
Justice Institute of British Columbia, CA	Dr. John Dill
Morgan State University (MSI)	Dr. Timothy Akers
Ontario Institute of Technology, CA	Dr. Christopher Collins
Pennsylvania State University	Dr. Alan MacEachren
Purdue University	Dr. David Ebert
Simon Fraser University, CA	Dr. Brian Fisher
Stanford University	Dr. Pat Hanrahan
University of Oxford, England	Dr. Min Chen
University of British Columbia, CA	Dr. John Dill
University of Calgary, CA	Dr. Sheelagh Carpendale
Jackson State University (MSI)	Dr. Richard Alo

University	PI
University of Manitoba, CA	Dr. Pourang Irani
University of North Carolina, Charlotte	Dr. William Ribarsky
University of Oxford, UK	Dr. Min Chen
University of Stuttgart, Germany	Dr. Tom Ertl
University of Texas at Austin	Dr. Kelly Gaither
University of Victoria, CA	Dr. Evert Lindquist
Oak Ridge National Labs	Dr. John Goodall
University of Washington	Dr. Mark Haselkorn
University of Notre Dame	Dr. Pat Flynn
Virginia Tech	Dr. Chris North

Figure 1: University Partners and Principal Investigators

VACCINE is strategically positioned to support the Department of Homeland Security in confronting the challenges of safeguarding our nation in preventing, responding to, and recovering from events including: criminal investigation, health surveillance, fraud detection, emergency response, natural disasters, and border and infrastructure security. VACCINE focuses on the research, development, and deployment of interactive visual analytic environments for decision making and communicating information among the massive homeland security data deluge. VACCINE integrates data and analysis into interactive visual displays to enable users to make discoveries, decisions, and plan action using a variety of information sources and visual/analytical techniques. Turning massive data into actionable knowledge through the field of visual analytic is vital to the mission of The Department of Homeland Security and its mission areas.

I. Accomplishments

During Year 5, the VACCINE team worked diligently to create a robust portfolio of research and academic projects, as well as to make significant progress in our outreach and overall transition activities. Highlights of our team's efforts include the data in Figure 3 as well as the following:

- VACCINE continued to build our **multi-agency public safety consortium** as well as our team of experts with additional organizations; we developed new relationships with organizations such as the University of Texas Police Department, Customs and Border Protection, Oak Ridge National Labs, Bethune-Cookman University, Crane Naval Base, Evansville Police Department, Chicago Police Department Office of Emergency Management Communications, and the Greater Cleveland Regional Transit Authority (and an official partnership with ALERT).

- Our **Visual Analytic Law Enforcement Toolkit (VALET & iVALET)** continues to be popular among police departments. New users include the Evansville Police Department, the New Albany Police Department, University of Texas Austin Police Department, as well as the Indianapolis Public Safety leadership. Additionally, multiple entities have expressed interest in licensing VALET and VACCINE is in the negotiation process.

- In September of 2013 the USCG awarded VACCINE Director and Purdue University Silicon Valley Professor of Electrical and Computer Engineering David S. Ebert, a **Meritorious Team Commendation**. The commendation was for achievement on the United States Coast Guard Port Resilience for Operational/Tactical Enforcement to Combat Terrorism (PROTECT) Team.

- The United States Coast Guard and VACCINE **co-hosted the fourth annual maritime risk event: the National Strategic Maritime Risk Stakeholders Alliance Meeting**. The Coast Guard and U.S. Department of Homeland Security officials met with other experts during an annual conference at Purdue University in November 2013 to discuss a wide range of issues related to maritime safety, risk, the arctic, climate change, natural disasters, inland waterways and interagency cooperation. This year's theme was "Data-Driven Risk-Based Decision Making in the Maritime Domain." The event brought together academic researchers with "operators" from the federal, state, and local levels and was designed to stimulate interagency conversation on important local, regional, and national topics. The conference drew participants from the Coast Guard, Department of Homeland Security, the Federal Emergency Management Agency, the Transportation Security Administration, Purdue, the Indianapolis Police Department, Royal Canadian Mounted Police, and homeland security and public safety agencies. Keynote speakers were Coast Guard Vice Admiral Robert Parker, Commander Atlantic Area, and Alan D.

Cohn, assistant secretary for strategy, planning, analysis and risk in the DHS Office of Policy. Rear Admirals Kevin Cook and Peter Brown, as well as Jim Kish from FEMA, were invited speakers.

- **Jigsaw** is being used by the Indianapolis Police Department, the West Lafayette Police Department, the Rock Hill Police Department (SC), and the Lafayette Police Department. There have been over 1100 downloads of the system, including Air Force Intelligence, AFRL Wright Patterson, Army Counterintelligence, Boeing Deloitte, Naval Research Lab, NCIC, PayPal, Thomson Reuters, United Nations Investigators Office, US Attorney's Office Organized Crime Taskforce, as well as numerous newspapers and police departments.

- **GARI (Gang Graffiti Recognition and Analysis)** is being used by the Indianapolis Metropolitan Police, the Indiana Intelligence Fusion Center Gang Task Force, the INGang program, the Cook County Sherriff's Department, the Navajo Nation, and the Illinois State Police. Additionally, a number of other law enforcement entities (approximately 400) have expressed interest in using and deploying the tool. We have developed a community version for release that runs in a similar manner, but only allows for the reporting of graffiti with no information visible to the individual uploading/reporting the graffiti image. The tool is in operation and has servers installed at the Indiana Intelligence Fusion Center in Indianapolis and the Cook Country Sherriff's Department in Chicago; a long term plan for maintenance and support is being explored. There are currently 54 users of the system in Indianapolis, and 23 within Cook County. There are an additional 70 or so users testing from our own server and over 1200 images have been collected and uploaded. Finally, the tool can also handle tattoo images of gang related content.

- As part of the **COAST** project, we continued work to develop the cgSARVA suite of tools that can be used to analyze all Coast Guard operations across the United States, based on module-based relationships. VACCINE is in Phase II of the project with plans to complete transition in Year 6.

- In collaboration with the VACCINE and the Miami-Dade County Department of Emergency Management, DITRG (Disaster Information Technologies Research Group (DITRG) at Florida International University) has produced a tool known as the **Multimedia Aided Disaster Information Integration System (MADIS)**. This tool, which has been successfully demoed during VACCINE Annual Meetings as well as through several disaster training scenarios, makes it easier for emergency managers to gather relevant information by automatically linking situation reports directly to imagery obtained and uploaded by responders and the public. Jesse Domack from FIU who has

been working on MADIS has received a number of recognitions in 2013. He was awarded the "Top Technology Student" by the Greater Miami Chamber of Commerce and the Computing Research Association awarded him an Honorable Mention in Computing Research for Outstanding Undergraduate Researcher Awards.

- VACCINE worked with the **U.S Customs and Border Protection Agency** to assist in the design of infographics to display their 2013 information in their annual report.

- VACCINE was awarded a $500,000 grant to explore **financial data and predictive financial visual analytics** by a different U.S. government agency. This project kicked off in December of 2013.

- An improved prototype system and iPad application based on Florida International's "**Integration Framework for Enhancing Emergency Response**" system continue to be evaluated by personnel at Miami-Dade Emergency Management (MDEM), and future pilot activities are planned as part of the evaluation process.

- We continue to develop our network of **Minority Serving Institutions** for engaging in visual analytics research and education. Morgan State University, Jackson State University, and Florida International University are official partners. Over the past year, there were numerous engagement opportunities and a number of collaborative projects with the MSI partners in both education and research. Morgan State has participating in both student and professional education courses VACCINE has conducted, as well as working with some of the Visual Analytics Tools (Valet) to see how they can add features or adapt the technology to their own needs on the Morgan State Campus. Additionally, this year we rotated the MSI Faculty Training to host at our partner school, Morgan State University. Florida International University continues to research and develop various visual analytics tools and systems for first responders in the Miami-Dade community. Finally, Bethune-Cookman University reached out to us regarding becoming a partner and helping to develop visual analytics curriculum for their program.

- VACCINE proposed and kicked off a collaborative project with the **ALERT** (another DHS COE) team to explore an electronic BOLO (be on the lookout – known as **eBolo**) system. The test bed for the project is Cleveland's light rail system. As Cleveland will be hosting the next Republican National Convention, having a system in place that can re-identify persons of interest entering a public transportation system could prove quite useful. The eBOLO system would function by having a suspect identified on the camera system and signaling authorities when a person with similar characteristics re-enters the system. Researchers and students from the ALERT and VACCINE teams have made a pre-emptive meeting to a number of sites in Cleveland and met with the Great Cleveland Regional Authority Light Rail's Chief of Police and Director of Security, John Joyce.

- The Center for Maritime, Island and Remote Extreme Environment Security (MIREES), the Costal Hazards Center of Excellence, and VACCINE have partnered to determine the optimal path for integrating three well known tools produced by each center (PortsMapper, ADCIRC, and cgSARVA) in order to have one interface or dashboard, if possible. The Coast Guard would like to see the functionality of each tool overplayed to provide a single solution for a number of their queries.

- The **SMART** tool (developed by Purdue University, German partners at Stuttgart University, and Penn State), has had an uptick in requests this year. The tool is being tested and in use by a number of different agencies. The US Coast Guard has been one of the bigger proponents for the tool – it was used in a Thunder over Louisville a maritime event for monitoring safety. Based off of the success of that event, it has since been used to examine hoax calls and is slated to be used to monitor Fleet Week in San Francisco in October of 2014. SMART has also been used by the Maine State Police, the Purdue Police, and the Boy Scouts of America. Additionally, other federal agencies such as CBP have expressed interest in using the system.

VACCINE Accomplishments July 1, 2013-June 30, 2014	
Categories of Accomplishments	**7/1/2013 through 06/30/2014 :**
Student Enrollment in COE Programs:	
Traditional undergraduate and graduate students attending classes	2287
Students registered in on-line or other distance learning courses	74,295
Homeland security professionals attending courses	0
COE Funded Students	53
Papers	62
Software Products Developed	27
New Courses Developed	2
New Certificates or Degree Programs Developed:	
New Degree Programs	7
New Certificates	1
New private or public licencees/partners using coursework licensed by the COE	0
Patent Applications	0
Patents Awarded	2
Requests for assistance or advice from DHS (# of different DHS contacts/projects/requests)	44
Requests for assistance or advice from Federal, State, Local Government	442
Follow-on funding from other sources	$1,418,104
Presentations	76
Congressional Testimonies	0
Projects Completed	7
Collaborative Projects	3

Figure 2: Summary of VACCINE Accomplishments

II. Business Model and Management Scope

The role of developing detailed operational requirements is critical for the successful transition of technologies into the various homeland security fields. The VACCINE Center of Excellence recognizes the need for significant end-user involvement through the entire life cycle development process. The VACCINE team has refined our business model (Figure 3) with the goal of connecting homeland security researchers with the intended end-users. Understanding the requirements of our end-users is critical to the research and development of technologies, which will be transitioned to the broader homeland security community, and secondarily to other markets. Part of that understanding takes the form of our Public Safety Consortium exchanges as well as our regular project meetings with stakeholders and end-users.

The Public Safety Consortium consists of a number of law enforcement, first responder, emergency management, and federal agencies that allow for data to be shared and research conducted, furthering the development of next generation homeland security technologies. The Consortium provides a framework where VACCINE can deploy its tools to the various agency members, and our end-users provide in-field or real world evaluation and feedback. The group meets regularly to discuss ongoing changes to technology and tools being developed, improvements to technologies that have been deployed and are being evaluated, as well as to brainstorm future tools that would facilitate increased accuracy and ease of understanding data. Year after year, the Public Safety Consortium continues to grow, and VACCINE continues to expand its end-user community beyond our local community. Technologies designed in this fashion have the ability to be translational across a larger community of end-users geographically.

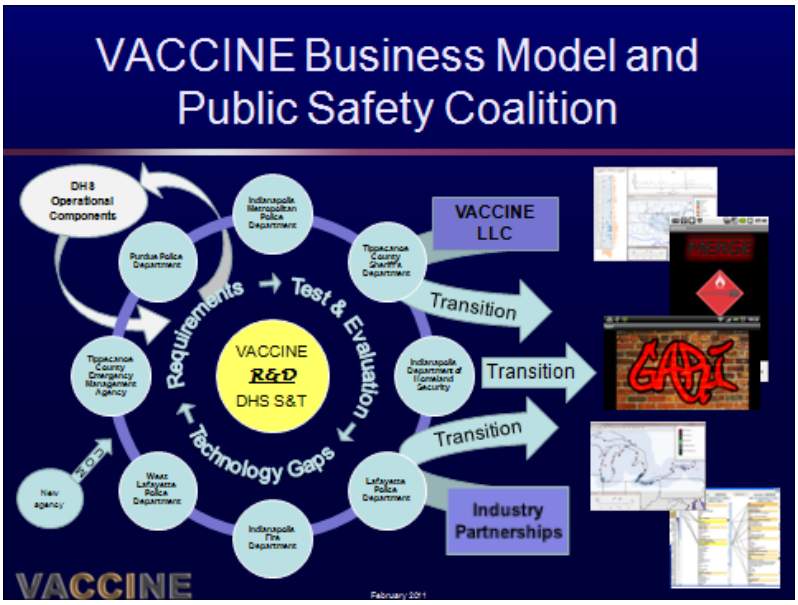

Figure 3: VACCINE Business Model

The VACCINE team has a strong, collaborative history and experience, which is essential to fostering internal collaboration, as well as collaboration with other DHS COEs, government agencies, field personnel, and researchers. Our Center's management structure has three components: management staff, a leadership board, and an external advisory board. The management staff is kept intentionally lean in order to maximize research and education funding while minimizing overhead. This team is responsible for overseeing the strategy, as well as the day to day operations of VACCINE. VACCINE staffing includes a director, managing director, center coordinator/administrative assistant, and education manager (part time) and finally an engagement and transition manager.

The VACCINE External Advisory Board provides strategic advice, information, and recommendations to the Center on basic and applied research activities, educational issues, and activities and operations related to visual analytics and command, control and interoperability in the homeland security environment. This board consists of the world's top experts in visual analytics and homeland security from the scientific, business, and government communities. Current membership includes:

- James Clamons

  Vice President Design Engineering, Harris Government Communications Systems
- David Kasik

  Enterprise Visualization Architect, Boeing
- Daniel Keim

  Professor and Head, Information Visualization and Data Analysis Research Group, University of Konstanz, Germany
- Joseph DiRenzo

  Senior Advisor to the Area Commander for Science, Technology and Innovation, United States Coast Guard, LANT Area
- Haesun Park
  Professor, Georgia Institute of Technology
- Constance Harris

  Educational Technologist, Purdue University

II. Research and Development Scope

The overall goal of VACCINE research is to create, deploy, and evaluate innovative and effective visual analytic environments—frameworks, methods, and software, which advance the start-of-the-art tools in analyzing massive, heterogeneous, incomplete, temporally evolving, homeland security data for anticipating, detecting, and responding to mission needs. Therefore, VACCINE has focused on developing new dynamic visual analytic techniques based on cognitive and perceptual principles that increase the user's effectiveness and create precision information environments.

The ever-growing volume of homeland security, science, engineering, and user-generated data has created a need for valuable, timely analysis tools that enable interactive visual analysis for comprehension and provide critical insights from this sea of data. Recently, this problem has been referred to as the "Big Data" problem. Big Data continues to be a growing topic within the IT and business community as exemplified by *The New York Times'* recent special section on Big Data, *IEEE Computer*'s special issue on Big Data, and over 10 special issues/sections of IEEE publications on Big Data in 2013. VACCINE researchers have focused on Big Data challenges since 2004 when Dr. Joe Kielman and DHS funded Dr. Jim Thomas to lead a team to define the research challenges of visual analytics for the problems facing our nation. The visual analytics research agenda (*Illuminating the Path: The Research and Development Agenda for Visual Analytics)* that was the result of our efforts is exactly focused on enabling discovery, decisions, and actions from Big Data. Our team has developed innovations in this area for almost 10 years and has extensive experience in solving Big Data challenges in public safety, public health, security, policy, business intelligence, social media, science, and engineering. VACCINE focuses on all of the dimensions of the Big Data problems: **Velocity, Volume,** and **Variety.** There are several groups who claim Veracity or Viscosity of data are the 4th dimension and we have expertise in those areas as well. Human-guided visual analytics can solve many of the problems that are still unsolved by most automated Big Data Analytics techniques.

For effective visual analytics, computational processing, data management, and visual representation are tightly integrated to efficiently present relevant information and solution alternatives to the user. Additionally, VACCINE has focused on improving both data management and statistical data modeling. To continue the successful deployment, scalability, and usability of developed technologies, we focused on integrating end-users from the beginning of a specific research and development project. Having our customers directly integrated with our projects allows them to instigate new projects, provide input and feedback, and transition paths for DHS technology transfer. Our projects are planned to be 6 to 36 months in duration with clearly defined deliverables and transition paths. Our main research thrusts are the following:

- **Core Visual Analytics Techniques** – Focusing on integrated, interactive visual exploration, analysis, and decision making environments to enable effective decisions from massive, time-evolving multimedia data.

- **Interactive Scalable Analytics Techniques** – A key challenge is developing statistical, spatiotemporal, image, video, signal, machine learning techniques designed and adapted for human-in-the-loop visual analytic environments that scale to real world "Big Data" solutions.

- **Science of Interaction for Visual Analytics** – Key findings in visual analytics have demonstrated that collaboration over and interaction with data are key components of an integrated computational-human decision making loop. This human-information interaction occurs at many levels from individual manipulation of data representation, to interactive cognitive discovery combined with automated analysis, to coordinative and distributed interactive analysis among groups of individuals. VACCINE has focused on clearly defining and developing a **Science of Interaction** to support ubiquitous and collaborative analysis and discovery utilizing new, transparent interaction tools.

- **Evaluation of Visual Analytics** in real world environments – Determining the effectiveness of visual analytics techniques and systems in actual operations use is a tremendous challenge since we are trying to determine if these new techniques and tools provide new insights, increase the rate of insights, or increase the effectiveness and efficiency of people doing complicated and sometimes very lengthy tasks. This is a completely different challenge than determining if someone can more readily find an outlier or pattern in a visualization or if someone can complete a very simple task more quickly. Traditional perceptual testing, computer interface, and human-computer interaction techniques are insufficient. Therefore, VACCINE researchers bridging cognitive science, visual cognition, human computer interaction, and visual analytics are exploring and advancing research in this area expanding and adapting techniques such as cognition in the wild and paired analytics.

- In May of 2014 VACCINE hosted a **Science of Evaluation Workshop** at the University of California San Diego. With approximately twenty individuals in attendance, the workshop attendees divided into groups and examined what it means to evaluate a visual interface or method and choose a specific application where those evaluations could be applied. The culmination of the workshop lead to a written document from each group; additionally, one group submitted theirs as a white paper for publication.

Themes

Our research and development efforts can also be categorized into three thematic overarching projects, our E2E projects, related to topic area and the end user community as follows:

- **Theme 1: Public Safety Coalition Projects** (e.g., state or local law enforcement, fire, emergency management)

- **Theme 2: Federal Operating Component Projects** (e.g., TSA, FEMA, Secret Service, ICE, CBP, USCIS, Coast Guard)

- **Theme 3: Visual Analytics for Security Applications (VASA)**

All of the projects associated with these themes have the following key pervasive homeland security problem characteristics: massive, time evolving, heterogeneous data of varying quality; multiple-scales of problem solving, planning, management, and action; coordinated information analysis; information security and privacy challenges; and a wide variety of needs, skills, and computing resources of involved personnel. The following is a list of research highlights that occurred during Year 5. Detailed descriptions of individual research projects can be found in Part VI, Research Projects and Descriptions (listed by institution).

Theme 1: Public Safety Coalition Projects Representative Project Highlights

- VACCINE continued building our **multi-agency public safety consortium** with organizations within the state of Indiana and extending it across the Midwest and Country. New partners include the Evansville Police Department, Indianapolis Public Safety Department, New Albany Police Department, Chicago Police Department Office of Emergency Management Communication, and the University of Texas Austin Police Department.

- **Jigsaw** is available for free download and is being used by the Indianapolis Police Department, the West Lafayette Police Department, the Rock Hill Police Department (SC), and the Lafayette Police Department. Currently, hundreds of people and organizations have downloaded the system, including Air Force Intelligence, AFRL Wright Patterson, Army Counterintelligence, Boeing, Deloitte, Naval Research Lab, NCIC, PayPal, Thomson Reuters, United Nations Investigators Office, US Attorney's Office Organized Crime Taskforce, as well as numerous newspapers and police departments.

- **GARI (Gang Graffiti Recognition and Analysis)** has been transitioned and deployed for use across Indiana through deployment the Indiana Fusion Center Gang Task Force Network (INGANG). It has also been deployed to the Cook County Illinois Sherriff's department and they are in the process of uploading over 20,000 gang graffiti images into the database. The system now also supports a tattoo database as well and the Indiana Department of Corrections is populating that database from their records. Additional requests from up to 400 independent agencies have also been received.

- Our **mobile phone hazardous material app (MERGE—Mobile Emergency Response Guide)** was delivered to TSA to be used in railcar inspections. Our tool allows a first responder to take a picture of the placard on a railcar or truck containing hazardous

materials. A transition plan for MERGE has been put into place and is currently being pursued. MERGE will appear on both iTunes and the Android app store in various forms over the next few months.

- An improved prototype system and iPad application based on Florida International's "**Integration Framework for Enhancing Emergency Response**" system continues to be evaluated by personnel at Miami-Dade Emergency Management (MDEM), and further pilot activities are planned as part of the evaluation process.

Theme 2: Federal Operating Component Projects

- We continue to improve **the Coast Guard Search and Rescue Visual Analytics (cgSARVA)** technology with more capabilities. As part of the **COAST** (Coastal Operations Analytical Suite of Tools) project, we continued work to develop the cgSARVA suite of tools that can be used to analyze all Coast Guard operations across the United States for multiple missions and considering multiple asset types (boat and air).

- **SMART (Social Media Analysis and Reporting Tool)** has been requested by a number of agencies and is currently being tested by the USCG, CBP, as well as the Red Cross. The USCG, for example, tested SMART at the Thunder Over Louisville event. This is a day-long air show and fireworks display held on and along the Ohio River in Louisville, Kentucky. Thunder Over Louisville serves as the kickoff event for the annual Kentucky Derby Festival, culminating with the Kentucky Derby on the first Saturday in May. The 2014 event drew an estimated 650,000 spectators to the Kentucky and Indiana sides of the Ohio River, as well as approximately 120 recreational boats that anchored in the river.

- Assistance with compilation of Annual Report for **Customs and Border Protection**. VACCINE created the infographics used in the official report.

Theme 3: VASA Project Highlights

The VASA project is a collaboration between VACCINE members, German Universities, and several international corporations to design a decision making environment considering cascading critical infrastructure issues. Effective analysis for emergency situations caused by severe weather conditions and natural disasters requires understanding of a comprehensive set of data, including weather, critical infrastructures, and transportation network logistics. However, both civic and business analysts often encounter difficulty in estimating the impact of an event, forecasting damage, and discovering optimal solutions from various resources due to incomplete sets of data, lack of reliable simulation models, and no existing environments for decision-making. We have designed and developing a visual analytics system that provides this environment for analysts and decision-makers.

The current VASA project components have been developed for power grid and smart grid issues related to alternative energy production fluctuations, computer network integration in the smartgrid, public transportation alternatives, food distribution networks, and severe events and disasters. The system has made it through beta testing and is currently being tweaked and completed.

III. Education Programs

During Year 5, VACCINE's educational initiatives focused on undergraduate and graduate level work (including work with MSI institutions) and professional education and training programs. The VACCINE educational mission is to educate current Homeland Security stakeholders and the next generation of talent in order to enable them to make effective decisions using the field of Visual Analytics as a knowledge base.

In November of 2012, VACCINE held an education summit in order to set educational goals for the remainder of the center's initial six year grant. Throughout the two day summit, various educational goals were discussed and the following actions were determined to be the educational goals for the remainder of the 6 years:

- VACCINE will collect the Visual Analytics courses offered at all partner institution.
- A number of the VACCINE schools now have master's degrees or certificates in Visual Analytics or Cyber Security, both of which are of interest to VACCINE. We are working on collecting this information or a regular basis.
- VACCINE would reach out to more community colleges in order to explore that option as a method of professional development/education.
- VACCINE decided to host a training for educators during the summer of 2013 on the Jackson State University campus in order to propagate the concept of visual analytics and explore how the discipline may be incorporated into a variety of fields.
- Explore schools with criminal justice programs to see if there is interest in that field.

In Year 5, VACCINE was able to make some headway in these goals. The education team has collected the courses offered in visual analytics at all partner centers and it providing that information on the website. VACCINE has been working with Ivy Tech to more thoroughly integrate visual analytics into their Criminal Justice coursework. This past spring we participated as guest lecturers to introduce the subject matter. Based on the success of the MSI Faculty Training (teaching the teacher) for visual analytics held at Jackson State University in July of 2013, VACCINE hosted another training at Morgan State University in the summer of 2014. VACCINE has also continued to graduate PhD, Masters, and HS STEM Fellows as we have every year. Additionally, each year, VACCINE participates in any number of briefings for many, varied audiences. This year the team presented countless times to groups ranging from Customs Immigration Service, to the SPAR group at DHS, to the Joint Task Force group in Key West. This process of educating various groups provides an outreach component for VACCINE we could not otherwise accomplish. The VACCINE team is able to reach a variety of audiences and give them a brief, but helpful view of visual analytics and what can be accomplished.

Minority Serving Institution Partners

VACCINE has a number MSI partners Florida International University, Morgan State University and, Jackson State University. We have worked closely with these schools, as they are part of the VACCINE team, in both the research area as well as the educational mission of the center. Throughout year 5 of the VACCINE center, there were numerous engagement and learning activities conducted with our MSI partners. A few are mentioned below:

- VACCINE hosted a DHS Summer Research Team Program for Minority Serving Institutions who participated in a research project with a VACCINE faculty member for the summer of 2014. The team was placed at Florida International University with Dr. Shu-Ching Chen.
- Our second annual MSI Faculty workshop was held at Morgan State University during the summer of 2014. Faculty instructors gave a two day summary of visual analytics applications and content and how that can apply for various disciplines. The attendees were other faculty members from MSIs who do not have familiarity with visual analytics.
- VACCINE had four Morgan State University undergrads come to Purdue's campus for a two week boot camp in Visual Analytics. The students were exposed to a number of VACCINE Center and commercial tools to help understand the power of using visual analytics.
- Bethune-Cookman University has expressed interest in becoming an MSI partner of VACCINE. They are working to develop a specialty in visual analytics and have recognized the expertise of the VACCINE team.

Undergraduate/Graduate Course Program

HS-STEM Career Development Program

The HS-STEM Career Development program is a competitive program funded through DHS that was established at Purdue in 2007 under David Ebert. Purdue offered fellowships to seven graduate students in 2007, three graduates and one undergraduate student in 2008, and three graduate students in 2010. Since we still had openings under the 2010 HS-STEM grant in 2011 and 2012, we continued to recruit new students. As a result of these recruitment efforts, we have added four new students to the program three who entered in fall of 2012. VACCINE applied for a continuation of funding through a proposal for the HS-STEM program and has been awarded additional funding to be distributed in year 5. As a result, additional HS STEM students were brought selected over the 2013-2014 school year and will begin in the fall of 2014.

The HS STEM program has had 2 graduates complete not only their degrees, but their years of service. Dr. Daniel Richardson received his PhD in Mechanical Engineering and completed his

year of service during the summer of 2013. He spent his time at Purdue researching and learning about Mechanical Engineering. The HS-STEM area he was most interested in was the Explosives, Detection, Mitigation, and Response arena. His project involved explosive detection and identification with advanced laser techniques. In order to complete his year of service, Daniel has been working as a National Research Council Research Associate at the Wright Patterson Air Force Base. He is currently part of the laser diagnostics group at the Air Force Research Laboratory (AFRL). Daniel's work has increased the understanding of fundamental fluid dynamics as well as the application of laser diagnostics to challenging environments. This, in turn, is related to the areas of explosive detection, biological, and chemical threat detection. Mr. Matt Levendoski spent his time at Purdue University pursuing a master's degree in cyber forensics. Matt graduated in the spring of 2013 and is still working on completing his service requirements. While he was a student, he did participate in a number of internships including work with Lockheed Martin and the Purdue Police Department in cyber forensics.

In order to create a cohort from students who have various disciplines, but all share an interest in Homeland Security, there are monthly HS STEM luncheons. This is a time for one student to present and the rest to learn where there are in their careers and research and how this all pertains to homeland security. Additionally, students are required to submit semester reports and updates on both their research and any service they are participating in. The VACCINE team has also added a resent, encouraged option to have the HS STEM Fellows serve as research assistants in the VACCINE lab if they are so qualified. This will begin in the fall of 2014, and it is expected they will have a more direct understanding of Homeland Security as a result.

SURF/VAST Program

Purdue University has a Summer Undergraduate Research Fellowship Program (SURF) in which, undergraduates have the opportunity to participate in research at various labs throughout the summer. In this program, approximately 150 undergraduate students spend 11 weeks working in individual labs and conduct research. VACCINE has participated in this program in the past, and did so again this year. We call our version of this program VASP (Visual Analytic Summer Program). In the summer of 2014, VACCINE hosted three students from Purdue University and one from California Baptist in the lab for 11 weeks. The students on individual projects, including SMART, Valet, and other smaller projects. The students who worked in the lab were so productive and interested in the research that we have offered them employment for the school year. As an additional note, the student the VACCINE lab had in the summer of 2013 are now graduate student research assistants for VACCINE. This model has served as an excellent training and recruitment opportunity.

Professional Training

A. Ivy Tech

VACCINE had been in continued contact with Ivy Tech, a network of community colleges throughout the state of Indiana. After meeting with a number of faculty and administrators, we have discussed a number of ways to incorporate Visual Analytics into the curriculum throughout year 5 of the center. While looking at community colleges to interact with, we determined Ivy Tech held a lot of potential due to its structure. While there is a campus in Lafayette, IN near Purdue University, there are actually 31 campuses across the state. When meeting with our local group, we discussed having VACCINE present at their Deans meeting, in which deans from each of the campuses get together to discuss curriculum. Another advantage of Ivy Tech is that a number of our first responder partners actual instruct part time at the Lafayette Campus, allowing them to understand and potential incorporate our tools into their coursework. As previously mentioned, VACCINE was able to participate in the form of guest lectures in the Spring of 2014 and we hope to continue this development.

B. Education and Training for First Responders

VACCINE routinely presents the tools and technology developed to a number of different law enforcement entities; occasionally those presentations take the form of professional training in addition to a presentation on the types of tools and applications developed by VACCINE. There have been a number of presentations to numerous public safety audiences over the past year that went through some of the tools step by step and provided use information. Further, some of the tools already have completed training videos and others are still in production. Additionally, during the VACCINE Annual Meeting in September of 2013, law enforcement officers and first responders were training on a number of the VACCINE tools. Trainings were conducted of the VALET/iVALET, Jigsaw, SMART, GARI, and MERGE. VACCINE is also in the process of making step by step short reference tutorials.

IV. Partnerships and Outreach

VACCINE has been very active in both its domestic and international outreach efforts. We have built upon our existing relationships and established many new collaborative partners as previously mentioned. The number of requests VACCINE receives for the tools and technology produced does not allow us to partner with every agency that make a request at this time (there have literally been hundreds of requests over the last year alone). Instead, we have focused our efforts on intense interaction with any end users we do partner with. Subsequently, we work to determine the best way to transition our technology to make it readily accessible to homeland security personnel. We are working diligently, daily, to determine the best way to interact and deploy our tools to all that request.

Technology Deployment

VACCINE's mission is to create tools and technologies for the first responder and homeland security community. Understanding that most first responders require tools that are mobile, VACCINE continues to develop a suite of tools for our stakeholders to use in the mobile environment. Our suite of tools includes:

VALET Visual Analytics law Enforcement Toolkit

The Visual Law Enforcement Toolkit (VALET) provides law enforcement agencies with a suite of analytical tools coupled with an interactive visual interface for data exploration and analysis, forecasting, planning, and management. This system includes linked views and interactive displays that spatiotemporally model criminal, traffic and civil (CTC) incidents and allows officials to observe patterns and quickly identify regions with higher probabilities of activity.

Our toolkit provides analysts with the ability to visualize different types of data sets (census data, daily weather reports, zoning tracts, prominent calendar dates, etc.) that provide an insight into correlations among CTC incidents and spatial demographics. In the spatial domain, we have implemented a kernel density estimation mapping technique that creates a color map of spatially distributed CTC events that allows analysts to quickly find and identify areas with unusually large activity levels. In the temporal domain, reports can be aggregated by day, week, month or year, allowing the analysts to visualize the CTC activities spatially over a period of time. Furthermore, we have incorporated temporal prediction algorithms to forecast future CTC incident levels within a 95% confidence interval. Such predictions aid law enforcement officials in understanding how hotspots may grow in the future in order to judiciously allocate resources and take preventive measures. Our system has been developed using

actual law enforcement data and is currently being evaluated and refined by VACCINE's Public Safety Consortium of law enforcement agencies.

The VALET software is available on a PC, iPhone, or iPad and has been deployed a number of agencies. VALET provides advanced analysis capabilities, allowing analysts to develop and test hypothesis about criminal activities within various areas of their communities. While development of VALET and iVALET has taken place over a number of years, this past year we have tested in operationally with a number of law enforcement agencies (specially the Ohio State Highway Patrol, the Lafayette Police Department, The Illinois State Police and the NYPD are all currently testing or using the software functionally). Given the current stage in development, we have reached out to license the technology and have ongoing negotiations with two entities.

MERGE (Mobile Emergency Response Guide)

Hazardous materials can react differently to stimuli and can cause problems in accidents and emergency situations. This fact makes them particularly dangerous to civilians and first responders. It is for this reason that the Emergency Response Guidebook was developed. This paper guide assists those in an emergency with the knowledge of how to handle hazardous materials. As one might expect, the guidebook is large and requires precious time to search an index to determine the best way to handle a particular hazardous material. The MERGE system is an electronic version of the guide with many new features and capabilities. These new capabilities include the use of image analysis methods to automatically determine the type of hazardous materials present based on an image taken of the sign/placard. MERGE has an easy to understand user interface to instruct an emergency responder or civilian in the proper way to handle a hazardous material emergency.

MERGE was developed at the request of our first responders. MERGE has been deployed to several law first responders groups and have very positive responses from our targeted user groups which include: the Lafayette, West Lafayette, Indianapolis, and St. Clair, MI Fire Departments, and is available by request. VACCINE is in the process of putting various versions of it on the Android App store as well as iTunes. Proceeds will come back to the VACCINE center to support updates on the software.

GARI (Gang Graffiti Automatic Recognition and Interpretation)

Gangs are a serious threat to public safety throughout the United States. Gang members are continuously migrating from urban cities to suburban areas. They are responsible for an increasing percentage of crime and violence in many communities. According to the National Gang Threat Assessment, approximately 1 million gang members belonging to more than 20,000

gangs were criminally active within all 50 states and the District of Columbia as of September 2008. Criminal gangs commit as much as 80 percent of the crime in many communities according to law enforcement officials throughout the nation.

Street gang graffiti is their most common way to communicate messages, including challenges, warnings, or intimidation to rival gangs. It is, however, an excellent way to track gang affiliation and growth, or even sometimes to obtain membership information. The goal of this project is to use the knowledge gained from our work in mobile devices and applications and leverage it towards the development of a mobile-based system capable of image analysis. This system will provide an accurate and useful output to a user base through a database of gang graffiti images.

The image analysis includes obtainment of metadata (e.g., geo-position, date, and time) and the extraction of relevant features (e.g., color, shape) from the gang graffiti image. The information is sent to a server and compared against the graffiti image database. The matched results are sent back to the device where the user can then review the results and provide extra inputs to refine information. Once the graffiti is completely decoded and interpreted, it is labeled and added to the database.

GARI is being used on iPhone and Android mobile devices. We have been in contact with Cook County and the INGang Network to discuss having their two servers communicate information/queries as a way of linking information across state lines. At present, VACCINE is exploring a few options for the long term sustainability while maintaining accessibility and ideally, a national database as opposed to a regional one.

SMART

SMART (formerly known as Scatterblogs) is a social media analysis tool which looks at real time twitter information to monitor and detect any anomalies for the purpose of alerting first responders to any incident they may need to respond to. Analysis of public behavior plays an important role in crisis management, disaster response, and evacuation planning. Unfortunately, collecting relevant data can be costly and finding meaningful information for analysis is challenging. Recent advances in technology have enabled social media services to support space-time indexed data, and internet users from all over the world have created a large volume of time-stamped, geo-located data. Such spatiotemporal data has immense value for increasing situational awareness of local events, providing insights for investigations and understanding the extent of incidents, their severity, and consequences, as well as their time-evolving nature.

The initial deployment and testing of SMART was conducted at the Boy Scout Jamboree in July of 2013. We worked with a number of volunteers at the event in order to determine key

word filters to look for in attempting to detect any event or threat to the 30,000 individuals that participated in the event in some role. The tool is still being refined, but there a number of agencies interested in using it and have seen it in action (including the USCG, CBP, various police departments across the country). The USCG, for example, tested SMART at the Thunder Over Louisville event. This is a day-long air show and fireworks display held on and along the Ohio River in Louisville, Kentucky. Thunder Over Louisville serves as the kickoff event for the annual Kentucky Derby Festival, culminating with the Kentucky Derby on the first Saturday in May. The 2014 event drew an estimated 650,000 spectators to the Kentucky and Indiana sides of the Ohio River, as well as approximately 120 recreational boats that anchored in the river. The tool has been developed into a web-based version to increase accessibility and currently incorporates Google trends, CNN Trends, Twitter, and public Facebook posts.

DHS Operating Components VACCINE Works With:

United States Coast Guard: CgSARVA – Coast Guard Search and Rescue Visual Analytics

VACCINE has spent the past four years building strong ties within the USCG. We have collaborated with them to build tools that can be adapted to real time situational areas. The most significant of these projects was a detailed model allowing a thorough assessment of all CG search and rescue cases in the Great Lakes. In the Coast Guard Search and Rescue Visual Analytics (CgSARVA) project, VACCINE presents a risk analysis system that enables the interactive visualization, analysis, and assessment of search and rescue (SAR) missions completed by each USCG station. The CgSARVA technology is deployed, and in use, at the USCG Atlantic Area Planning and Analysis Division, and has also been verified, validated, and accredited by the USCG for use Coast Guard wide.

The system enables the interactive analysis of trends, patterns, anomalies, and distribution of cases and associated sorties. Additionally, this assessment tool enables the determination of potential increase or decrease in risk with a reallocation of a resource; as well as known increases or decreases in the response time. The CgSARVA system features include the following:

•Linked calendar and line graph views for analyzing data patterns and distributions

• Interactive filter controls for assessing case distribution loads and locations

• Density estimation for hotspot generation

- Linked time slider controls for interactive temporal animation and exploration
- Interactive statistical summary tools for report generation

The CgSARVA technology is a vital component for analyzing risk assessment as Coast Guard staffing levels fluctuate due to budget changes, retiring volunteers, and a variety of other factors. This system provides managers and analysts with a suite of tools for analyzing the distribution of previous search and rescue cases and a methodology for understanding the risk, efficiencies, and benefits involved with reallocation or reduction of resources. Additionally, VACCINE also worked to develop iOPAR and ORAM for use by the Coast Guard in reviewing their operational protocols and risk management. Those tools have not yet been accredited and are described in detail in the project reports.

VACCINE has also been working with CBP over the past year. While they are in the process of testing some VACCINE technology, we were able to provide them with the infographics used in their annual report.

VACCINE is also continuing work on a Data Integration Framework for Enhancing Emergency Response Situation Reports with Multi-Agency, Multi-Partner Multimedia Data. Responders in the field (both public and private participants) are capturing footage, pictures and video, of the disaster area with mobile phones. This data is being collected but is not integrated in the incidence command systems where situation reports, incidence action plans, etc. are being held. When these materials are entered into such systems, it's done so in a manual way which is time consuming and requires careful human review and management. To support emergency management operations, Florida International University is using advanced data integration and visual analytics techniques to analyze situation reports, incident action plans, and other type of responder reports, pictures and video clips captured in the field and automatically augment/link the reports directly to relevant multimedia content obtain in the field. Data integration techniques will be used to identify disaster specific keywords and will be used to identify the documents.

Additional State and Federal Partners Partnerships

VACCINE works closely with state and federal agencies to receive data relevant to our projects. VACCINE has a well-established process for entering into Memorandums of Understanding and Non-Disclosure Agreements to ensure protection of the parties and data involved.

- FEMA (Federal Emergency Management Agency)
- IICD (Infrastructure Information Collection Division)
- GMO (Geospatial Management Office)
- DHS internal Geospatial Working Group
- DHS University Programs
- DHS US-CERT Operations
- DHS Research Transition Working Group
- U.S. Department of State, Office of the Geographer
- National Institute of Justice
- National Institutes of Health
- National Science Foundation
- Department of Health and Human Services
- Pacific Northwest National Laboratory
- Argonne National Laboratory
- U.S. Customs and Border Protection
- Oak Ridge National Laboratories
- Defense Research & Development Canada
- Indiana State Department of Health
- Illinois Terrorism Task Force

Corporate Involvement

In 2010, the VACCINE Center and the Purdue Research Foundation established a unique VACCINE Corporate Affiliate Program to promote VACCINE's goals and initiatives. In broad outline, this program provides the framework to enable corporations to make tax deductible gifts to support research, education, and training activities for all VACCINE member institutions. The basic structure is through the establishment of a non-profit Limited Liability Corporation (VACCINE LLC) which is managed by the Purdue Research Foundation and overseen by VACCINE.. The

corporate donations are true gifts, but are structured in a manner that the corporation can choose to have a portion of the support be distributed to a specific partner school. There are practical benefits to donors, including the following:

- Membership in the VACCINE, LLC is by invitation only. Member companies need to be complementary as opposed to competitive in nature.
- Corporate affiliates should be in a position to enter into separate research agreements directly with member institutions to develop proprietary technologies, contractually obligated deliverables, etc.
- Corporate affiliates will be in a position to gain early information about ongoing basic research projects at member institutions before publication.
- Corporate affiliates will have opportunities to identify and recruit students at member institutions.
- The Corporate Affiliates program will provide a forum for donors to explore research collaborations and sponsorships.
- Corporate donors will have opportunities for employed scientists to take sabbaticals to participate in relevant research projects at member institutions.

The founding member of VACCINE, LLC was Motorola Solutions. VACCINE continues to work very closely with Motorola in conjunction with the Chicago Police Department Office of Emergency Management Communication on an LTE project. In addition to Motorola, the VACCINE team has been engaged with a number of companies including the following:

- Aegis
- ArgonST
- BanField, the Pet Hospital
- Bank of America
- Boeing
- CRGT
- Duke Energy
- General Dynamics
- Hallmark
- Harris Corporation
- J2

- Kimberly Clark
- Kx Systems
- NVIDIA
- Oculus Info, Inc.
- Siemens
- VACCINE routinely presents the tools and technology developed to a number of different law enforcement entities; occasionally those presentations take the form of professional training in addition to a presentation on the types of tools and applications developed by VACCINE. There have been a number of presentations to numerous public safety audiences over the past year that went through some of the tools step by step and provided use information. Further, some of the tools already have completed training videos and others are still in production. Additionally, during the VACCINE Annual Meeting in September of 2013, law enforcement officers and first responders were training on a number of the VACCINE tools. Trainings were conducted of the VALET/iVALET, Jigsaw, SMART, GARI, and MERGE. VACCINE is also in the process of making step by step short reference tutorials.

Additional academic partners outside of schools comprising VACCINE:

- Regenstrief Institute
- Mississippi Valley State University
- Center for Infectious Disease Dynamics, Penn State
- San Diego Supercomputer Center
- West Houston Center for Science and Engineering
- Central Washington University
- SUNY Albany
- Penn State Institute for Cyberscience
- Houston Community College
- California State University Dominguez Hills
- University of Maryland
- CREATE
- NCFPD
- CCICADA
- ALERT
- Rochester Institute Technology
- DIEM

VACCINE has a number of international partnerships, most of which do presently or have in the past collaborated on research project. These partners include:

- Carleton University, Canada
- Chalmers University, Sweden
- Dalhousie University, Canada
- Justice Institute of British Columbia, Canada
- Linkoping University
- Linnaeus University
- National Institute for Research in Computer Science and Control
- Ontario Institute of Technology, Canada
- Simon Fraser University, Canada
- Swansea University
- University of British Columbia, Canada
- University of Calgary, Canada
- University of Gävle
- University of Groningen, Netherlands
- University of Oxford

- University of Konstanz
- University of Manitoba, Canada
- University of Stuttgart, Germany
- University of Victoria, Canada

V. Technology Transition

Throughout this document, it should have become evident that VACCINE is committed to getting our technologies and programs into the hands of the individuals that need them. Since VACCINE's inception in 2009, DHS has gradually moved towards an aggressive technology transition strategy. It is imperative to show value to the end-users via getting VACCINE tools deployed. As mentioned earlier, the role of developing detailed operational requirements is critical for the successful transition of technologies into the various homeland security fields. The VACCINE Center of Excellence recognizes the need for significant end-user-in-the-loop involvement in the entire life cycle development process.

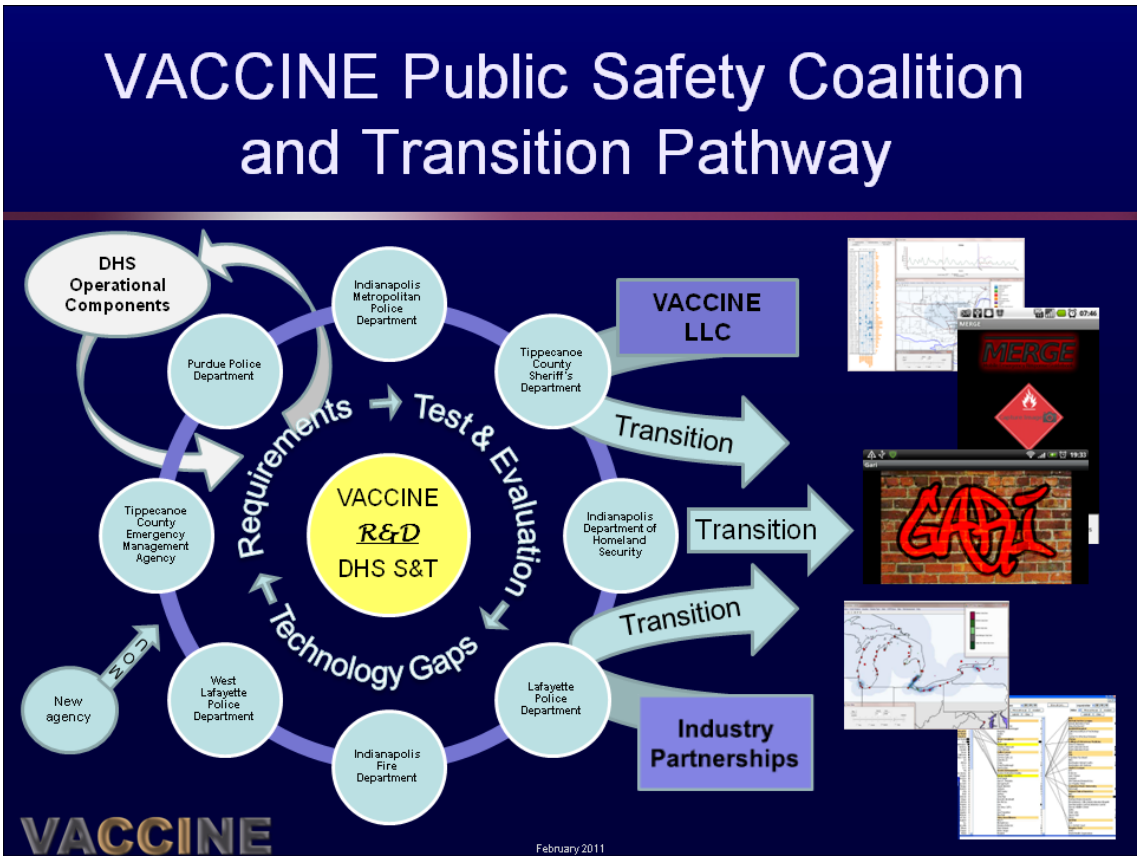

Figure 4: VACCINE Transition Pathway

The following list summarizes the VACCINE technologies and their stage of transition and deployment. While deployed for evaluation, the feedback we receive has resulted in continuous refinements to meet the needs of the users. In some cases, we are releasing new versions of technologies once a month.

JigSaw – VA for Exploring and Understanding Document Collections (Georgia Tech)

- Deployed and currently used
- Available for download (free) on the website

VALET - Visual Analytics Law Enforcement Toolkit

- Deployed for Test & Evaluation Feedback
- Lafayette PD, W. Lafayette PD, Purdue PD, Tippecanoe County Sheriff, Illinois State Police, Ohio State Highway Patrol, NYPD, Indianapolis Public Safety Department, University of Texas at Austin Police Department, New Albany Police Department, Evansville Police Department
- In licensing negotiations

GARI - Gang Graffiti Automatic Recognition and Interpretation

- Initial Prototype Deployed May 2011
- GARI server transitioned to the Indiana Intelligence Fusion Center March 2013
- GARI server transitioned to the Cook County Sherriff's Department May 2013
- Requested by multiple hundreds of agencies
- Exploring providing the tool as a national app via iTunes and the Android App store and having a third party vet users.

cgSARVA - Coast Guard Search and Rescue Visual Analytics

- Deployed for Operational Use – USCG LANT – 2010
- Phase II almost complete for transition to 771

MERGE - Mobile Emergency Response Guide

- Initial Prototype deployed May 2011
- Indianapolis Fire, Lafayette Fire

- Being deployed to iTunes and Android App store

SMART – Social Media Analysis Reporting Toolkit

- Initial Prototype deployed in July 2013 to the Boy Scouts of America for testing at their Annual Jamboree
- The USCG tested SMART at the Thunder Over Louisville event. This is a day-long air show and fireworks display held on and along the Ohio River in Louisville, Kentucky. Thunder Over Louisville serves as the kickoff event for the annual Kentucky Derby Festival, culminating with the Kentucky Derby on the first Saturday in May. The 2014 event drew an estimated 650,000 spectators to the Kentucky and Indiana sides of the Ohio River, as well as approximately 120 recreational boats that anchored in the river.
- Still in testing and evaluating with a number of police and federal agencies. The Red Cross is interested in testing SMART for its application and use in disaster preparedness and response initiatives..

Arizona State University

VACCINE Annual Report – Year 5

Please complete **ALL** fields.
This form must be emailed to Mary Padget at padget@purdue.edu **by July 18, 2014.**
If any item does not apply to your project, please indicate "NA" under the heading.

Institution: Arizona State University

PI and/or Co-PI: Ross Maciejewski

Project Name: Uncertainty of Identity

Academic Disciplines: Computer Science

Keywords associated with project: Visual Analytics, Social Media, Identity, Cybersecurity

Theme for Research Projects (Check all that apply)
If this is not a research project, indicate "NA" below.

	Public Safety Coalition Projects (state or local law enforcement, fire, emergency management, etc.)
	Federal Operating Component Projects (TSA,FEMA, Secret Service, ICE, CBP, USCIS, Coast Guard)
	Enterprise Resiliency Environments
	Event Evacuations
x	Visual Analytics for Security Applications
	International Collaborations
	N/A

Theme for Education Projects (Check all that apply)
If this is not an education project, indicate "NA" below.

	Minority or Underserved Programs
	Undergraduate and Graduate Education Program
	Professional Education and In-Service Programs
x	N/A

VACCINE Annual Report – Year 5

Please complete **ALL** fields.
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If any item does not apply to your project, please indicate "NA" under the heading.

Students Supported on Project

Graduate Research Assistants (include name(s), university and department)

Yifan Zhang, Feng Wang and Yafeng Lu, Computer Science, Arizona State University

Undergraduate supported students (need number only)	3
O**ther Graduate Students** (non-supported) involved in project (need number only)	
Other Undergraduate Students (non-supported) involved in project (need number only)	

Student Thesis in 2013 (include name, thesis title, university, department, degree, date)

Research Problem /Abstract (in 200 words or less, provide a summary of the project goals and objectives, **in simple language understandable to someone outside the project's field).**

Within social network data, there exist communities of users that grow and shrink over time. These communities share information and their network links and shared information can provide us with additional information about the spread of topics and information exchange in both the real and virtual world. These connections can provide direct clues as to the nature of an individual's identity and their role within both online and offline communities, allowing us to create cyber-geodemographic profiles. In order to extract such information, we plan to explore the overall characterization of social network structure with respect to its relationship with geographic places. We plan to quantify the similarity of users not only with respect to their locations at certain times but also with respect to their relationships in geographic space (locally and globally). We will define metrics for describing average characteristics of individuals and communities in relation with their geographic space that can be used to detect unusual behavior within a community.

VACCINE Annual Report – Year 5

Please complete **ALL** fields.

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If any item does not apply to your project, please indicate "NA" under the heading.

Technical Approach (Check all that apply)

Data Collection Methods

X	Compiling & Sorting DB
X	Data Mining
	Expert Consultation
	Field Monitors
	Survey
	Other:

Analytic Methods

	Case Studies
	Modeling
X	Sampling
x	Statistical Analysis
	Other:

Nature of Research

	Applied
	Basic
	Consultatio
	n
	Coordination/Integration
x	Education
	Hybrid Basic—Applied
	Hybrid Applied—Consultation

Deliverables (other than publications and reports listed below)

We are currently working on developing an online identity toolkit with partners from UCL.

http://ec2-54-201-211-102.us-west-2.compute.amazonaws.com:8080/nameweb/html/

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Technology Transitions (describe any products/technologies in process or that have completed transition to commercialization; include actions and progress to date)

None currently.

Additional Funding Sources Leveraged: include amount, source of funding, PI and period of performance

None currently.

VACCINE Annual Report – Year 5

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If any item does not apply to your project, please indicate "NA" under the heading.

Collaborating Partners (academic Co-PI's, businesses, or other government funding agencies)

Paul Longley, University College of London; Mirco Musolesi, University of Birmingham, UK; Raj Muttukrishnan, City College of London; David Ebert, Purdue University

Collaborating End-Users (specific DHS operating components such as FEMA, TSA, Coast Guard or federal, state, local law enforcement, fire, emergency management, etc.)

Please provide name of agency, contact name and email address.

None Currently.

Collaboration with other VACCINE project teams, national labs, and other Homeland Security Centers of Excellence (CREATE, NCFPD, START, PACER, ALERT, NCBSI, MIREES, ZADD, CHC and NTSCOE).

Describe purpose and nature of the collaboration and any follow-up to the discussion, if applicable.

None Currently.

VACCINE Annual Report – Year 5

Please complete **ALL** fields.
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If any item does not apply to your project, please indicate "NA" under the heading.

Project Outcomes (Publications, Presentations, etc., based on this VACCINE-funded project)

Peer-Reviewed/Refereed Publications, Journals, Conferences: list only citation below, must also provide/attach electronic copy of all individual publications to VACCINE

See supplemental document.

Other Reports (including white papers, book chapters, manuscripts submitted, in revision or accepted/in press [not including those in preparation], other publications)

Presentations (include title, presenter, date, meeting, location. Attach PowerPoint if available). If additional space is needed, please attach a separate Word document listing relevant materials.

See supplemental document.

Patents/Copyrights (List names)

NA

VACCINE Annual Report – Year 5

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If any item does not apply to your project, please indicate "NA" under the heading.

Summary of Outcomes and Impact of Project

This work has resulted in a VAST 2013 challenge award, 4 publications and an Undergraduate Honors thesis.

Impact or success story associated with project

Issues Encountered, if applicable: intellectual property, data sensitivity, publication of high risk/sensitive/proprietary findings, institutional collaboration and relationships, etc.

NA

Changes in research plans, if applicable: describe any major changes in the project's plans or objectives, such as initiatives added or omitted, compared to those outlined in the original, funded proposal.

NA

Supporting Documentation: list items and attach electronically, including survey instruments, photos, models, letters to participants, or other unique documentation.

NA

Peer-Reviewed/Refereed Publications, Journals, Conferences:

Submitted:

7) Lu, Y., Krueger, R., Thom, D., Wang, F., Koch, S., Ertl, T., Maciejewski, R., "Integrating Predictive Analytics and Social Media," IEEE Conference on Visual Analytics Science and Technology, 2014.
8) Malik, A., Maciejewski, R., McCullough, S., Towers, S., Ebert, D., "Proactive Spatiotemporal Resource Allocation and Predictive Visual Analytics for Community Policing and Law Enforcement," IEEE Transactions on Visualization and Computer Graphics, 2014.

Accepted:

1) Wang, F., Ibarra, J., Adnan, M., Longley, P., Maciejewski, R., "What's In a Name? Data Linkage, Demography and Visual Analytics," *Eurovis Workshop on Visual Analytics*, 2014.
2) Lu, Y., Wang, F., Maciejewski, R., "Business Intelligence from Social Media: A Study from the VAST Box-Office Challenge," IEEE Computer Graphics and Applications, 2014
3) Razip, A. M. M., Malik, A., Afzal, S., Joshi, S., Maciejewski, R., Jang, Y., Elmqvist, N., Ebert, D. S., "A Mobile Visual Analytics Approach for Situational Awareness and Risk Assessment," *IEEE Pacific Visualization Symposium*, 2014
4) Malik, A., Maciejewski, R., Jang, Y., Oliveros, S., Yang, Y., Maule, B., White, M., Ebert, D. S., "A Visual Analytics Process for Maritime Response, Resource Allocation and Risk Assessment," *Information Visualization*, 13(2): 93-110, 2014.
5) Zhang, Y., Adnan, M., Longley, P., Maciejewski, R., "Exploring Geo-Genealogy Using Internet Surname Search Histories," *Journal of Maps*, 9(4):481-485, 2013.
6) Kim, S., Maciejewski, R., Malik, A., Jang, Y., Ebert, D. S., Isenberg, T., "Bristle Maps: A Multivariate Abstraction Technique for Geovisualization," *IEEE Transactions on Visualization and Computer Graphics*, 19(9): 1438-1454, 2013.
7) Lu, Y., Wang, F., Maciejewski, R., "VAST 2013 Mini-Challenge 1: Box Office VAST - Team VADER," *IEEE Conference on Visual Analytics Science and Technology*, October, 2013.

Presentations (include title, presenter, date, meeting, location. Attach PowerPoint if available). If additional space is needed, please attach a separate Word document listing relevant materials.

T1. Maciejewski, R., "What's in a Name? Data Linkage, Demography and Visual Analytics," EuroVA, June, 2014.
T2. Maciejewski, R., "Enabling Predictive Analytics Through Visualization," University of Arizona, January, 2014
T3. Maciejewski, R., "Abstracting Attribute Space for Transfer Function Exploration and Design," IEEE VIS, October, 2013.
T4. Maciejewski, R., "Bristle Maps: A Multivariate Abstraction Technique for Geovisualization," IEEE VIS, October, 2013.
T5. Lu, Y., "Box Office VAST – VADER," IEEE VIS, October, 2013.
T6. Maciejewski, R., "Integrating a Visual Analytics Curriculum Into Your Own Classroom," Jackson State University, Mississippi, July 2013.
T7. Maciejewski, R., "Analytical Brushing for Spatiotemporal Analysis," University College of London, United Kingdom, July, 2013.
T8. Maciejewski, R., "Analytical Brushing for Spatiotemporal Analysis," City College of London, United Kingdom, July, 2013.
T9. Maciejewski, R., "An Introduction to Concepts in Visual Analytics," *Visual Analytics Summer School at Middlesex University*, United Kingdom, July 2013. ---

Florida International University

VACCINE Annual Report – Year 5

Please complete **ALL** fields.
This form must be emailed to Mary Padget at padget@purdue.edu **by July 18, 2014.**
If any item does not apply to your project, please indicate "NA" under the heading.

Institution: Florida International University

PI and/or Co-PI: Dr. Shu-Ching Chen (PI)

Project Name: A Data Integration Framework for Enhancing Emergency Response Situation Reports with Multi-Agency, Multi-Partner Multimedia Data

Academic Disciplines: Computer Science

Keywords associated with project: Disaster Situation Report, Multimedia Semantic Retrieval, and Data Mining

Theme for Research Projects (Check all that apply)
If this is not a research project, indicate "NA" below.

X	Public Safety Coalition Projects (state or local law enforcement, fire, emergency management, etc.)
	Federal Operating Component Projects (TSA,FEMA, Secret Service, ICE, CBP, USCIS, Coast Guard)
	Enterprise Resiliency Environments
	Event Evacuations
	Visual Analytics for Security Applications
	International Collaborations
	N/A

Theme for Education Projects (Check all that apply)
If this is not an education project, indicate "NA" below.

	Minority or Underserved Programs
X	Undergraduate and Graduate Education Program
	Professional Education and In-Service Programs
	N/A

VACCINE Annual Report – Year 5

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If any item does not apply to your project, please indicate "NA" under the heading.

Students Supported on Project

Graduate Research Assistants (include name(s), university and department)

Li Zheng, School of Computing and Information Sciences, Florida International University
Chao Shen, School of Computing and Information Sciences, Florida International University

Undergraduate supported students (need number only)	0
Other Graduate Students (non-supported) involved in project (need number only)	5
Other Undergraduate Students (non-supported) involved in project (need number only)	1

Student Thesis in 2013 (include name, thesis title, university, department, degree, date)

Research Problem /Abstract (in 200 words or less, provide a summary of the project goals and objectives, **in simple language understandable to someone outside the project's field).**

The so called Multimedia-Aided Disaster Information System (MADIS) is proposed to improve the work of all the agencies and emergency managers involved in the recovery process of a disaster scenario. In the prototype system, advanced data integration and visual analytic techniques are used to analyze situation reports automatically augment/link them to relevant pictures and videos of disaster areas. For enhancing the report-image association system, we also develop a disaster search engine to effectively organize and retrieve disaster information available online. To be specific, the disaster search engine provides the functionality of collecting, organizing, retrieving and visualizing disaster information via advanced data mining and multimedia processing techniques. The developed system can greatly help decision makers and emergency managers in the area to get insight into the actual disaster situation and make quick responses. Furthermore, to better understand situation updates about a disaster from a large number of disaster-related documents, and obtain a big picture of the disaster's effects, we augment the system by developing a storyline generation component for summarizing multiple disaster-related documents to generate a two-layer hierarchical storyline to improve situation awareness during or after disasters.

VACCINE Annual Report – Year 5

Please complete **ALL** fields.
This form must be emailed to Mary Padget at padget@purdue.edu **by July 18, 2014.**
If any item does not apply to your project, please indicate "NA" under the heading.

Technical Approach (Check all that apply)

Data Collection Methods

X	Compiling & Sorting DB
X	Data Mining
X	Expert Consultation
X	Field Monitors
X	Survey
	Other:

Analytic Methods

X	Case Studies
X	Modeling
X	Sampling
X	Statistical Analysis
	Other:

Nature of Research

X	Applied
	Basic
	Consultatio
X	n
X	Coordination/Integration
	Education
	Hybrid Basic—Applied
	Hybrid Applied—Consultation

Deliverables (other than publications and reports listed below)

1. A textual storyline generation method for improving situation awareness in disaster management.
2. A bipartite graph based approach for comparative summarization on city safety.
3. Web-based demo on storyline generation for disaster management (http://bigdata-node01.cs.fiu.edu/HurricaneStoryline/)
4. Web-based demo on city safety comparison (http://bigdata-node01.cs.fiu.edu/CitySafetyComparison/)
5. A content-based multimedia retrieval approach based on feature correlation clustering and fusion.

VACCINE Annual Report – Year 5

Please complete **ALL** fields.
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If any item does not apply to your project, please indicate "NA" under the heading.

Technology Transitions (describe any products/technologies in process or that have completed transition to commercialization; include actions and progress to date)

N/A

Additional Funding Sources Leveraged: include amount, source of funding, PI and period of performance

"A Research and Educational Framework to Advance Disaster Information Management in Computer Science PhD Programs," Department of Homeland Security 2010-ST-062-000039, $400,000, 2/1/2011 - 1/31/2015, Shu-Ching Chen (PI), Tao Li (Co-PI), Jinpeng Wei (Co-PI), and Ming Zhao (Co-PI).

VACCINE Annual Report – Year 5

Please complete **ALL** fields.
This form must be emailed to Mary Padget at padget@purdue.edu **by July 18, 2014.**
If any item does not apply to your project, please indicate "NA" under the heading.

Collaborating Partners (academic Co-PI's, businesses, or other government funding agencies)

Dr. Tao Li (Co-PI) and Steven Luis (Senior Investigator)

Collaborating End-Users (specific DHS operating components such as FEMA, TSA, Coast Guard or federal, state, local law enforcement, fire, emergency management, etc.)

Please provide name of agency, contact name and email address.

Soheila Ajabshir - GISP, FPEM
Systems Manager
Miami-Dade County Department of Emergency Management (DEM)
9300 NW 41 St., Doral, FL 33178
Phone: 305-468-5417

Collaboration with other VACCINE project teams, national labs, and other Homeland Security Centers of Excellence (CREATE, NCFPD, START, PACER, ALERT, NCBSI, MIREES, ZADD, CHC and NTSCOE).

Describe purpose and nature of the collaboration and any follow-up to the discussion, if applicable.

N/A

VACCINE Annual Report – Year 5

Please complete **ALL** fields.
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If any item does not apply to your project, please indicate "NA" under the heading.

Project Outcomes (Publications, Presentations, etc., based on this VACCINE-funded project)

Peer-Reviewed/Refereed Publications, Journals, Conferences: list only citation below, must also provide/attach electronic copy of all individual publications to VACCINE

If additional space is needed, please attach a separate Word document listing relevant materials.

Accepted:

1. Fan Yang, Xuan Li, Qianmu Li, and Tao Li. "Exploring the diversity in cluster ensemble generation: Random sampling and random projection." Expert Systems with Applications 41, no. 10 (2014): 4844-4866.
2. Jingxuan Li, Wei Peng, Tao Li, Tong Sun, Qianmu Li, and Jian Xu. "Social network user influence sense-making and dynamics prediction." Expert Systems with Applications 41, no. 11 (2014): 5115-5124.
3. Wubai Zhou, Chao Shen, Tao Li, Shu-Ching Chen, Ning Xie, and Jinpeng Wei "A Bipartite-Graph Based Approach for Disaster Susceptibility Comparisons among Cities," accepted for publication, The 15th IEEE International Conference on Inforamtion Reuse and Integration (IRI 2014), San Francisco, USA, August 13-15, 2014.
4. Wubai Zhou, Chao Shen, Tao Li, Shu-Ching Chen, and Ning Xie. "Generating Textual Storyline to Improve Situation Awareness in Disaster Management," accepted for publication, The 15th IEEE International Conference on Inforamtion Reuse and Integration (IRI 2014), San Francisco, USA, August 13-15, 2014.
5. Hsin-Yu Ha, Fausto C. Fleites, Shu-Ching Chen, and Min Chen, "Correlation-based Re-ranking for Semantic Concept Detection," accepted for publication, The 15th IEEE International Conference on Inforamtion Reuse and Integration (IRI 2014), San Francisco, USA, August 13-15, 2014.
6. Hsin-Yu Ha, Fausto C. Fleites, and Shu-Ching Chen, "Building Multi-model Collaboration in Detecting Multimedia Semantic Concepts," 9th IEEE International Conference on Collaborative Computing: Networking, Applications and Worksharing, October 20-23, 2013, Austin, Texas, USA.
7. Hsin-Yu Ha, Fausto C. Fleites, and Shu-Ching Chen, "Content-Based Multimedia Retrieval Using Feature Correlation Clustering and Fusion," International Journal of Multimedia Data Engineering and Management (IJMDEM), Volume 4, No. 2, pp. 46-64, 2013.

Other Reports (including white papers, book chapters, manuscripts submitted, in revision or accepted/in press [not including those in preparation], other publications)
N/A

Presentations (include title, presenter, date, meeting, location. Attach PowerPoint if available). If additional space is needed, please attach a separate Word document listing relevant materials.
N/A

Patents/Copyrights (List names)

Applications: N/A
Awarded: N/A

VACCINE Annual Report – Year 5

Please complete **ALL** fields.
This form must be emailed to Mary Padget at padget@purdue.edu **by July 18, 2014.**
If any item does not apply to your project, please indicate "NA" under the heading.

Summary of Outcomes and Impact of Project

A Disaster Multimedia Search Engine is developed as an iPad application and can be used for retrieving and visualizing the categorized disaster multimedia data. The underlying key techniques include various multimedia semantic analysis and retrieval methods developed by our group. We also develop web-based systems for storyline generation and disaster susceptibility comparisons among cities based on text mining and visualization techniques. The developed methods will greatly improve situation awareness during or after disasters.

Impact or success story associated with project

The proposed prototype system will be continuously evaluated by the personnel at Miami-Dade Emergency Management (MDEM), where evaluation activities regarding the developed application will be conducted. The feedback will be collected as a reference to further improve our system.

Issues Encountered, if applicable: intellectual property, data sensitivity, publication of high risk/sensitive/proprietary findings, institutional collaboration and relationships, etc.

N/A

Changes in research plans, if applicable: describe any major changes in the project's plans or objectives, such as initiatives added or omitted, compared to those outlined in the original, funded proposal.

N/A

Supporting Documentation: list items and attach electronically, including survey instruments, photos, models, letters to participants, or other unique documentation.

N/A

Georgia Institute of Technology

VACCINE Annual Report – Year 5

Please complete **ALL** fields.
This form must be emailed to Mary Padget at padget@purdue.edu **by July 18, 2014.**
If any item does not apply to your project, please indicate "NA" under the heading.

Institution: Georgia Institute of Technology

PI and/or Co-PI: John Stasko

Project Name: Visual Analytics for Investigative Analysis on Text Documents (Jigsaw)

Academic Disciplines: Computer science, visual analytics

Keywords associated with project: visual analytics, information visualization, data analysis, interaction

Theme for Research Projects (Check all that apply)
If this is not a research project, indicate "NA" below.

XXX	Public Safety Coalition Projects (state or local law enforcement, fire, emergency management, etc.)
	Federal Operating Component Projects (TSA,FEMA, Secret Service, ICE, CBP, USCIS, Coast Guard)
	Enterprise Resiliency Environments
	Event Evacuations
	Visual Analytics for Security Applications
	International Collaborations
	N/A

Theme for Education Projects (Check all that apply)
If this is not an education project, indicate "NA" below.

	Minority or Underserved Programs
	Undergraduate and Graduate Education Program
	Professional Education and In-Service Programs
XXX	N/A

VACCINE Annual Report – Year 5

Please complete **ALL** fields.
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If any item does not apply to your project, please indicate "NA" under the heading.

Students Supported on Project

Graduate Research Assistants (include name(s), university and department)

Anand Sainath, Georgia Tech, School of Interactive Computing

Undergraduate supported students (need number only)	0
O**ther Graduate Students** (non-supported) involved in project (need number only)	0
Other Undergraduate Students (non-supported) involved in project (need number only)	1

Student Thesis in 2013 (include name, thesis title, university, department, degree, date)

None

Research Problem /Abstract (in 200 words or less, provide a summary of the project goals and objectives, **in simple language understandable to someone outside the project's field).**

Many people and organizations routinely perform analysis that involves large collections of documents, and in particular, textual documents such as case reports, news articles, or suspicious activity reports. Investigators may seek to investigate an individual or incident, or they may simply be exploring with hopes to discover stories, narratives, or threats that may be embedded across the document collection. We have developed a visual analytics system named Jigsaw that helps investigators in such scenarios. Jigsaw pairs computational analysis of the documents with a collection of visualizations that each portrays different aspects of the documents, including connections between different entities. Thus, the system acts like a visual index onto a document collection, highlighting connections between entities and allowing the investigator to understand the context of events in a more timely and accurate manner. Jigsaw helps analysts "put the pieces together" and link initially unconnected activities into a more coherent story. We are working with law enforcement and public safety organizations to explore how Jigsaw can be used in their work.

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Please complete **ALL** fields.

This form must be emailed to Mary Padget at padget@purdue.edu **by July 18, 2014.**

If any item does not apply to your project, please indicate "NA" under the heading.

Technical Approach (Check all that apply)

Data Collection Methods

	Compiling & Sorting DB
	Data Mining
	Expert Consultation
	Field Monitors
	Survey
XXX	Other:

Analytic Methods

XXX	Case Studies
	Modeling
	Sampling
XXX	Statistical Analysis
XXX	Other:

Nature of Research

XXX	Applied
XXX	Basic
	Consultatio
	n
	Coordination/Integration
	Education
	Hybrid Basic—Applied
	Hybrid Applied—Consultation

Deliverables (other than publications and reports listed below)

We have made the Jigsaw system available on the internet for anyone to download. This past year we created a Google discussion group around the project.

VACCINE Annual Report – Year 5

Please complete **ALL** fields.
This form must be emailed to Mary Padget at padget@purdue.edu **by July 18, 2014.**
If any item does not apply to your project, please indicate "NA" under the heading.

Technology Transitions (describe any products/technologies in process or that have completed transition to commercialization; include actions and progress to date)

NA

Additional Funding Sources Leveraged: include amount, source of funding, PI and period of performance

"FODAVA-Lead: Dimension Reduction and Data Reduction: Foundations for Visualization", National Science Foundation & Dept. of Homeland Security, PI: Haesun Park, $3,000,000 (9/08-8/14)

VACCINE Annual Report – Year 5

Please complete **ALL** fields.
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If any item does not apply to your project, please indicate "NA" under the heading.

Collaborating Partners (academic Co-PI's, businesses, or other government funding agencies)

Collaborating End-Users (specific DHS operating components such as FEMA, TSA, Coast Guard or federal, state, local law enforcement, fire, emergency management, etc.)

Please provide name of agency, contact name and email address.

Cindy Marion, West Lafayette Police Dept., IN, (765) 775-5200,

Damien Williams, Rock Hill Police Dept., SC, damienwilliams@cityofrockhill.com

Collaboration with other VACCINE project teams, national labs, and other Homeland Security Centers of Excellence (CREATE, NCFPD, START, PACER, ALERT, NCBSI, MIREES, ZADD, CHC and NTSCOE).

Describe purpose and nature of the collaboration and any follow-up to the discussion, if applicable.

NA

Project Period (only complete if different than 4/1/12-6/30-13) 7/1/13-6/30/14

VACCINE Annual Report – Year 5

Please complete **ALL** fields.

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Project Outcomes (Publications, Presentations, etc., based on this VACCINE-funded project)

Peer-Reviewed/Refereed Publications, Journals, Conferences: list only citation below, must also provide/attach electronic copy of all individual publications to VACCINE

If additional space is needed, please attach a separate Word document listing relevant materials.

Submitted:

Accepted:

Carsten Görg, Youn-ah Kang, Zhicheng Liu, and John Stasko, "Visual Analytics Support for Intelligence Analysis", *IEEE Computer*, Vol. 46, No. 7, July 2013, pp. 30-38.

Carsten Görg, Zhicheng Liu, Jaeyeon Kihm, Jaegul Choo, Haesun Park, John T. Stasko, "Combining Computational Analyses and Interactive Visualization for Document Exploration and Sensemaking in Jigsaw", *IEEE Transactions on Visualization and Computer Graphics*, Vol. 19, No. 10, October 2013, pp. 1646-1663.

Zhicheng Liu, Sham Navathe, and John Stasko, "Ploceus: Modeling, Visualizing and Analyzing Tabular Data as Networks", *Information Visualization*, Vol. 13, No. 1, January 2014, pp. 59-89.

Youn-ah Kang and John Stasko, "Characterizing the intelligence analysis process through a longitudinal field study: Implications for visual analytics", *Information Visualization*, Vol. 13, No. 2, April 2014, pp. 134-158.

Other Reports (including white papers, book chapters, manuscripts submitted, in revision or accepted/in press [not including those in preparation], other publications)

Carsten Görg, Zhicheng Liu, and John Stasko, "Reflections on the Evolution of the Jigsaw Visual Analytics System", *Information Visualization*, accepted to appear.

Presentations (include title, presenter, date, meeting, location. Attach PowerPoint if available). If additional space is needed, please attach a separate Word document listing relevant materials.

The Value of Visualization for Exploring and Understanding Data, John Stasko, Nov. 2013, Distinguished Lecture Series , Univ. of Arizona Computer Science Dept., Tucson, AZ.

Combining Computational Analyses and Interactive Visualization for Document Exploration and Sensemaking in Jigsaw, Carsten Görg, Oct. 2014, IEEE VIS Conference, Atlanta, GA.

The Value of Visualization for Exploring and Understanding Data, John Stasko, April 2014, Invited talk, Exploratory Data Analysis Workshop at SIAM Intl. Conference on Data Mining, Philadelphia, PA.

The Value of Visualization…and Why Interaction Matters, John Stasko, June 2014, Capstone Lecture at the 2014 EuroVis Conference, Swansea, Wales.

Visual Analytics for Investigative Analysis and Exploration of Documents and Data, John Stasko, July 2014, Keynote lecture at Canadian Visual Analytics School (CANVAS) at VIVA Center, July 2014, Vancouver, B.C.

Patents/Copyrights (List names)

VACCINE Annual Report – Year 5

Please complete **ALL** fields.
This form must be emailed to Mary Padget at padget@purdue.edu **by July 18, 2014.**

Summary of Outcomes and Impact of Project

We have continued our development and distribution of the Jigsaw visual analytics system. (See http://www.cc.gatech.edu/gvu/ii/jigsaw.) During the past year, we added new functionality to the system and made a number of bug fixes and updates, ultimately leading to a new release. We also created a Google group for people interested in tracking the system more closely. We probably average about 5-10 downloads of the system per day. We also continue to work on a version of the system that would expose an API to various classes and methods in it so that other people could connect their own code to Jigsaw. Over the last year we have had a number of papers appear about our work on Jigsaw. One (*TVCG,* Oct. '13) explores how to combine computational text analyses with interactive visualization to help investigators exploring document collections. In another article (*Computer,* July '13) we describe how visual analytics systems like Jigsaw can assist intelligence analysis.

In October 2013, project PI Dr. John Stasko served as General Chair for the 2013 IEEE VIS meeting in Atlanta, which included the VAST, InfoVis, and SciVis Conferences. Although it fell during the government shut-down, nearly 900 people still attended the conference.

Dr. Stasko was invited to give the Capstone Lecture at the 2014 EuroVis Conference in Swansea, Wales.

This grant also has supported research in the past on another project for visual analytics called Ploceus. A journal paper about Ploceus appeared in the *Information Visualization* journal this past year.

Impact or success story associated with project

We have had about 3000 downloads of the Jigsaw system now. It is being used in various university classes on visual analytics and intelligence analysis and has been downloaded by a wide variety of organizations in government and industry.

Issues Encountered, if applicable: intellectual property, data sensitivity, publication of high risk/sensitive/proprietary findings, institutional collaboration and relationships, etc.

NA

Changes in research plans, if applicable: describe any major changes in the project's plans or objectives, such as initiatives added or omitted, compared to those outlined in the original, funded proposal.

NA

Supporting Documentation: list items and attach electronically, including survey instruments, photos, models, letters to participants, or other unique documentation.

NA

JACKSON STATE UNIVERSITY

Institution: Jackson State University

PI and/or Co-PI: Dr. Richard Alo

Project Name: GIS Implementations

Academic Disciplines:

Keywords associated with project:

Theme for Research Projects (Check all that apply)
If this is not a research project, indicate "NA" below.

	Public Safety Coalition Projects (state or local law enforcement, fire, emergency management, etc.)
	Federal Operating Component Projects (TSA,FEMA, Secret Service, ICE, CBP, USCIS, Coast Guard)
	Enterprise Resiliency Environments
	Event Evacuations
	Visual Analytics for Security Applications
	International Collaborations
	N/A

Theme for Education Projects (Check all that apply)
If this is not an education project, indicate "NA" below.

	Minority or Underserved Programs
	Undergraduate and Graduate Education Program
	Professional Education and In-Service Programs
	N/A

Conducted MSI VACCINE Workshop - June 9 -12, 2013

Students Supported on Project

Graduate Research Assistants (include name(s), university and department)

Undergraduate supported students (need number only)	0
O**ther Graduate Students** (non-supported) involved in project (need number only)	2
Supported by other funds	
Other Undergraduate Students (non-supported) involved in project (need number only)	2

Student Thesis in 2013 (include name, thesis title, university, department, degree, date)

Research Problem /Abstract (in 200 words or less, provide a summary of the project goals and objectives, **in simple language understandable to someone outside the project's field).**

Abstract Disparities in the geographic accessibility to health care may be due to the location/distribution of the population and the characteristics of the transportation infrastructure relative to spatial arrangement of the health care delivery system within a region. Access to health care is a complicated concept and is largely dependent on the characteristics of the population in need of services. The most significant features affecting the health status and health outcomes involve distance between the population's geographic regions and health care facilities and the travel time taken to reach the health care delivery system. Because of Mississippi's rural nature and uneven distribution of physicians, geographic disparities exist in access to primary care services leaving women, children, elderly and general populations in underserved health care regions. The purpose of the research is to identify hot spots of vulnerable population burdened due to geographical accessibility to right kind of health services. This research investigates these features by using network-based GIS methods in ten counties with urban-rural settings. The methodology assesses the geographic accessibility of three types of critical health care facilities: obstetrician/gynaecology (Women in child bearing age); paediatrics (children) and Trauma/Burn Centers (general population). To examine, using network analyst GIS functionalities, these facilities are geocoded, and optimal travel-time based service areas were generated and pertinent vulnerable population data layers were developed. The results identified hot spots of vulnerable populations residing outside the optimal service areas, with rural regions and pregnant women bearing most of the health burden due to geographic inaccessibility. This GIS methodology equip health administrators and policy makers in providing comprehensive view of the health systems from a territorial perspective while assisting them in making conscious policy decisions.

Technical Approach (Check all that apply)

Data Collection Methods

X	Compiling & Sorting DB
X	Data Mining
X	Expert Consultation
X	Field Monitors
X	Survey
X	Other:

Analytic Methods

	Case Studies
X	Modeling
X	Sampling
X	Statistical Analysis
	Other:

Nature of Research

X	Applied
	Basic
	Consultatio
	n
	Coordination/Integration
	Education
	Hybrid Basic—Applied
	Hybrid Applied—Consultation

Deliverables (other than publications and reports listed below)

First responder apps.

Technology Transitions (describe any products/technologies in process or that have completed transition to commercialization; include actions and progress to date)

Additional Funding Sources Leveraged: include amount, source of funding, PI and period of performance

Collaborating Partners (academic Co-PI's, businesses, or other government funding agencies)

Collaborating End-Users (specific DHS operating components such as FEMA, TSA, Coast Guard or federal, state, local law enforcement, fire, emergency management, etc.)

Please provide name of agency, contact name and email address.

Collaboration with other VACCINE project teams, national labs, and other Homeland Security Centers of Excellence (CREATE, NCFPD, START, PACER, ALERT, NCBSI, MIREES, ZADD, CHC and NTSCOE).

Describe purpose and nature of the collaboration and any follow-up to the discussion, if applicable.

Project Period (only complete if different than 4/1/12-6/30-13)

June 1, 2013 - May 31, 2014

VACCINE Annual Report – Year 5

Please complete **ALL** fields.
This form must be emailed to Mary Padget at padget@purdue.edu **by July 18, 2014.**
If any item does not apply to your project, please indicate "NA" under the heading.

Project Outcomes (Publications, Presentations, etc., based on this VACCINE-funded project)

Peer-Reviewed/Refereed Publications, Journals, Conferences: list only citation below, must also provide/attach electronic copy of all individual publications to VACCINE

If additional space is needed, please attach a separate Word document listing relevant materials.

Submitted:

1. Yerramilli, Sudha. "Potential Impact of Climate Changes on the Inundation Risk Levels in a Dam Break Scenario." *ISPRS International Journal of Geo-Information* 2.1 (2013): 110-134.

2. Dodla, Venkata B., and Sudha Yerramilli. "A Geographic Information System Model for Hurricane Track Prediction." *American Journal of Geographic Information System* 3.2 (2014): 75-87.

3. Yerramilli, Sudha., Fonesca, Duber Gomez "Assessing Geographical Inaccessibility to Health Care: Using GIS Network Based Methods." *Public Health Research* (Accepted, 2014)

Accepted:

1. Yerramilli, Sudha., Fonesca, Duber Gomez "Assessing Geographical Inaccessibility to Health Care: Using GIS Network Based Methods." *Public Health Research* (Accepted, 2014)

Other Reports (including white papers, book chapters, manuscripts submitted, in revision or accepted/in press [not including those in preparation], other publications)

Invited Book Chapter

1. Yerramilli, Sudha. "GIS in monitoring of Hurricanes and Cyclones", Encyclopedia of Natural Hazards", Taylor and Francis Publication (Submitted and in review, 2014)

Reports

1. Prepared for MSDH : *Geospatial Resource Guide for vulnerable and At-Risk populations* and Presented at MSDH state level Risk population workgroup meeting (March 2014)

2. Prepared Report for Central Mississippi Area Health Education Center (CMAHEC) with Tugaloo College on "*Statewide Spatial Analysis of Health Trends in MS*" (Sep 2013)

Presentations (include title, presenter, date, meeting, location. Attach PowerPoint if available). If additional space is needed, please attach a separate Word document listing relevant materials.

Patents/Copyrights (List names)

Applications:

Awarded:

VACCINE Annual Report – Year 5

Please complete **ALL** fields.

This form must be emailed to Mary Padget at padget@purdue.edu **by July 18, 2014.**

If any item does not apply to your project, please indicate "NA" under the heading.

Summary of Outcomes and Impact of Project

Impact or success story associated with project

Issues Encountered, if applicable: intellectual property, data sensitivity, publication of high risk/sensitive/proprietary findings, institutional collaboration and relationships, etc.

Changes in research plans, if applicable: describe any major changes in the project's plans or objectives, such as initiatives added or omitted, compared to those outlined in the original, funded proposal.

Supporting Documentation: list items and attach electronically, including survey instruments, photos, models, letters to participants, or other unique documentation.

Morgan State University

VACCINE Annual Report – Year 5

Please complete **ALL** fields.

This form must be emailed to Mary Padget at padget@purdue.edu **by July 18, 2014.**

If any item does not apply to your project, please indicate "NA" under the heading.

Institution: Morgan State University

PI and/or Co-PI: Dr. Kofi Nyarko, Dr. Timothy Akers

Project Name: iLaw Enforcement Apps Assistance Program for Students (iLEAPS)

Academic Disciplines: Electrical Engineering, Computer Science

Keywords associated with project: Mobile apps, crime analytics, Campus safety

Theme for Research Projects (Check all that apply)

If this is not a research project, indicate "NA" below.

x	Public Safety Coalition Projects (state or local law enforcement, fire, emergency management, etc.)
	Federal Operating Component Projects (TSA,FEMA, Secret Service, ICE, CBP, USCIS, Coast Guard)
	Enterprise Resiliency Environments
	Event Evacuations
x	Visual Analytics for Security Applications
	International Collaborations
	N/A

Theme for Education Projects (Check all that apply)

If this is not an education project, indicate "NA" below.

	Minority or Underserved Programs
	Undergraduate and Graduate Education Program
	Professional Education and In-Service Programs
x	N/A

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Please complete **ALL** fields.
This form must be emailed to Mary Padget at padget@purdue.edu **by July 18, 2014.**
If any item does not apply to your project, please indicate "NA" under the heading.

Students Supported on Project

Graduate Research Assistants (include name(s), university and department)

none

Undergraduate supported students (need number only)	5
O**ther Graduate Students** (non-supported) involved in project (need number only)	0
Other Undergraduate Students (non-supported) involved in project (need number only)	0

Student Thesis in 2013 (include name, thesis title, university, department, degree, date)

none

Research Problem /Abstract (in 200 words or less, provide a summary of the project goals and objectives, **in simple language understandable to someone outside the project's field).**

On most college and university campuses, students, faculty and staff are not aware of the telephone number for the campus police and often resort to dialing 911 when an incident occurs on campus. When the police dispatch receives these calls, they often redirect them to campus police, since the city's police forces are unfamiliar with the physical layout of college campuses. Valuable time can be lost due to lack of geographic familiarity and communication delays. To address this problem, MSU has created a campus security system, comprising of mobile apps and a web service that provides students, staff, and faculty with a means to easily contact campus police and dispatch when help is needed. Dispatch and police are then able to efficiently coordinate a response. The use of this system will expedite responses to potential threat areas on a college campus with the added benefit of mitigating additional harm due to late responses by police. Furthermore, text-messaging integration will enable officers, dispatch and the user to expeditiously share information where all text communication is automatically stored for later reference. Lastly, integration with campus security camera video footage will enable officers to quickly reference video footage based on the geographic occurrences of crimes.

VACCINE Annual Report – Year 5

Please complete **ALL** fields.
This form must be emailed to Mary Padget at padget@purdue.edu **by July 18, 2014.**
If any item does not apply to your project, please indicate "NA" under the heading.

Technical Approach (Check all that apply)

Data Collection Methods

	Compiling & Sorting DB
	Data Mining
	Expert Consultation
	Field Monitors
x	Survey
x	Other: Data is acquired from mobile apps; processed/stored/retrieved in/from a database

Analytic Methods

	Case Studies
	Modeling
	Sampling
	Statistical Analysis
x	Other: Use of full SDLC, design/functionality changes driven by surveys from alpha/beta testers

Nature of Research

x	Applied
	Basic
	Consultatio
	n
	Coordination/Integration
	Education
	Hybrid Basic—Applied
	Hybrid Applied—Consultation

Deliverables (other than publications and reports listed below)

- Undergraduate students trained in various methods of mobile app development, requirements analysis, data collection and analysis, and documentation/technical writing
- Mobile campus security app for the end user (students/admin/faculty)
- Mobile campus security app for police officers
- Campus security web service for dispatch to coordinate activity between both mobile apps
- Surveys from beta testers consisting of project steak holders (students, faculty, campus security)

VACCINE Annual Report – Year 5

Please complete **ALL** fields.

This form must be emailed to Mary Padget at padget@purdue.edu **by July 18, 2014.**

If any item does not apply to your project, please indicate "NA" under the heading.

Technology Transitions (describe any products/technologies in process or that have completed transition to commercialization; include actions and progress to date)

none

Additional Funding Sources Leveraged: include amount, source of funding, PI and period of performance

none

VACCINE Annual Report – Year 5

Please complete **ALL** fields.
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If any item does not apply to your project, please indicate "NA" under the heading.

Collaborating Partners (academic Co-PI's, businesses, or other government funding agencies)

none

Collaborating End-Users (specific DHS operating components such as FEMA, TSA, Coast Guard or federal, state, local law enforcement, fire, emergency management, etc.)

Please provide name of agency, contact name and email address.

Morgan State Campus Police
Deputy Chief of Police Lance Hatcher
lance.hatcher@morgan.edu

Collaboration with other VACCINE project teams, national labs, and other Homeland Security Centers of Excellence (CREATE, NCFPD, START, PACER, ALERT, NCBSI, MIREES, ZADD, CHC and NTSCOE).

Describe purpose and nature of the collaboration and any follow-up to the discussion, if applicable.

none

Project Period (only complete if different than 4/1/12-6/30-13)

VACCINE Annual Report – Year 5

Please complete **ALL** fields.
This form must be emailed to Mary Padget at padget@purdue.edu **by July 18, 2014.**
If any item does not apply to your project, please indicate "NA" under the heading.

Project Outcomes (Publications, Presentations, etc., based on this VACCINE-funded project)

Peer-Reviewed/Refereed Publications, Journals, Conferences: list only citation below, must also provide/attach electronic copy of all individual publications to VACCINE

If additional space is needed, please attach a separate Word document listing relevant materials.

Submitted:

none

Accepted:

none

Other Reports (including white papers, book chapters, manuscripts submitted, in revision or accepted/in press [not including those in preparation], other publications)

none

Presentations (include title, presenter, date, meeting, location. Attach PowerPoint if available). If additional space is needed, please attach a separate Word document listing relevant materials.

none

Patents/Copyrights (List names)

Applications:

Awarded:

VACCINE Annual Report – Year 5

Please complete **ALL** fields.
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If any item does not apply to your project, please indicate "NA" under the heading.

Summary of Outcomes and Impact of Project

Students have undergone hands on training for various web and mobile application technologies while continuously developing the various components of the iLEAPS system through the use of the Software Development Lifecycle.

Impact or success story associated with project

The MSU campus police department has been extremely interested in the further development of the iLEAPS system. They have committed to help field test the system when complete and to provide critical information for the incorporation for predictive crime analytics.

Issues Encountered, if applicable: intellectual property, data sensitivity, publication of high risk/sensitive/proprietary findings, institutional collaboration and relationships, etc.

none

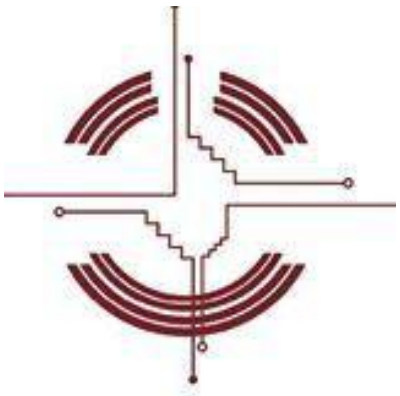
Changes in research plans, if applicable: describe any major changes in the project's plans or objectives, such as initiatives added or omitted, compared to those outlined in the original, funded proposal.

none

Supporting Documentation: list items and attach electronically, including survey instruments, photos, models, letters to participants, or other unique documentation.

Application screen shots

Navajo Technical College



VACCINE Annual Report – Year 5

Please complete **ALL** fields.

This form must be emailed to Mary Padget at padget@purdue.edu **by July 18, 2014.**

If any item does not apply to your project, please indicate "NA" under the heading.

Institution: Navajo Technical University

PI and/or Co-PI: Alice Carron

Project Name: Navajo Nation Graffiti Project

Academic Disciplines: Social Sciences, Computer Science, math, Logic, Geography, Area Studies

Keywords associated with project: Navajo Nation, graffiti, American Indian

Theme for Research Projects (Check all that apply)

If this is not a research project, indicate "NA" below.

	Public Safety Coalition Projects (state or local law enforcement, fire, emergency management, etc.)
	Federal Operating Component Projects (TSA,FEMA, Secret Service, ICE, CBP, USCIS, Coast Guard)
	Enterprise Resiliency Environments
	Event Evacuations
	Visual Analytics for Security Applications
	International Collaborations
x	N/A

Theme for Education Projects (Check all that apply)

If this is not an education project, indicate "NA" below.

x	Minority or Underserved Programs
x	Undergraduate and Graduate Education Program
	Professional Education and In-Service Programs
	N/A

VACCINE Annual Report – Year 5

Please complete **ALL** fields.
This form must be emailed to Mary Padget at padget@purdue.edu **by July 18, 2014.**
If any item does not apply to your project, please indicate "NA" under the heading.

Students Supported on Project

Graduate Research Assistants (include name(s), university and department) N/A

Navajo Technical University- UNDERGRADUATE STUDENTS:
Aaron Huber, Winston Cambridge, Dustin Perry, Myron Peters, Antwone Temple

Undergraduate supported students (need number only)	5
O**ther Graduate Students** (non-supported) involved in project (need number only)	0
Other Undergraduate Students (non-supported) involved in project (need number only)	0

Student Thesis in 2013 (include name, thesis title, university, department, degree, date)

Research Problem /Abstract (in 200 words or less, provide a summary of the project goals and objectives, **in simple language understandable to someone outside the project's field).** The Navajo Nation lies in Arizona, New Mexico, and Utah. It covers more than 25,000 square miles, making it bigger than the State of West Virginia. 50% of the population is under age 21; 41% are under age 18; and 25% are under age 9. The purpose of this project is to begin documenting locations of recent gang-related activity by monitoring gang graffiti in various reservation communities. NTU students will learn programming, applications, data collection, and mapping, as they map gang-related activity throughout their communities. Working with local law enforcement we plan to develop curriculum so that we can develop and successfully maintain effective intervention and prevention initiatives.

VACCINE Annual Report – Year 5

Please complete **ALL** fields.

This form must be emailed to Mary Padget at padget@purdue.edu **by July 18, 2014.**

If any item does not apply to your project, please indicate "NA" under the heading.

Technical Approach (Check all that apply)

Data Collection Methods

	Compiling & Sorting DB
	Data Mining
	Expert Consultation
x	Field Monitors
x	Survey
	Other:

Analytic Methods

	Case Studies
	Modeling
x	Sampling
	Statistical Analysis
	Other:

Nature of Research

x	Applied
	Basic
	Consultatio
	n
	Coordination/Integration
	Education
	Hybrid Basic—Applied
	Hybrid Applied—Consultation

Deliverables (other than publications and reports listed below) Photographs delivered to local police.

VACCINE Annual Report – Year 5

Please complete **ALL** fields.

This form must be emailed to Mary Padget at padget@purdue.edu **by July 18, 2014.**

If any item does not apply to your project, please indicate "NA" under the heading.

Technology Transitions (describe any products/technologies in process or that have completed transition to commercialization; include actions and progress to date) N/A

Additional Funding Sources Leveraged: include amount, source of funding, PI and period of performance

N/A

VACCINE Annual Report – Year 5

Please complete **ALL** fields.
This form must be emailed to Mary Padget at padget@purdue.edu **by July 18, 2014.**
If any item does not apply to your project, please indicate "NA" under the heading.

Collaborating Partners (academic Co-PI's, businesses, or other government funding agencies) N/A- (Navajo Nation requested to keep photos private and within the reservation community.)

Collaborating End-Users (specific DHS operating components such as FEMA, TSA, Coast Guard or federal, state, local law enforcement, fire, emergency management, etc.) N/A

Please provide name of agency, contact name and email address.

Collaboration with other VACCINE project teams, national labs, and other Homeland Security Centers of Excellence (CREATE, NCFPD, START, PACER, ALERT, NCBSI, MIREES, ZADD, CHC and NTSCOE). N/A

Describe purpose and nature of the collaboration and any follow-up to the discussion, if applicable.

Project Period (only complete if different than 4/1/12-6/30-13)

VACCINE Annual Report – Year 5

Please complete **ALL** fields.
This form must be emailed to Mary Padget at padget@purdue.edu **by July 18, 2014.**
If any item does not apply to your project, please indicate "NA" under the heading.

Project Outcomes (Publications, Presentations, etc., based on this VACCINE-funded project) There were no formal presentations however- We had five undergraduate interns and two faculty members who cooperated with local Law Enforcement collecting images of graffiti across the Navajo Nation reservation using the GARI software installed on Google Nexus phones. Individuals handled separate geographic areas around the Four-Corners region of Utah, Colorado, New Mexico, and Arizona with primary focus on locations within Arizona and New Mexico. Local areas included Shiprock NM, Window Rock AZ, Fort Defiance AZ, and Crownpoint NM. Individuals uploaded images to the server located in Indiana. Currently, there are over 700 images housed on the server.

Peer-Reviewed/Refereed Publications, Journals, Conferences: list only citation below, must also provide/attach electronic copy of all individual publications to VACCINE N/A

If additional space is needed, please attach a separate Word document listing relevant materials.

Submitted:

Accepted:

Other Reports (including white papers, book chapters, manuscripts submitted, in revision or accepted/in press [not including those in preparation], other publications)

Presentations (include title, presenter, date, meeting, location. Attach PowerPoint if available). If additional space is needed, please attach a separate Word document listing relevant materials.

Patents/Copyrights (List names) N/A

Applications:

Awarded:

VACCINE Annual Report – Year 5

Please complete **ALL** fields.
This form must be emailed to Mary Padget at padget@purdue.edu **by July 18, 2014.**
If any item does not apply to your project, please indicate "NA" under the heading.

Summary of Outcomes and Impact of Project

Impact or success story associated with project The interns were more than eager to collect data and were invaluable in locating graffiti through family and acquaintances. Several of the students had a personal history with gang activity. They took on the project with the hope that it would have a positive impact on deterring the gang-related activity that directly influences their families. Their communities are struggling with outside influences coming from gangs from other parts of the country. They felt this project gave them one more tool in the war on gang activities encroaching on the reservation. Now there is a pilot database of gang symbols that law enforcement can make use of in the future.

Issues Encountered, if applicable: Intellectual property issues were a concern among reservation community members. Also, areas identified to be mapped covered a larger land mass than originally anticipated. Another problem encountered was the apparent fragility of the phones. All the phones screens cracked possibly due to the high winds and dust storms encountered. In the future, it is recommended to purchase protective covers along with the purchase of any phones. Another recommendation is to add the capability to choose a GPS coordinate/point from which the range of selections can be applied. Currently, the only way to view images that are outside the maximum range is to choose all images. This can be problematic if there are a large number of images because they all have to be downloaded to the phone in order to view an area of interest.

Changes in research plans, if applicable: describe any major changes in the project's plans or objectives, such as initiatives added or omitted, compared to those outlined in the original, funded proposal. Our plan was to have student interns photograph graffiti in their reservation communities in order to help deter crime. We also planned to share this data with local law enforcement. We have shared these photos with local police and are working to develop curriculum with our law department.

Supporting Documentation: list items and attach electronically, including survey instruments, photos, models, letters to participants, or other unique documentation. N/A

Pennsylvania State University

VACCINE Annual Report – Year 5

Please complete **ALL** fields.
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If any item does not apply to your project, please indicate "NA" under the heading.

Institution: Penn State University

PI and/or Co-PI: PI: Alan M. MacEachren; CoPI: Prasenjit Mitra

Project Name: E2E - GeoTxt Web Service: Web Service for Geolocating Text Documents

Academic Disciplines: Geography & Information Science and Technology, Computer Science

Keywords associated with project: geographic information retrieval, Twitter geoparsing, visual analytics for crowd-sourcing

Theme for Research Projects (Check all that apply)
If this is not a research project, indicate "NA" below.

x	Public Safety Coalition Projects (state or local law enforcement, fire, emergency management, etc.)
	Federal Operating Component Projects (TSA,FEMA, Secret Service, ICE, CBP, USCIS, Coast Guard)
	Enterprise Resiliency Environments
	Event Evacuations
x	Visual Analytics for Security Applications
	International Collaborations
	N/A

Theme for Education Projects (Check all that apply)
If this is not an education project, indicate "NA" below.

	Minority or Underserved Programs
	Undergraduate and Graduate Education Program
	Professional Education and In-Service Programs
	N/A

VACCINE Annual Report – Year 5

Please complete **ALL** fields.
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If any item does not apply to your project, please indicate "NA" under the heading.

Students Supported on Project

Graduate Research Assistants (include name(s), university and department)

Morteza Karimzadeh (Penn State, PhD candidate, Geography)
Chong Zhou (Penn State, PhD candidate, Computer Science)
Siddhartha Banerjee (Penn State, PhD candidate, Information Sciences and Technology)

Undergraduate supported students (need number only)	
O**ther Graduate Students** (non-supported) involved in project (need number only)	2
Other Undergraduate Students (non-supported) involved in project (need number only)	1

Student Thesis in 2013 (include name, thesis title, university, department, degree, date)

Research Problem /Abstract (in 200 words or less, provide a summary of the project goals and objectives, **in simple language understandable to someone outside the project's field).**

GeoTxt, is a flexible and extensible web-services "geoparsing" application programming interface (API) that other applications can utilize to recognize place references in microblog posts and in other text documents, disambiguate the place references, and then geolocate them. GeoTxt also supports an associated visual web interface that enables users to extract and locate place references from individual documents and provide feedback to the system on accuracy of the results. Research and development during the July, 2013-June, 2014 period resulted in the following advances: (a) development of a strategy to build a corpus of tweets related to a range of event types that are annotated to identify place references in the text and to geolocate those place references (for use in training and testing algorithms to do these tasks in an automated way); (b) porting of the Geonames geographical database of over 8 million placenames to a fast-access index to support quick look up and place disambiguation; (c) development and implementation of strategies to improve the recognition of place names in microblog text; (d) provision of the methods as a web service made available to other VACCINE research teams as well as to an industry collaborator building a global event database; and (e) adaptation of the methods to run in a distributed computing environment to support processing of large volumes of text documents.

VACCINE Annual Report – Year 5

Please complete **ALL** fields.

This form must be emailed to Mary Padget at padget@purdue.edu **by July 18, 2014.**

If any item does not apply to your project, please indicate "NA" under the heading.

Technical Approach (Check all that apply)

Data Collection Methods

X	Compiling & Sorting DB
X	Data Mining
	Expert Consultation
	Field Monitors
	Survey
x	Other: query to streaming APIs

Analytic Methods

x	Case Studies
	Modeling
x	Sampling
x	Statistical Analysis
	Other:

Nature of Research

	Applied
	Basic
	Consultatio
	n
	Coordination/Integration
x	Education
	Hybrid Basic—Applied
	Hybrid Applied—Consultation

Deliverables (other than publications and reports listed below)

- The GeoTxt API, available on request to DHS partners and other collaborators.
- The GeoTxt web interface that enables users to process individual documents by hand.

VACCINE Annual Report – Year 5

Please complete **ALL** fields.
This form must be emailed to Mary Padget at padget@purdue.edu **by July 18, 2014.**
If any item does not apply to your project, please indicate "NA" under the heading.

Technology Transitions (describe any products/technologies in process or that have completed transition to commercialization; include actions and progress to date)

We have partnered with Parus Analytics (http://parusanalytics.com/) to provide geographic entity recognition, geographic disambiguation, and geo-coordinates for place references in news stories. Parsus Analytics is developing a new global event data set (PHOENIX), focused on political and related events (details at: http://openeventdata.org/datasets/phoenix/Phoenix.documentation.pdf).

GeoTxt is also being integrated as the backend geographic entity recognition, disambiguation, and co-coding systems to support SensePlace 2, our spatial-temporal twitter analytics environment. The early stages of SensePlace 2 (and its precursor SensePlace) were funded through VACCINE. Current support comes from the U.S.Army Corps of Engineers, with a focus on supporting analysis of the geographic and social components of crises and other events globally.

Additional Funding Sources Leveraged: include amount, source of funding, PI and period of performance

None at this time.

VACCINE Annual Report – Year 5

Please complete **ALL** fields.
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If any item does not apply to your project, please indicate "NA" under the heading.

Collaborating Partners (academic Co-PI's, businesses, or other government funding agencies)

(as noted above): Parus Analytics (http://parusanalytics.com/)

Collaborating End-Users (specific DHS operating components such as FEMA, TSA, Coast Guard or federal, state, local law enforcement, fire, emergency management, etc.)

Please provide name of agency, contact name and email address.

Collaboration with other VACCINE project teams, national labs, and other Homeland Security Centers of Excellence (CREATE, NCFPD, START, PACER, ALERT, NCBSI, MIREES, ZADD, CHC and NTSCOE).

Describe purpose and nature of the collaboration and any follow-up to the discussion, if applicable.

We have provided access to the GeoTxt API to the Purdue VACCINE group and have started to adapt GeoTxt to support processing of a range of documents types in support of visual analytics tools being developed at the UNCC VACCINE site.

Project Period: 7/1/14-6/30-14

VACCINE Annual Report – Year 5

Please complete **ALL** fields.
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If any item does not apply to your project, please indicate "NA" under the heading.

Project Outcomes (Publications, Presentations, etc., based on this VACCINE-funded project)

Peer-Reviewed/Refereed Publications, Journals, Conferences: list only citation below, must also provide/attach electronic copy of all individual publications to VACCINE

If additional space is needed, please attach a separate Word document listing relevant materials.

Submitted: (none pending at this time)
Accepted (published):

- Blanford JI, Bernhardt J, Savelyev A, Wong-Parodi G, Carleton AM, Titley DW, MacEachren AM. (2014) Tweeting and Tornadoes. In: 11th International ISCRAM Conference. University Park, Pennsylvania

- Karimzadeh, M., Huang, W., Banerjee, S., Wallgrün, J, Hardisty, F., Pezanowski, S., Mitra, P., and MacEachren, A.M. (2013) GeoTxt: A Web API to Leverage Place References in Text. ACM SIGSPATIAL International Conference on Advances in Geographic Information Systems, Orlando, FL, November 5-8, 2013.

- McClendon, S., and Robinson, A.C. (2013) Leveraging Geospatially-Oriented Social Media Communications in Disaster Response. *International Journal of Information Systems for Crisis Response and Management*. 5(1): 22-40.

Other Reports (including white papers, book chapters, manuscripts submitted, in revision or accepted/in press [not including those in preparation], other publications): NA

Presentations (include title, presenter, date, meeting, location. Attach PowerPoint if available). If additional space is needed, please attach a separate Word document listing relevant materials.

- Hardisty, Frank, and Alexander Savelyev. 2013. "Coordinating Views within Interactive Web Geovisualization." In 26th International Cartographic Conference. Dresden, Germany.
- Karimzadeh, M. (2014). Geospatial Cyberinfrastructure to Support Sustained Polar and Environmental Sciences. The 110th Annual Meeting of the Association of American Geographers. Tampa: April 8-12, 2014. http://meridian.aag.org/callforpapers/program/AbstractDetail.cfm?AbstractID=60308
- MacEachren, AM (2013) Moving forward: Reasoning about movement and other things dynamic. Keynote address at the European Cooperation in Science and Technology MOVE conference, Vienna, Austria, October 1, 2013.
- MacEachren, Alan M. (2013) Geo-Visual Analytics & 'Big' Data: Leveraging Geo-Information in Unstructured Data, Dept. of Geography Coffee Hour, Penn State, Dec. 6, 2013
- Mullins R., Hardisty F., Pezanowski S., Sujatha Das, Savelyev A., MacEachren AM, Mitra P., Jaiswal A. (2013) Designing a Web Service to Geo-Locate Subjects of Volunteered, Textual Geographic Information. August 29th 2013, International Cartographic Conference, Dresden, Germany.

Patents/Copyrights (List names): N/A

VACCINE Annual Report – Year 5

Please complete **ALL** fields.
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If any item does not apply to your project, please indicate "NA" under the heading.

Summary of Outcomes and Impact of Project

Progress has been made during the year on multiple aspects of the GeoTxt geoparsing service. These include: (1) development and implementation of text processing rules that improve recognition of place names in non-standard form found in Twitter (e.g., embedded in hashtags); (2) implementation of hierarchical reasoning tools to improve disambiguation among place names; (3) replacement of the GeoNames.org web service for locating place references (once recognized) with a local Solr place name index populated with the more than 8 million place names from the open GeoNames database (this enables implementation of our own ranking and reasoning schemes to select among many instances of names); (4) design and implementation of a crowd source-based approach to building a corpus of tweets with place references annotated to be used in testing performance of GeoTxt; and (5) adaptation of GeoTxt to provide a geoparsing service for news stories, Wikipedia pages, and other sources to meet needs of collaborators (both within VACCINE and beyond).

Impact or success story associated with project

One outcome with potential for substantial impact is that GeoTxt has been selected as the geoparser being used by startup Parsus Analytics to build their global event database (Phoenix). A second outcome is that GeoTxt is now fully integrated into the dataflow pipeline of SensePlace 2 to support space-time analysis of microblog posts about natural disasters and other events relevant to security. As noted above, development for SensePlace 2, initiated with DHS support, is currently supported by the U.S. Army Corps of Engineers.

Issues Encountered, if applicable: intellectual property, data sensitivity, publication of high risk/sensitive/proprietary findings, institutional collaboration and relationships, etc.: NA

Changes in research plans, if applicable: describe any major changes in the project's plans or objectives, such as initiatives added or omitted, compared to those outlined in the original, funded proposal.

The process of building an unbiased and accurate corpus of tweets with place references annotated, disambiguated, and located proved to be more challenging than initially expected. Key challenges are: (a) ambiguity about what counts as a place reference (e.g., in "I'm at McDonalds", standard named entity recognition software would identify "McDonalds" as an organization, but the speaker is clearly referring to being at a specific place in the world, a particular restaurant), and (b) challenges to disambiguation of place references once recognized (building a corpus with places located accurately requires both geographic expertise and knowledge of tools used to identify candidate places). Based on the research, we now have a plan for a set of two linked visual analytics tools for use in building annotated corpora for use in testing geoparsing software.

Supporting Documentation: list items and attach electronically, including survey instruments, photos, models, letters to participants, or other unique documentation.

GeoTxt can be tried manually at: www.GeoTxt.org

VACCINE Annual Report – Year 5

Please complete **ALL** fields.

This form must be emailed to Mary Padget at padget@purdue.edu **by July 18, 2014.**

If any item does not apply to your project, please indicate "NA" under the heading.

Institution: Penn State University

PI and/or Co-PI: Alan M. MacEachren

Project Name: Map Symbology Transition

Academic Disciplines: Geography

Keywords associated with project: mapping, symbology, symbol standardization

Theme for Research Projects (Check all that apply)

If this is not a research project, indicate "NA" below.

x	Public Safety Coalition Projects (state or local law enforcement, fire, emergency management, etc.)
	Federal Operating Component Projects (TSA,FEMA, Secret Service, ICE, CBP, USCIS, Coast Guard)
	Enterprise Resiliency Environments
	Event Evacuations
	Visual Analytics for Security Applications
	International Collaborations
	N/A

Theme for Education Projects (Check all that apply)

If this is not an education project, indicate "NA" below.

	Minority or Underserved Programs
	Undergraduate and Graduate Education Program
	Professional Education and In-Service Programs
	N/A

VACCINE Annual Report – Year 5

Please complete **ALL** fields.
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If any item does not apply to your project, please indicate "NA" under the heading.

Students Supported on Project

Graduate Research Assistants (include name(s), university and department)

Ryan Mullins, Penn State, Geography (MS student); hired in May, 2014 as a Software Engineer at Aptima, Inc.

Undergraduate supported students (need number only)	
O**ther Graduate Students** (non-supported) involved in project (need number only)	1
Other Undergraduate Students (non-supported) involved in project (need number only)	

Student Thesis in 2013 (include name, thesis title, university, department, degree, date)

Research Problem /Abstract (in 200 words or less, provide a summary of the project goals and objectives, **in simple language understandable to someone outside the project's field).**

A number of agencies within DHS employ maps as part of their daily operations. To facilitate inter-agency communication, cooperation, and consistency with map-based information and tools, DHS has directed attention to standardization of map symbology. With the support of DHS, Penn State has been researching map symbol standardization since 2009. The goals of this research include: (a) Investigating the use and usability of the ANSI INCITS 415-2006 standard; (b) Developing a process to refine mission-specific symbol standards; (c) Enabling the sharing of symbols through a feature-rich online "Store"; (d) Determining appropriate map symbology for mobile use within DHS. The results of this work, in addition to a comprehensive understanding of DHS mapping needs and the many roles for map symbols to meet those needs, is a pair of integrated web applications (Symbol Store and Symbol Reviewer) that this transition project has focused on adapting to work within the Federal Geographic Data Committee managed GeoPlatform: https://geoplatform.gov/. A working system with web-based guides on strategies for using map symbols provided in both web and mobile maps has been completed for implementation in GeoPlatform.

VACCINE Annual Report – Year 5

Please complete **ALL** fields.
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If any item does not apply to your project, please indicate "NA" under the heading.

Technical Approach (Check all that apply)

Data Collection Methods

	Compiling & Sorting DB
	Data Mining
	Expert Consultation
	Field Monitors
x	Survey
x	Other: software developed for web contribution of map symbols by practitioners

Analytic Methods

x	Case Studies
	Modeling
	Sampling
	Statistical Analysis
	Other:

Nature of Research

x	Applied
	Basic
	Consultatio
	n
	Coordination/Integration
	Education
	Hybrid Basic—Applied
	Hybrid Applied—Consultation

Deliverables (other than publications and reports listed below)

Symbol Store: currently at www.symbolstore.org (will be moved to www.GeoPlatform.gov once testing is completed).

Tutorials for integrating map symbols into web and mobile maps:

a) Using the SymbolStore to Create a Stand-Alone Web Map; https://github.com/RyanMullins/Tutorial-SymbolStoreClassic
b) MapBox.js and the SymbolStore API; https://github.com/RyanMullins/Tutorial-SymbolStoreAPI
c) Using the SymbolStore API in Mobile Apps; https://github.com/RyanMullins/Tutorial-SymbolStoreMobile

VACCINE Annual Report – Year 5

Please complete **ALL** fields.
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If any item does not apply to your project, please indicate "NA" under the heading.

Technology Transitions (describe any products/technologies in process or that have completed transition to commercialization; include actions and progress to date)

Working versions of both the Symbol Store and the Symbol Reviewer applications have been adapted (with input from GeoPlatform staff) for installation in the GeoPlatform.gov web portal. The deployment is still in progress pending testing on the GeoPlatform side and any edits that that may prompt. We anticipate a public release by the end of August.

Additional Funding Sources Leveraged: include amount, source of funding, PI and period of performance

none

VACCINE Annual Report – Year 5

Please complete **ALL** fields.
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If any item does not apply to your project, please indicate "NA" under the heading.

Collaborating Partners (academic Co-PI's, businesses, or other government funding agencies)

Collaborating End-Users (specific DHS operating components such as FEMA, TSA, Coast Guard or federal, state, local law enforcement, fire, emergency management, etc.)

In earlier stages of the project, there was substantial input form the DHS Geospatial Management Office, FEMA, IICD, and CBP.

Please provide name of agency, contact name and email address.

Primary DHS contact is Honore Nyuyse, Program Manager, U.S. DHS | S&T | RSD | HBI; Honore.Nyuyse@hq.dhs.gov; Office: 202-254-6781

Collaboration with other VACCINE project teams, national labs, and other Homeland Security Centers of Excellence (CREATE, NCFPD, START, PACER, ALERT, NCBSI, MIREES, ZADD, CHC and NTSCOE).

Describe purpose and nature of the collaboration and any follow-up to the discussion, if applicable.

Early collaboration was with PNNL, who managed the initial contract prior to the shift of the project to be within VACCINE.

Project Period: 7/1/13-6/30/14

VACCINE Annual Report – Year 5

Please complete **ALL** fields.
This form must be emailed to Mary Padget at padget@purdue.edu **by July 18, 2014.**
If any item does not apply to your project, please indicate "NA" under the heading.

Project Outcomes (Publications, Presentations, etc., based on this VACCINE-funded project)

Peer-Reviewed/Refereed Publications, Journals, Conferences: list only citation below, must also provide/attach electronic copy of all individual publications to VACCINE

If additional space is needed, please attach a separate Word document listing relevant materials.

Published:

- Robinson AC, Pezanowski S, Troedson S, Bianchetti RA, Blanford JI, Stevens J, Guidero E, Roth RE, MacEachren AM. (2013) SymbolStore.org: A Web-based Platform for Sharing Map Symbols. Cartography & Geographic Information Science, 40(5): 415-426. *published June 2013, but reported last year as In Press

- Robinson, A., Pezanowski, S., Stevens, J., Mullins, R., Blanford, J., Bianchetti, R. and MacEachren, A.M. 2013: Sharing and Discovering Map Symbols with SymbolStore.org. Proceedings of the International Cartographic Conference, Dresden, Germany, August 25-30, 2013.

- Stevens JE, Robinson AC, MacEachren AM. (2013) Designing Map Symbols for Mobile Devices: Challenges, Best Practices, and the Utilization of Skeuomorphism. In: Proceedings of the International Cartographic Conference. Proceedings of the International Cartographic Conference. Dresden, Germany.

Other Reports (including white papers, book chapters, manuscripts submitted, in revision or accepted/in press [not including those in preparation], other publications)

- Pezanowski, S. and MacEachren, A. M. (2014) Symbol Reviewer Design and Features, report on Symbology Transition, submitted to DHS VACCINE Center of Excellence.

Presentations (include title, presenter, date, meeting, location. Attach PowerPoint if available). If additional space is needed, please attach a separate Word document listing relevant materials.

- Hulsey, S. (2013) Symbol Sharing Tools for Cartographers at NASA. North American Cartographic Information Society (NACIS) annual meeting 2013, Greenville, SC, October 9-11, 2013.

- Mullins, R. (2013) Questions Facing Map Design in the Age of Mobility and Siri. North American Cartographic Information Society (NACIS) annual meeting 2013, Greenville, SC, October 9-11, 2013.

Patents/Copyrights (List names): N/A

VACCINE Annual Report – Year 5

Please complete **ALL** fields.
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If any item does not apply to your project, please indicate "NA" under the heading.

Summary of Outcomes and Impact of Project

Multiple improvements to the Symbol Store application have been made due to feedback from work with users. Additionally, the Symbol Store API has been enhanced and simplified to allow a developer to easily search and access symbols in the Symbol Store. A set of fully documented examples have been produced of web map (both Esri and an alternative) and mobile map applications that can connect directly to Symbol Store through the extended API along with documentation on the process for implementing the functionality (all posted on Github for wide access).

Symbol Store serves hundreds of symbols. To make them accessible, we added *query expansion* functionality that allows users to find map symbols even if they do not know the official symbol name (e.g., entering "boat" will retrieve not only the symbols with "boat" in their name but also symbols associated with marine incidents and ferries). This was implemented using the concept of semantic distance, and the WordNet database of all English words and their relations. Since computing semantic distance is computationally expensive, we pre-compiled indexes of the best symbol match for every noun in the English language and applied computational strategies that cut the index creation time by a factor of 30.

Symbol Store is working on the GeoPlatform.gov Server. We continue to work with the FGDC staff to prepare the system prior to public access; the latter is anticipated within 1 month of this report date. Symbol Reviewer is operational on the www.symbolstore.org web site and will be installed in the GeoPlatform at the convenience of GeoPlatform staff.

Impact or success story associated with project

The success story associated with Symbol Store and Symbol Reviewer is that it was deemed to be sufficiently useful to the broad federal agency community that it belongs in the GeoPlatform portal that provides a common access point to geospatial data and technologies.

Issues Encountered, if applicable: intellectual property, data sensitivity, publication of high risk/sensitive/proprietary findings, institutional collaboration and relationships, etc.

Some negotiation between DHS and the GeoPlatform host was required to make implementation and future maintenance choices and this delayed deployment somewhat.

Changes in research plans, if applicable: describe any major changes in the project's plans or objectives, such as initiatives added or omitted, compared to those outlined in the original, funded proposal.

A software flaw in an Esri application used in Symbol Store to ingest Esri Stylefiles of map symbols has prevented support for Stylefile additions by users through the Symbol Reviewer. This issue can be addressed by building a self-contained application that users can run locally to convert their map symbols before uploading them. Thus, until resources are available to create this application and the mechanism to distribute it, the Symbol Reviewer supports upload of symbols only in png and svg formats.

Supporting Documentation: list items and attach electronically, including survey instruments, photos, models, letters to participants, or other unique documentation.

User guide to Symbol Reviewer is integrated into the web application and the brief report on the Symbol Reviewer design and functionality is downloadable along with the published papers.

Purdue University

VACCINE Annual Report – Year 5

Please complete **ALL** fields.

This form must be emailed to Mary Padget at padget@purdue.edu **by July 18, 2014.**

If any item does not apply to your project, please indicate "NA" under the heading.

Institution: Purdue University PI and/or

Co-PI: Dr. Edward Delp

Project Name: GARI: Gang Graffiti Recognition and Analysis

Academic Disciplines: Electrical and Computer Engineering

Keywords associated with project:

Theme for Research Projects (Check all that apply)

If this is not a research project, indicate "NA" below.

XX	Public Safety Coalition Projects (state or local law enforcement, fire, emergency management, etc.)
	Federal Operating Component Projects (TSA,FEMA, Secret Service, ICE, CBP, USCIS, Coast Guard)
	Enterprise Resiliency Environments
	Event Evacuations
	Visual Analytics for Security Applications
	International Collaborations
	N/A

Theme for Education Projects (Check all that apply)

If this is not an education project, indicate "NA" below.

	Minority or Underserved Programs
	Undergraduate and Graduate Education Program
	Professional Education and In-Service Programs
	N/A

VACCINE Annual Report – Year 5

Please complete **ALL** fields.
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If any item does not apply to your project, please indicate "NA" under the heading.

Students Supported on Project

Graduate Research Assistants (include name(s), university and department)

Albert Parra
Bin Zhao
Joonoo Kim

Undergraduate supported students (need number only)

1

O**ther Graduate Students** (non-supported) involved in project (need number only)

Other Undergraduate Students (non-supported) involved in project (need number only)

Student Thesis in 2013 (include name, thesis title, university, department, degree, date)

Research Problem /Abstract (in 200 words or less, provide a summary of the project goals and objectives, **in simple language understandable to someone outside the project's field).**

Gangs are a serious threat to public safety throughout the United States. Gang members are continuously migrating from urban cities to suburban areas. They are responsible for an increasing percentage of crime and violence in many communities.According to the National Gang Threat Assessment, approximately 1 million gang members belonging to more than 20,000 gangs were criminally active within all 50 states and the District of Columbia as of September 2008. Criminal gangs commit as much as 80 percent of the crime in many communities according to law enforcement officials throughout the nation. Street gang graffiti is their most common way to communicate messages, including challenges, warnings or intimidation to rival gangs. It is, however, an excellent way to track gang affiliation and growth, or even sometimes to obtain membership information.

The goal of this project is the development of a mobile-based system capable of gang graffiti and gang tattoo image analysis. This system will provide an accurate and useful output to a user based on a database of gang graffiti tattoo images.

VACCINE Annual Report – Year 5

Please complete **ALL** fields.

This form must be emailed to Mary Padget at padget@purdue.edu **by July 18, 2014.**

If any item does not apply to your project, please indicate "NA" under the heading.

Technical Approach (Check all that apply)

Data Collection Methods

	Compiling & Sorting DB
XX	Data Mining
	Expert Consultation
	Field Monitors
	Survey
XX	Other: geotagged image collection

Analytic Methods

	Case Studies
XX	Modeling
	Sampling
XX	Statistical Analysis
	Other:

Nature of Research

XX	Applied
XX	Basic
	Consultation
	Coordination/Integration
	Education
	Hybrid Basic—Applied
	Hybrid Applied—Consultation

Deliverables (other than publications and reports listed below)

There are versions of the GARI system that have been deployed by the Indiana Fusion Center and Cook County Sheriff Office. We have had inqurues from more than 20 law enforcement agencies in the US. Both an Android and iPhone version of the applications are available.

VACCINE Annual Report – Year 5

Please complete **ALL** fields.

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If any item does not apply to your project, please indicate "NA" under the heading.

Technology Transitions (describe any products/technologies in process or that have completed transition to commercialization; include actions and progress to date)

We have talk with several companies that are interested in transitioning the GARI system.

Additional Funding Sources Leveraged: include amount, source of funding, PI and period of performance

VACCINE Annual Report – Year 5

Please complete **ALL** fields.
This form must be emailed to Mary Padget at padget@purdue.edu **by July 18, 2014.**
If any item does not apply to your project, please indicate "NA" under the heading.

Collaborating Partners (academic Co-PI's, businesses, or other government funding agencies)

Collaborating End-Users (specific DHS operating components such as FEMA, TSA, Coast Guard or federal, state, local law enforcement, fire, emergency management, etc.)

Please provide name of agency, contact name and email address.

This contact information for the law enforcement people can be obtained from Kaethe.

Collaboration with other VACCINE project teams, national labs, and other Homeland Security Centers of Excellence (CREATE, NCFPD, START, PACER, ALERT, NCBSI, MIREES, ZADD, CHC and NTSCOE).

Describe purpose and nature of the collaboration and any follow-up to the discussion, if applicable.

Project Period (only complete if different than 4/1/12-6/30-13)

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Please complete **ALL** fields.
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Project Outcomes (Publications, Presentations, etc., based on this VACCINE-funded project)

Peer-Reviewed/Refereed Publications, Journals, Conferences: list only citation below, must also provide/attach electronic copy of all individual publications to VACCINE

A. Parra, B. Zhao, J. Kim, Joonsoo, E. J. Delp, "Recognition, segmentation and retrieval of gang graffiti images on a mobile device," Proceedings of the IEEE International Conference on Technologies for Homeland Security, pp. 178 – 183, November 2013, Waltham, MA.

If additional space is needed, please attach a separate Word document listing relevant materials.

Submitted:

VACCINE Annual Report – Year 5

Please complete **ALL** fields.
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If any item does not apply to your project, please indicate "NA" under the heading.

Summary of Outcomes and Impact of Project

Impact or success story associated with project

Issues Encountered, if applicable: intellectual property, data sensitivity, publication of high risk/sensitive/proprietary findings, institutional collaboration and relationships, etc.

Changes in research plans, if applicable: describe any major changes in the project's plans or objectives, such as initiatives added or omitted, compared to those outlined in the original, funded proposal.

Supporting Documentation: list items and attach electronically, including survey instruments, photos, models, letters to participants, or other unique documentation.

VACCINE Annual Report – Year 5

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If any item does not apply to your project, please indicate "NA" under the heading.

Institution: Purdue University PI

and/or Co-PI: Dr. Edward Delp

Project Name: MERGE: Mobile Emergency Response Guide

Academic Disciplines: Electrical and Computer Engineering

Keywords associated with project:

Theme for Research Projects (Check all that apply)

If this is not a research project, indicate "NA" below.

XX	Public Safety Coalition Projects (state or local law enforcement, fire, emergency management, etc.)
	Federal Operating Component Projects (TSA,FEMA, Secret Service, ICE, CBP, USCIS, Coast Guard)
	Enterprise Resiliency Environments
	Event Evacuations
	Visual Analytics for Security Applications
	International Collaborations
	N/A

Theme for Education Projects (Check all that apply)

If this is not an education project, indicate "NA" below.

	Minority or Underserved Programs
	Undergraduate and Graduate Education Program
	Professional Education and In-Service Programs
	N/A

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If any item does not apply to your project, please indicate "NA" under the heading.

Students Supported on Project

Graduate Research Assistants (include name(s), university and department)

Albert Parra
Bin Zhao
Joonoo Kim

Undergraduate supported students (need number only)	1
O**ther Graduate Students** (non-supported) involved in project (need number only)	
Other Undergraduate Students (non-supported) involved in project (need number only)	

Student Thesis in 2013 (include name, thesis title, university, department, degree, date)

Research Problem /Abstract (in 200 words or less, provide a summary of the project goals and objectives, **in simple language understandable to someone outside the project's field).**

Hazardous materials can cause serious accidents, emergency situations and therefore can make them dangerous to society and the environment. A federal law in the US requires vehicles transporting hazardous materials to be marked with a standard sign (hazmat sign) identifying the type of hazardous material the vehicle is carrying. Hazmat signs help identify the material and determine what special equipment, procedures and precautions should be taken in the event of an emergency. This information is contained in the Emergency Response Guidebook (ERG) published by the US Department of Transportation (DOT).

The MERGE system is an integrated mobile-based system that makes use of location-based services and image analysis methods to automatically interpret the hazmat sign and quickly provide guide information to users. The MERGE mobile application is capable of detecting hazmat signs from an image and querying an internal database to provide accurate information to first responders in real time. MERGE has an easy to understand user interface to instruct emergency responders or civilian in the proper way to handle a hazardous material emergency.

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If any item does not apply to your project, please indicate "NA" under the heading.

Technical Approach (Check all that apply)

Data Collection Methods

	Compiling & Sorting DB
XX	Data Mining
	Expert Consultation
	Field Monitors
	Survey
XX	Other: geotagged image collection

Analytic Methods

	Case Studies
XX	Modeling
	Sampling
XX	Statistical Analysis
	Other:

Nature of Research

XX	Applied
XX	Basic
	Consultation
	Coordination/Integration
	Education
	Hybrid Basic—Applied
	Hybrid Applied—Consultation

Deliverables (other than publications and reports listed below)

There are versions of the MERGE system that have been deployed by the TSA and local fire departments. Both an Android and iPhone version of the application are available.

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Please complete **ALL** fields.
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If any item does not apply to your project, please indicate "NA" under the heading.

Collaborating Partners (academic Co-PI's, businesses, or other government funding agencies)

Collaborating End-Users (specific DHS operating components such as FEMA, TSA, Coast Guard or federal, state, local law enforcement, fire, emergency management, etc.)

Please provide name of agency, contact name and email address.

This contact information for the TSA people can be obtained from Kaethe.

Collaboration with other VACCINE project teams, national labs, and other Homeland Security Centers of Excellence (CREATE, NCFPD, START, PACER, ALERT, NCBSI, MIREES, ZADD, CHC and NTSCOE).

Describe purpose and nature of the collaboration and any follow-up to the discussion, if applicable.

Project Period (only complete if different than 7/1/12-6/30/14)

VACCINE Annual Report – Year 5

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If any item does not apply to your project, please indicate "NA" under the heading.

Project Outcomes (Publications, Presentations, etc., based on this VACCINE-funded project)

Peer-Reviewed/Refereed Publications, Journals, Conferences: list only citation below, must also provide/attach electronic copy of all individual publications to VACCINE

A. Parra Pozo, B. Zhao, A. Haddad, M. Boutin, E. Delp, "Hazardous Material Sign Detection And Recognition," Proceedings of the IEEE International Conference on Image Processing, September 2013, Melbourne, Australia.

B. Zhao, A. Parra, E. Delp, "Mobile-Based Hazmat Sign Detection And Recognition," Proceedings of the IEEE Global Conference on Signal and Information Processing, December 2013, Austin, TX.

If additional space is needed, please attach a separate Word document listing relevant materials.

Submitted:

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If any item does not apply to your project, please indicate "NA" under the heading.

Summary of Outcomes and Impact of Project

Impact or success story associated with project

Issues Encountered, if applicable: intellectual property, data sensitivity, publication of high risk/sensitive/proprietary findings, institutional collaboration and relationships, etc.

Changes in research plans, if applicable: describe any major changes in the project's plans or objectives, such as initiatives added or omitted, compared to those outlined in the original, funded proposal.

Supporting Documentation: list items and attach electronically, including survey instruments, photos, models, letters to participants, or other unique documentation.

VACCINE Annual Report – Year 5

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If any item does not apply to your project, please indicate "NA" under the heading.

Technical Approach (Check all that apply)

Data Collection Methods

	Compiling & Sorting DB
XX	Data Mining
	Expert Consultation
	Field Monitors
	Survey
XX	Other: geotagged image collection

Analytic Methods

	Case Studies
XX	Modeling
	Sampling
XX	Statistical Analysis
	Other:

Nature of Research

XX	Applied
XX	Basic
	Consultation
	Coordination/Integration
	Education
	Hybrid Basic—Applied
	Hybrid Applied—Consultation

Deliverables (other than publications and reports listed below)

There are versions of the MERGE system that have been deployed by the TSA and local fire departments. Both an Android and iPhone version of the application are available.

VACCINE Annual Report – Year 5

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If any item does not apply to your project, please indicate "NA" under the heading.

Technology Transitions (describe any products/technologies in process or that have completed transition to commercialization; include actions and progress to date)

We have talk with several companies that are interested in transitioning the MERGE system.

Additional Funding Sources Leveraged: include amount, source of funding, PI and period of performance

VACCINE Annual Report – Year 5

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Collaborating Partners (academic Co-PI's, businesses, or other government funding agencies)

Collaborating End-Users (specific DHS operating components such as FEMA, TSA, Coast Guard or federal, state, local law enforcement, fire, emergency management, etc.)

Please provide name of agency, contact name and email address.

This contact information for the TSA people can be obtained from Kaethe.

Collaboration with other VACCINE project teams, national labs, and other Homeland Security Centers of Excellence (CREATE, NCFPD, START, PACER, ALERT, NCBSI, MIREES, ZADD, CHC and NTSCOE).

Describe purpose and nature of the collaboration and any follow-up to the discussion, if applicable.

Project Period (only complete if different than 4/1/12-6/30-13)

VACCINE Annual Report – Year 5

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A. Parra Pozo, B. Zhao, A. Haddad, M. Boutin, E. Delp, "Hazardous Material Sign Detection And Recognition," Proceedings of the IEEE International Conference on Image Processing, September 2013, Melbourne, Australia.

B. Zhao, A. Parra, E. Delp, "Mobile-Based Hazmat Sign Detection And Recognition," Proceedings of the IEEE Global Conference on Signal and Information Processing, December 2013, Austin, TX.

If additional space is needed, please attach a separate Word document listing relevant materials.

Submitted:

VACCINE Annual Report – Year 5

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If any item does not apply to your project, please indicate "NA" under the heading.

Summary of Outcomes and Impact of Project

Impact or success story associated with project

Issues Encountered, if applicable: intellectual property, data sensitivity, publication of high risk/sensitive/proprietary findings, institutional collaboration and relationships, etc.

Changes in research plans, if applicable: describe any major changes in the project's plans or objectives, such as initiatives added or omitted, compared to those outlined in the original, funded proposal.

Supporting Documentation: list items and attach electronically, including survey instruments, photos, models, letters to participants, or other unique documentation.

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If any item does not apply to your project, please indicate "NA" under the heading.

Institution: Purdue University

PI and/or Co-PI: Dr. David S. Ebert

Project Name: Analyzing High-dimensional Multivariate Network Links with Integrated Anomaly Detection, Highlighting and Exploration

Academic Disciplines:

Keywords associated with project:

Theme for Research Projects (Check all that apply)

	Public Safety Coalition Projects (state or local law enforcement, fire, emergency management, etc.)
X	Federal Operating Component Projects (TSA,FEMA, Secret Service, ICE, CBP, USCIS, Coast Guard)
	Enterprise Resiliency Environments
	Event Evacuations
	Visual Analytics for Security Applications
X	International Collaborations
	N/A

Theme for Education Projects (Check all that apply)
If this is not an education project, indicate "NA" below.

	Minority or Underserved Programs
	Undergraduate and Graduate Education Program
	Professional Education and In-Service Programs
X	N/A

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Please complete **ALL** fields.
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If any item does not apply to your project, please indicate "NA" under the heading.

Students Supported on Project

Graduate Research Assistants (include name(s), university and department)

Sungahn Ko, Electrical and Computer Engineering, Purdue University
Shehzad Afzal, Electrical and Computer Engineering, Purdue University
Junghoon Chae, Electrical and Computer Engineering, Purdue University
Abish Malik, Electrical and Computer Engineering, Purdue University

Undergraduate supported students (need number only) 0

Other Graduate Students (non-supported) involved in project (need number only) 0

Other Undergraduate Students (non-supported) involved in project (need number only) 0

Student Thesis in 2013 (include name, thesis title, university, department, degree, date)

Sungahn Ko, AIDED DECISION-MAKING THROUGH VISUAL ANALYTICS SYSTEMS FOR LARGE MULTIVARIATE, SPATIOTEMPORAL, HIERARCHICAL AND NETWORK DATA, Purdue University, Electrical and Computer Engineering, PhD, 6 Aug 2013

Research Problem /Abstract (in 200 words or less, provide a summary of the project goals and objectives, **in simple language understandable to someone outside the project's field).**

This research focuses on the integration of a family of visual analytics techniques for analyzing high-dimensional, multivariate network data that features spatial and temporal information, network connections, and a variety of other categorical and numerical data types. Such data types are commonly encountered in transportation, shipping, and logistics industries. Due to the scale and complexity of the data, it is essential to integrate techniques for data analysis, visualization, and exploration. We present new visual representations, Petal and Thread, to effectively present many-to-many network data including multi-attribute vectors. In addition, we deploy an information-theoretic model for anomaly detection across varying dimensions, displaying highlighted anomalies in a visually consistent manner, as well as supporting a managed process of exploration. Lastly, we evaluate the proposed methodology through data exploration and an empirical study.

VACCINE Annual Report – Year 5

Please complete **ALL** fields.

This form must be emailed to Mary Padget at padget@purdue.edu **by July 18, 2014.**

If any item does not apply to your project, please indicate "NA" under the heading.

Technical Approach (Check all that apply)

Data Collection Methods

X	Compiling & Sorting DB
	Data Mining
	Expert Consultation
	Field Monitors
	Survey
	Other:

Analytic Methods

X	Case Studies
	Modeling
	Sampling
X	Statistical Analysis
	Other:

Nature of Research

X	Applied
	Basic
	Consultation
	Coordination/Integration
	Education
	Hybrid Basic—Applied
	Hybrid Applied—Consultation

Deliverables (other than publications and reports listed below)

We developed an interactive visual analytics system where users can explore spatial multivariate node-link data.

VACCINE Annual Report – Year 5

Please complete **ALL** fields.

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If any item does not apply to your project, please indicate "NA" under the heading.

Technology Transitions (describe any products/technologies in process or that have completed transition to commercialization; include actions and progress to date)

N/A

Additional Funding Sources Leveraged: include amount, source of funding, PI and period of performance

N/A

VACCINE Annual Report – Year 5

Please complete **ALL** fields.
This form must be emailed to Mary Padget at padget@purdue.edu **by July 18, 2014.**
If any item does not apply to your project, please indicate "NA" under the heading.

Collaborating Partners (academic Co-PI's, businesses, or other government funding agencies)

Dr. Min Chen, Oxford University

Dr. Simon Walton, Oxford University

Dr. Yun Jang, Sejong University

Collaborating End-Users (specific DHS operating components such as FEMA, TSA, Coast Guard or federal, state, local law enforcement, fire, emergency management, etc.)

Please provide name of agency, contact name and email address.

N/A

Collaboration with other VACCINE project teams, national labs, and other Homeland Security Centers of Excellence (CREATE, NCFPD, START, PACER, ALERT, NCBSI, MIREES, ZADD, CHC and NTSCOE).

Describe purpose and nature of the collaboration and any follow-up to the discussion, if applicable.

Dr. Min Chen and Dr. Simon Walton, Oxford University: anomaly detection algorithm design

Dr. Yun Jang, Sejong University: collaborative design of visualizations

VACCINE Annual Report – Year 5

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If any item does not apply to your project, please indicate "NA" under the heading.

Project Outcomes (Publications, Presentations, etc., based on this VACCINE-funded project)

Peer-Reviewed/Refereed Publications, Journals, Conferences: list only citation below, must also provide/attach electronic copy of all individual publications to VACCINE

If additional space is needed, please attach a separate Word document listing relevant materials.

Submitted:

N/A

Accepted:

N/A

Sungahnn Ko, Shehzad Afzal, Yang Yang, Junghoon Chae, Abish Malik, Yun Jang David Ebert, "Analyzing High-dimensional Multivariate Network Links with Integrated Anomaly Detection, Highlighting and Exploration", IEEE Conference on Visual Analytics Sciences and Technology, 2014 (To be published)

N/A

Other Reports (including white papers, book chapters, manuscripts submitted, in revision or accepted/in press [not including those in preparation], other publications)

N/A

Presentations (include title, presenter, date, meeting, location. Attach PowerPoint if available). If additional space is needed, please attach a separate Word document listing relevant materials.

N/A

Patents/Copyrights (List names)

Applications: N/A

Awarded: N/A

VACCINE Annual Report – Year 5

Please complete **ALL** fields.
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If any item does not apply to your project, please indicate "NA" under the heading.

Summary of Outcomes and Impact of Project

A professional analyst from an industry-leading company that deals with flight delay data evaluated our system and our approaches used in this work. The analyst mentioned that, at this company, they do not have such visual tools that can enable visual analysis of multiple variables at different locations and different times. Therefore, our system is excellent for dealing with challenging data in the flight delay domain, and it is cutting-edge work for the industry. In particular, the information theory based anomaly detection approach is very intriguing, and it has not been applied to analyses in the industry as of today.

Impact or success story associated with project

N/A

Issues Encountered, if applicable: intellectual property, data sensitivity, publication of high risk/sensitive/proprietary findings, institutional collaboration and relationships, etc.

N/A

Changes in research plans, if applicable: describe any major changes in the project's plans or objectives, such as initiatives added or omitted, compared to those outlined in the original, funded proposal.

N/A

Supporting Documentation: list items and attach electronically, including survey instruments, photos, models, letters to participants, or other unique documentation.

N/A

VACCINE Annual Report – Year 5

Please complete **ALL** fields.

This form must be emailed to Mary Padget at padget@purdue.edu **by July 18, 2014.**

If any item does not apply to your project, please indicate "NA" under the heading.

Institution: Purdue University

PI and/or Co-PI: Dr. David S. Ebert

Project Name: COAST: Coastal Operations and Analysis Suite of Tools

Academic Disciplines: Computer Science

Keywords associated with project: visualization, optimization, operations, GIS

Theme for Research Projects (Check all that apply)

If this is not a research project, indicate "NA" below.

	Public Safety Coalition Projects (state or local law enforcement, fire, emergency management, etc.)
X	Federal Operating Component Projects (TSA,FEMA, Secret Service, ICE, CBP, USCIS, Coast Guard)
	Enterprise Resiliency Environments
	Event Evacuations
	Visual Analytics for Security Applications
	International Collaborations
	N/A

Theme for Education Projects (Check all that apply)

If this is not an education project, indicate "NA" below.

	Minority or Underserved Programs
	Undergraduate and Graduate Education Program
	Professional Education and In-Service Programs
X	N/A

VACCINE Annual Report – Year 5

Please complete **ALL** fields.
This form must be emailed to Mary Padget at padget@purdue.edu **by July 18, 2014.**
If any item does not apply to your project, please indicate "NA" under the heading.

Students Supported on Project

Graduate Research Assistants (include name(s), university and department)
Silvia Oliveros-Torres – Electrical and Computer Engineering, Purdue University
Guizhen Wang – Electrical and Computer Engineering, Purdue University

Undergraduate supported students (need number only)	0
O**ther Graduate Students** (non-supported) involved in project (need number only)	0
Other Undergraduate Students (non-supported) involved in project (need number only)	0

Student Thesis in 2013 (include name, thesis title, university, department, degree, date)

Research Problem /Abstract (in 200 words or less, provide a summary of the project goals and objectives, **in simple language understandable to someone outside the project's field).**

Coastal Operations and Analysis Suite of Tools (COAST) aims to analyze all the Coast Guard operations across all districts in the United States. VACCINE has developed a visual analytics component that includes a GIS visualization and a coverage module.

The visual analytics system includes linked views and interactive displays that allow the interactive analysis of trends, patterns and anomalies among the U.S. Coast Guard operations.

The most recent improvements include the calculation of five different metrics that analyze all the stations with one or multiple districts. The metrics provide an understanding about which stations have the greatest load and what will the impact be if the number of assets are reduced in the station. The metrics also take into account the multiple air facilities the Coast Guard operates.

Other recent developments include the detailed analysis of the Coast Guard Air Station coverage. Based on the type of aircraft available the system calculates the coverage assuming that the aircraft can land at any point along the coast line instead of having to return to base, such calculation can improve the searching times and coverage of the air stations.

Finally, the Rescue 21 dataset was added to the framework, allowing the analyst to visualize the towers and their coverage and using the information available to think and test different hypotheses as well as optimize resources based on the use of the towers.

VACCINE Annual Report – Year 5

Please complete **ALL** fields.

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If any item does not apply to your project, please indicate "NA" under the heading.

Technical Approach (Check all that apply)

Data Collection Methods

X	Compiling & Sorting DB
X	Data Mining
X	Expert Consultation
	Field Monitors
	Survey
	Other:

Analytic Methods

	Case Studies
X	Modeling
X	Sampling
X	Statistical Analysis
	Other:

Nature of Research

	Applied
	Basic
	Consultation
	Coordination/Integration
	Education
X	Hybrid Basic—Applied
	Hybrid Applied—Consultation

Deliverables (other than publications and reports listed below)

The COAST software along with the user manual and appropriate documentation will be delivered to Coast Guard Headquarters (CG-771).

VACCINE Annual Report – Year 5

Please complete **ALL** fields.
This form must be emailed to Mary Padget at padget@purdue.edu **by July 18, 2014.**
If any item does not apply to your project, please indicate "NA" under the heading.

Technology Transitions (describe any products/technologies in process or that have completed transition to commercialization; include actions and progress to date)

The underlying framework of COAST called cgSARVA has been officially validated and verified by the Coast Guard.

Additional Funding Sources Leveraged: include amount, source of funding, PI and period of performance

N/A

VACCINE Annual Report – Year 5

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If any item does not apply to your project, please indicate "NA" under the heading.

Collaborating Partners (academic Co-PI's, businesses, or other government funding agencies)

Collaborating End-Users (specific DHS operating components such as FEMA, TSA, Coast Guard or federal, state, local law enforcement, fire, emergency management, etc.)

Please provide name of agency, contact name and email address.

Coast Guard Headquarters, Office of Requirements and Analysis(CG-771):

* CDR Kevin Hanson

* LT Chad Conrad

Operations Research Analyst

Office of Requirements and Analysis|CG-771 202-372-

2533

Collaboration with other VACCINE project teams, national labs, and other Homeland Security Centers of Excellence (CREATE, NCFPD, START, PACER, ALERT, NCBSI, MIREES, ZADD, CHC and NTSCOE).

Describe purpose and nature of the collaboration and any follow-up to the discussion, if applicable.

N/A

VACCINE Annual Report – Year 5

Please complete **ALL** fields.
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If any item does not apply to your project, please indicate "NA" under the heading.

Project Outcomes (Publications, Presentations, etc., based on this VACCINE-funded project)

Peer-Reviewed/Refereed Publications, Journals, Conferences: list only citation below, must also provide/attach electronic copy of all individual publications to VACCINE

If additional space is needed, please attach a separate Word document listing relevant materials.

Submitted:

N/A

Accepted:

N/A

Other Reports (including white papers, book chapters, manuscripts submitted, in revision or accepted/in press [not including those in preparation], other publications)

N/A

Presentations (include title, presenter, date, meeting, location. Attach PowerPoint if available). If additional space is needed, please attach a separate Word document listing relevant materials.

N/A

Patents/Copyrights (List names)

Applications: N/A

Awarded: N/A

VACCINE Annual Report – Year 5

Please complete **ALL** fields.
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If any item does not apply to your project, please indicate "NA" under the heading.

Summary of Outcomes and Impact of Project

CG-771 utilizes the COAST software to generate images used in the reports used for operations planning.

Impact or success story associated with project

N/A

Issues Encountered, if applicable: intellectual property, data sensitivity, publication of high risk/sensitive/proprietary findings, institutional collaboration and relationships, etc.

Data for the LE mission is being omitted for foreign nationals.

Changes in research plans, if applicable: describe any major changes in the project's plans or objectives, such as initiatives added or omitted, compared to those outlined in the original, funded proposal.

N/A

Supporting Documentation: list items and attach electronically, including survey instruments, photos, models, letters to participants, or other unique documentation.

N/A

VACCINE Annual Report – Year 5

Please complete **ALL** fields.

This form must be emailed to Mary Padget at padget@purdue.edu **by July 18, 2014.**

If any item does not apply to your project, please indicate "NA" under the heading.

Institution: Purdue University

PI and/or Co-PI: Dr. David S. Ebert

Project Name: Fantasy Officer

Academic Disciplines: Computer Engineering

Keywords associated with project: Performance

Theme for Research Projects (Check all that apply)

If this is not a research project, indicate "NA" below.

X	Public Safety Coalition Projects (state or local law enforcement, fire, emergency management, etc.)
	Federal Operating Component Projects (TSA,FEMA, Secret Service, ICE, CBP, USCIS, Coast Guard)
	Enterprise Resiliency Environments
	Event Evacuations
	Visual Analytics for Security Applications
	International Collaborations
	N/A

Theme for Education Projects (Check all that apply)

If this is not an education project, indicate "NA" below.

	Minority or Underserved Programs
	Undergraduate and Graduate Education Program
	Professional Education and In-Service Programs
X	N/A

VACCINE Annual Report – Year 5

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If any item does not apply to your project, please indicate "NA" under the heading.

Students Supported on Project

Graduate Research Assistants (include name(s), university and department)
Calvin Yau, Purdue University, Electrical and Computer Engineering

Undergraduate supported students (need number only)	1
O**ther Graduate Students** (non-supported) involved in project (need number only)	0
Other Undergraduate Students (non-supported) involved in project (need number only)	0

Student Thesis in 2013 (include name, thesis title, university, department, degree, date)

Research Problem /Abstract (in 200 words or less, provide a summary of the project goals and objectives, **in simple language understandable to someone outside the project's field).**

Collaborating with Chief Patrick Flannelly, we propose the Fantasy Officer project to gamify the performance of police officers in Lafayette Police Department for better performance comparison and for motivating maximized performance.

VACCINE Annual Report – Year 5

Please complete **ALL** fields.

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If any item does not apply to your project, please indicate "NA" under the heading.

Technical Approach (Check all that apply)

Data Collection Methods

X	Compiling & Sorting DB
	Data Mining
	Expert Consultation
	Field Monitors
X	Survey
	Other:

Analytic Methods

	Case Studies
X	Modeling
	Sampling
X	Statistical Analysis
	Other:

Nature of Research

	Applied
X	Basic
	Consultation
X	Coordination/Integration
	Education
	Hybrid Basic—Applied
	Hybrid Applied—Consultation

Deliverables (other than publications and reports listed below)

Web Application

VACCINE Annual Report – Year 5

Please complete **ALL** fields.

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If any item does not apply to your project, please indicate "NA" under the heading.

Technology Transitions (describe any products/technologies in process or that have completed transition to commercialization; include actions and progress to date)

N/A

Additional Funding Sources Leveraged: include amount, source of funding, PI and period of performance

N/A

VACCINE Annual Report – Year 5

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If any item does not apply to your project, please indicate "NA" under the heading.

Collaborating Partners (academic Co-PI's, businesses, or other government funding agencies)

Collaborating End-Users (specific DHS operating components such as FEMA, TSA, Coast Guard or federal, state, local law enforcement, fire, emergency management, etc.)

Please provide name of agency, contact name and email address.

Lafayette Police Department, Patrick J. Flannelly, pjflannelly@lafayette.in.gov

Collaboration with other VACCINE project teams, national labs, and other Homeland Security Centers of Excellence (CREATE, NCFPD, START, PACER, ALERT, NCBSI, MIREES, ZADD, CHC and NTSCOE).

Describe purpose and nature of the collaboration and any follow-up to the discussion, if applicable.

N/A

Project Period (only complete if different than 7/1/13-6/30-14)

N/A

VACCINE Annual Report – Year 5

Please complete **ALL** fields.
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If any item does not apply to your project, please indicate "NA" under the heading.

Project Outcomes (Publications, Presentations, etc., based on this VACCINE-funded project)

Peer-Reviewed/Refereed Publications, Journals, Conferences: list only citation below, must also provide/attach electronic copy of all individual publications to VACCINE

If additional space is needed, please attach a separate Word document listing relevant materials.

Submitted

: N/A

Accepted:

N/A

Other Reports (including white papers, book chapters, manuscripts submitted, in revision or accepted/in press [not including those in preparation], other publications)
N/A

Presentations (include title, presenter, date, meeting, location. Attach PowerPoint if available). If additional space is needed, please attach a separate Word document listing relevant materials.

N/A

Patents/Copyrights (List names)

Applications: N/A

VACCINE Annual Report – Year 5

Please complete **ALL** fields.

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If any item does not apply to your project, please indicate "NA" under the heading.

Awarded: N/A

Summary of Outcomes and Impact of Project

The project started at the end of May and is currently still in progress

Impact or success story associated with project

N/A

Issues Encountered, if applicable: intellectual property, data sensitivity, publication of high risk/sensitive/proprietary findings, institutional collaboration and relationships, etc.

N/A

Changes in research plans, if applicable: describe any major changes in the project's plans or objectives, such as initiatives added or omitted, compared to those outlined in the original, funded proposal.

N/A

Supporting Documentation: list items and attach electronically, including survey instruments, photos, models, letters to participants, or other unique documentation.

N/A

VACCINE Annual Report – Year 5

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If any item does not apply to your project, please indicate "NA" under the heading.

Institution: Purdue University

PI and/or Co-PI: Dr. David S. Ebert

Project Name: Safety in View: A Public Safety Visual Analytics Tool Based on CCTV Camera Angles of View

Academic Disciplines: Computer Engineering

Keywords associated with project: Safe walking path, Camera data utilization

Theme for Research Projects (Check all that apply)
If this is not a research project, indicate "NA" below.

X	Public Safety Coalition Projects (state or local law enforcement, fire, emergency management, etc.)
	Federal Operating Component Projects (TSA,FEMA, Secret Service, ICE, CBP, USCIS, Coast Guard)
	Enterprise Resiliency Environments
	Event Evacuations
	Visual Analytics for Security Applications
	International Collaborations
	N/A

Theme for Education Projects (Check all that apply)
If this is not an education project, indicate "NA" below.

	Minority or Underserved Programs
X	Undergraduate and Graduate Education Program
	Professional Education and In-Service Programs
	N/A

VACCINE Annual Report – Year 5

Please complete **ALL** fields.
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If any item does not apply to your project, please indicate "NA" under the heading.

Students Supported on Project

Graduate Research Assistants (include name(s), university and department)

Hanye Xu, Purdue University, ECE
Abish Malik, Purdue University, ECE
Shehzad Afzal, Purdue University , ECE

Undergraduate supported students (need number only)	1
O**ther Graduate Students** (non-supported) involved in project (need number only)	0
Other Undergraduate Students (non-supported) involved in project (need number only)	0

Student Thesis in 2013 (include name, thesis title, university, department, degree, date)

Research Problem /Abstract (in 200 words or less, provide a summary of the project goals and objectives, **in simple language understandable to someone outside the project's field).**

Campus security and police departments have implemented a multitude of safety precautions, including CCTV cameras. The efficiency and effectiveness of using CCTV camera resources for preventing crimes result in higher demand. We implemented a visual analytics tool to analyze the existing CCTV camera resources and suggest improved allocation schemas based on blind spots and crime data. Our tool provides the user with an interactive safe path calculation method for walking purpose on the basis of the maximum monitoring area. Additionally, avoiding buildings in the calculated path is an optional control factor. Our tool also provides functions for crime data analysis. The camera-alarming function highlights the cameras that a specific crime occurred in their visible range. The camera-ranking function highlights the camera that records the largest number of crime incidents. Based on the historical crime data, we suggest locations for future camera installation.

VACCINE Annual Report – Year 5

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If any item does not apply to your project, please indicate "NA" under the heading.

Technical Approach (Check all that apply)

Data Collection Methods

	Compiling & Sorting DB
	Data Mining
X	Expert Consultation
	Field Monitors
	Survey
	Other:

Analytic Methods

X	Case Studies
	Modeling
	Sampling
	Statistical Analysis
	Other:

Nature of Research

X	Applied
X	Basic
	Consultation
	Coordination/Integration
	Education
	Hybrid Basic—Applied
	Hybrid Applied—Consultation

Deliverables (other than publications and reports listed below)

An interactive map that allows users to choose start point and destination for generating a path.

VACCINE Annual Report – Year 5

Please complete **ALL** fields.

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If any item does not apply to your project, please indicate "NA" under the heading.

Technology Transitions (describe any products/technologies in process or that have completed transition to commercialization; include actions and progress to date)

N/A

Additional Funding Sources Leveraged: include amount, source of funding, PI and period of performance

N/A

VACCINE Annual Report – Year 5

Please complete **ALL** fields.
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If any item does not apply to your project, please indicate "NA" under the heading.

Collaborating Partners (academic Co-PI's, businesses, or other government funding agencies)

N/A

Collaborating End-Users (specific DHS operating components such as FEMA, TSA, Coast Guard or federal, state, local law enforcement, fire, emergency management, etc.)

Please provide name of agency, contact name and email address.

Captain Eric H. Chin

Purdue Police Department

ehchin@purdue.edu

Collaboration with other VACCINE project teams, national labs, and other Homeland Security Centers of Excellence (CREATE, NCFPD, START, PACER, ALERT, NCBSI, MIREES, ZADD, CHC and NTSCOE).

Describe purpose and nature of the collaboration and any follow-up to the discussion, if applicable.

N/A

VACCINE Annual Report – Year 5

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If any item does not apply to your project, please indicate "NA" under the heading.

Project Outcomes (Publications, Presentations, etc., based on this VACCINE-funded project)

Peer-Reviewed/Refereed Publications, Journals, Conferences: list only citation below, must also provide/attach electronic copy of all individual publications to VACCINE

If additional space is needed, please attach a separate Word document listing relevant materials.

Submitted: N/A

Accepted: N/A

Other Reports (including white papers, book chapters, manuscripts submitted, in revision or accepted/in press [not including those in preparation], other publications)

N/A

Presentations (include title, presenter, date, meeting, location. Attach PowerPoint if available). If additional space is needed, please attach a separate Word document listing relevant materials.

N/A

Patents/Copyrights (List names)

Applications: N/A

Awarded: N/A

VACCINE Annual Report – Year 5

Please complete **ALL** fields.
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If any item does not apply to your project, please indicate "NA" under the heading.

Summary of Outcomes and Impact of Project

N/A

Impact or success story associated with project

N/A

Issues Encountered, if applicable: intellectual property, data sensitivity, publication of high risk/sensitive/proprietary findings, institutional collaboration and relationships, etc.

N/A

Changes in research plans, if applicable: describe any major changes in the project's plans or objectives, such as initiatives added or omitted, compared to those outlined in the original, funded proposal.

N/A

Supporting Documentation: list items and attach electronically, including survey instruments, photos, models, letters to participants, or other unique documentation.

N/A

VACCINE Annual Report – Year 5

Please complete **ALL** fields.

This form must be emailed to Mary Padget at padget@purdue.edu **by July 18, 2014.**

If any item does not apply to your project, please indicate "NA" under the heading.

Institution: Purdue University

PI and/or Co-PI: Dr. David S. Ebert

Project Name: SMART (Social Media Analytics and Reporting Toolkit)

Academic Disciplines:

Keywords associated with project: Visual Analytics, Social Media Analytics, and Disaster Management

Theme for Research Projects (Check all that apply)

If this is not a research project, indicate "NA" below.

V	Public Safety Coalition Projects (state or local law enforcement, fire, emergency management, etc.)
V	Federal Operating Component Projects (TSA,FEMA, Secret Service, ICE, CBP, USCIS, Coast Guard)
	Enterprise Resiliency Environments
	Event Evacuations
V	Visual Analytics for Security Applications
	International Collaborations
	N/A

Theme for Education Projects (Check all that apply)

If this is not an education project, indicate "NA" below.

	Minority or Underserved Programs
	Undergraduate and Graduate Education Program
	Professional Education and In-Service Programs
V	N/A

VACCINE Annual Report – Year 5

Please complete **ALL** fields.
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If any item does not apply to your project, please indicate "NA" under the heading.

Students Supported on Project

Graduate Research Assistants (include name(s), university and department)
Junghoon Chae, Ph.D. Purdue University, Electrical and Computer Engineering
Jiawei Zhang, Ph.D. Purdue University, Electrical and Computer Engineering
Shehzad Afzal, Ph.D. Purdue University, Electrical and Computer Engineering

Undergraduate supported students (need number only)	2
O**ther Graduate Students** (non-supported) involved in project (need number only)	0
Other Undergraduate Students (non-supported) involved in project (need number only)	0

Student Thesis in 2013 (include name, thesis title, university, department, degree, date)

Research Problem /Abstract (in 200 words or less, provide a summary of the project goals and objectives, **in simple language understandable to someone outside the project's field).**

Recent advances in technology have enabled social media services to support space-time indexed data. Such spatiotemporal data has immense value for increasing situational awareness of local events, providing insights for investigations and understanding the extent of incidents. However, the large volume of unstructured social media data hinders effective exploration and examination. Analysts require new methods for monitoring their topics of interest, identifying trends and anomalies, and dealing with the data volume and its dynamic nature. Our system provides users with scalable and interactive social media data (e.g., Twitter, Facebook) analysis and visualization including the exploration and the examination of abnormal topics and events. We have developed a new approach to let analysts build task-tailored message filters (classifiers) in an interactive and visual manner. The created filter methods can be orchestrated and adapted afterwards for interactive, visual real-time monitoring and analysis. In addition, web and news media sources (i.e., Google and CNN trends) are incorporated in the system. Our system also provide an email alert service to automatically send emails if the number of incoming tweets containing specific keywords exceeds a threshold. We provide such functionalities through not only desktop application, but also highly interactive and accessible Web interfaces.

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Please complete **ALL** fields.

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If any item does not apply to your project, please indicate "NA" under the heading.

Technical Approach (Check all that apply)

Data Collection Methods

	Compiling & Sorting DB
V	Data Mining
	Expert Consultation
	Field Monitors
	Survey
	Other:

Analytic Methods

V	Case Studies
V	Modeling
	Sampling
V	Statistical Analysis
	Other:

Nature of Research

	Applied
	Basic
	Consultation
	Coordination/Integration
	Education
V	Hybrid Basic—Applied
	Hybrid Applied—Consultation

Deliverables (other than publications and reports listed below)

Coast Guard in Louisville used our system to monitor Thunder Over Louisville festival in April, 2014. They will use our system to monitor Festival of Riverboats in Louisville, in October, 2014.

Purdue Police Department used our system to monitor Purdue Football in September and October, 2014.

Coast Guard in San Francisco will use our system to monitor San Francisco Fleet Week in October, 2014.

VACCINE Annual Report – Year 5

Please complete **ALL** fields.

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If any item does not apply to your project, please indicate "NA" under the heading.

Technology Transitions (describe any products/technologies in process or that have completed transition to commercialization; include actions and progress to date)

N/A

Additional Funding Sources Leveraged: include amount, source of funding, PI and period of performance

N/A

VACCINE Annual Report – Year 5

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If any item does not apply to your project, please indicate "NA" under the heading.

Collaborating Partners (academic Co-PI's, businesses, or other government funding agencies)

Collaborating End-Users (specific DHS operating components such as FEMA, TSA, Coast Guard or federal, state, local law enforcement, fire, emergency management, etc.)

Please provide name of agency, contact name and email address.

N/A

Collaboration with other VACCINE project teams, national labs, and other Homeland Security Centers of Excellence (CREATE, NCFPD, START, PACER, ALERT, NCBSI, MIREES, ZADD, CHC and NTSCOE).

Describe purpose and nature of the collaboration and any follow-up to the discussion, if applicable.

N/A

Project Period (only complete if different than 7/1/13-6/30-14)

N/A

VACCINE Annual Report – Year 5

Please complete **ALL** fields.
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If any item does not apply to your project, please indicate "NA" under the heading.

Project Outcomes (Publications, Presentations, etc., based on this VACCINE-funded project)

Peer-Reviewed/Refereed Publications, Journals, Conferences: list only citation below, must also provide/attach electronic copy of all individual publications to VACCINE

If additional space is needed, please attach a separate Word document listing relevant materials.

Submitted:

Zhan, J., Afzal, S., Chase, J., Wang, G., Thom, D., Matie, S., Elmqvist, E., Ebert, D., "Visual Analytics of User-influence based Dynamic Social Networks using Twitter Data", IEEE Visual Analytics Science and Technology (VAST)Conference, 2014

Accepted:

Chae, J., Thom, D., Jang, Y., Kim, S., Ertl, T., Ebert, D., "Visual Analytics of Microblog Data for Public Behavior Response Analysis in Disaster Events", extended journal paper, Computers and Graphics, 2014.

Chae, J., Thom, D., Jang, Y., Kim, S., Ertl, T., Ebert, D., "Visual Analytics of Microblog Data for Public Behavior Analysis in Disaster Events," Eurovis Workshop on Visual Analytics, 2013.

Other Reports (including white papers, book chapters, manuscripts submitted, in revision or accepted/in press [not including those in preparation], other publications)

Presentations (include title, presenter, date, meeting, location. Attach PowerPoint if available). If additional space is needed, please attach a separate Word document listing relevant materials.

Patents/Copyrights (List names)

Applications: N/A

Awarded: N/A

VACCINE Annual Report – Year 5

Please complete **ALL** fields.
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If any item does not apply to your project, please indicate "NA" under the heading.

Summary of Outcomes and Impact of Project

This technology provides analysts with scalable and interactive social media analysis and visualization through topic extraction, combination of filters, cluster examination, and stream categorization for increasing situational awareness in disaster events and accidents using social media data. These components are tightly integrated into a highly interactive visual analysis workbench that allows an analyst to observe, supervise, and configure the methods in each individual analysis process.

The system also incorporates automatic notifications through email alert and summary. Based on user-defined keywords, the system collects relevant social media information and send to users through emails for better and quicker situational awareness in various abnormal events.

Impact or success story associated with project

N/A

Issues Encountered, if applicable: intellectual property, data sensitivity, publication of high risk/sensitive/proprietary findings, institutional collaboration and relationships, etc.

N/A

Changes in research plans, if applicable: describe any major changes in the project's plans or objectives, such as initiatives added or omitted, compared to those outlined in the original, funded proposal.

N/A

Supporting Documentation: list items and attach electronically, including survey instruments, photos, models, letters to participants, or other unique documentation.

N/A

VACCINE Annual Report – Year 5

Please complete **ALL** fields.

This form must be emailed to Mary Padget at padget@purdue.edu **by July 18, 2014.**

If any item does not apply to your project, please indicate "NA" under the heading.

Institution: Purdue University

PI and/or Co-PI: Dr. David S. Ebert

Project Name: Social Media and Healthcare Analytics for Identification of Emerging Health Threats

Academic Disciplines: Computer Engineering, Statistics

Keywords associated with project: Social media analytics, healthcare analytics

Theme for Research Projects (Check all that apply)

If this is not a research project, indicate "NA" below.

✓	Public Safety Coalition Projects (state or local law enforcement, fire, emergency management, etc.)
	Federal Operating Component Projects (TSA,FEMA, Secret Service, ICE, CBP, USCIS, Coast Guard)
	Enterprise Resiliency Environments
	Event Evacuations
	Visual Analytics for Security Applications
	International Collaborations
	N/A

Theme for Education Projects (Check all that apply)

If this is not an education project, indicate "NA" below.

	Minority or Underserved Programs
	Undergraduate and Graduate Education Program
	Professional Education and In-Service Programs
✓	N/A

VACCINE Annual Report – Year 5

Please complete **ALL** fields.
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If any item does not apply to your project, please indicate "NA" under the heading.

Students Supported on Project

Graduate Research Assistants (include name(s), university and department)

Shehzad Afzal, Purdue University, Department of Electrical and Computer Engineering

Undergraduate supported students (need number only)	0
O**ther Graduate Students** (non-supported) involved in project (need number only)	0
Other Undergraduate Students (non-supported) involved in project (need number only)	0

Student Thesis in 2013 (include name, thesis title, university, department, degree, date)

Research Problem /Abstract (in 200 words or less, provide a summary of the project goals and objectives, **in simple language understandable to someone outside the project's field).**

Assessing current and emerging health threats is important for public health officials in order to make timely decisions about mitigative measures and allocation of resources required under different scenarios. Syndromic surveillance systems often rely on analyzing data received from a specific domain such as chief complaints data collected through hospitals, social media streams, aggregated web searches, news stories, etc. Information collected through multiple data sources could provide better understanding of extent and severity of emerging health threats and also reduces dependence on a single data source. It also helps scientists understand the characteristics of syndromic diseases, discover correlations among different factors and understand contributing factors in disease outbreak scenarios. This project focusses on providing a visual analytics environment that enables analysts combine chief complaints data collected through hospitals, social media data from Twitter's API and weather data to make comprehensive assessments about disease outbreaks.

VACCINE Annual Report – Year 5

Please complete **ALL** fields.

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If any item does not apply to your project, please indicate "NA" under the heading.

Technical Approach (Check all that apply)

Data Collection Methods

✓	Compiling & Sorting DB
✓	Data Mining
	Expert Consultation
	Field Monitors
	Survey
	Other:

Analytic Methods

	Case Studies
✓	Modeling
	Sampling
✓	Statistical Analysis
	Other:

Nature of Research

✓	Applied
	Basic
	Consultation
	Coordination/Integration
	Education
	Hybrid Basic—Applied
	Hybrid Applied—Consultation

Deliverables (other than publications and reports listed below)

Visual Analytics application providing interactive linked visualizations for analyzing social media, healthcare and weather data.

VACCINE Annual Report – Year 5

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If any item does not apply to your project, please indicate "NA" under the heading.

Technology Transitions (describe any products/technologies in process or that have completed transition to commercialization; include actions and progress to date)

N/A

Additional Funding Sources Leveraged: include amount, source of funding, PI and period of performance

N/A

VACCINE Annual Report – Year 5

Please complete **ALL** fields.
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If any item does not apply to your project, please indicate "NA" under the heading.

Collaborating Partners (academic Co-PI's, businesses, or other government funding agencies)

Dr. Sherry Towers (Research Professor, Mathematical and Computational Modeling Sciences Center, ASU)

Collaborating End-Users (specific DHS operating components such as FEMA, TSA, Coast Guard or federal, state, local law enforcement, fire, emergency management, etc.)

Please provide name of agency, contact name and email address.

N/A

Collaboration with other VACCINE project teams, national labs, and other Homeland Security Centers of Excellence (CREATE, NCFPD, START, PACER, ALERT, NCBSI, MIREES, ZADD, CHC and NTSCOE).

Describe purpose and nature of the collaboration and any follow-up to the discussion, if applicable.

N/A

Project Period (only complete if different than 7/1/13-6/30-14)

N/A

VACCINE Annual Report – Year 5

Please complete **ALL** fields.
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If any item does not apply to your project, please indicate "NA" under the heading.

Project Outcomes (Publications, Presentations, etc., based on this VACCINE-funded project)

Peer-Reviewed/Refereed Publications, Journals, Conferences: list only citation below, must also provide/attach electronic copy of all individual publications to VACCINE

If additional space is needed, please attach a separate Word document listing relevant materials.

Submitted:

N/A

Accepted:

N/A

Other Reports (including white papers, book chapters, manuscripts submitted, in revision or accepted/in press [not including those in preparation], other publications)

N/A

Presentations (include title, presenter, date, meeting, location. Attach PowerPoint if available). If additional space is needed, please attach a separate Word document listing relevant materials.

Temporal/geo-spatial analytics of epidemic data and forecasting epidemic spread, Shehzad Afzal, 08-05-2014. First International and Interdisciplinary Workshop on the Ecology, Evolution and Dynamics of Dengue and other Related Diseases, Arizona State University.

Patents/Copyrights (List names)

Applications: N/A

Awarded: N/A

VACCINE Annual Report – Year 5

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If any item does not apply to your project, please indicate "NA" under the heading.

Summary of Outcomes and Impact of Project

N/A

Impact or success story associated with project

N/A

Issues Encountered, if applicable: intellectual property, data sensitivity, publication of high risk/sensitive/proprietary findings, institutional collaboration and relationships, etc.

N/A

Changes in research plans, if applicable: describe any major changes in the project's plans or objectives, such as initiatives added or omitted, compared to those outlined in the original, funded proposal.

N/A

Supporting Documentation: list items and attach electronically, including survey instruments, photos, models, letters to participants, or other unique documentation.

N/A

VACCINE Annual Report – Year 5

Please complete **ALL** fields.

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If any item does not apply to your project, please indicate "NA" under the heading.

Institution: Purdue University

PI and/or Co-PI: Dr. David S. Ebert

Project Name: VALET : Visual Analytics Law Enforcement Toolkit

Academic Disciplines: Computer Engineering

Keywords associated with project: Public safety, risk assessment, situational awareness

Theme for Research Projects (Check all that apply)

If this is not a research project, indicate "NA" below.

X	Public Safety Coalition Projects (state or local law enforcement, fire, emergency management, etc.)
	Federal Operating Component Projects (TSA,FEMA, Secret Service, ICE, CBP, USCIS, Coast Guard)
	Enterprise Resiliency Environments
	Event Evacuations
	Visual Analytics for Security Applications
	International Collaborations
	N/A

Theme for Education Projects (Check all that apply)

If this is not an education project, indicate "NA" below.

	Minority or Underserved Programs
	Undergraduate and Graduate Education Program
	Professional Education and In-Service Programs
X	N/A

VACCINE Annual Report – Year 5

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If any item does not apply to your project, please indicate "NA" under the heading.

Students Supported on Project

Graduate Research Assistants (include name(s), university and department)

Abish Malik, Purdue University, Electrical and Computer Engineering

Undergraduate supported students (need number only)	2
O**ther Graduate Students** (non-supported) involved in project (need number only)	0
Other Undergraduate Students (non-supported) involved in project (need number only)	0

Student Thesis in 2013 (include name, thesis title, university, department, degree, date)

Research Problem /Abstract (in 200 words or less, provide a summary of the project goals and objectives, **in simple language understandable to someone outside the project's field).**

The exploration of criminal incident reports for detecting trends, discovering anomalies and evaluating resource usage is an ever-expanding issue for law enforcement agencies. Tools need to be developed that assist law enforcement officials in their analysis in order to take preventive measures and judiciously allocate available resources. In order to better facilitate crime incident analysis, the Visual Analytics Law Enforcement Toolkit (VALET) provides a comprehensive visual analytics system for both PCs and mobile devices which provides police officials with access to their data on the fly. Our system allows users to visualize data geo-spatially on a map and provides filtering tools that filter crime by the type of offense committed. The crime being visualized can additionally be filtered by time to analyze the correlation of different crimes with time. Our system enables users to view a history of previous crime incidents and forecast a pattern of crime using automated algorithms. Moreover, the users have the ability to receive immediate feed of events.

VACCINE Annual Report – Year 5

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If any item does not apply to your project, please indicate "NA" under the heading.

Technical Approach (Check all that apply)

Data Collection Methods

	Compiling & Sorting DB
X	Data Mining
X	Expert Consultation
	Field Monitors
	Survey
	Other:

Analytic Methods

	Case Studies
X	Modeling
	Sampling
X	Statistical Analysis
	Other:

Nature of Research

X	Applied
	Basic
	Consultation
	Coordination/Integration
	Education
	Hybrid Basic—Applied
	Hybrid Applied—Consultation

Deliverables (other than publications and reports listed below)

The desktop and mobile application released to the various public safety agencies.

N/A

VACCINE Annual Report – Year 5

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If any item does not apply to your project, please indicate "NA" under the heading.

Technology Transitions (describe any products/technologies in process or that have completed transition to commercialization; include actions and progress to date)

N/A

Additional Funding Sources Leveraged: include amount, source of funding, PI and period of performance

N/A

VACCINE Annual Report – Year 5

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If any item does not apply to your project, please indicate "NA" under the heading.

Collaborating Partners (academic Co-PI's, businesses, or other government funding agencies)

Collaborating End-Users (specific DHS operating components such as FEMA, TSA, Coast Guard or federal, state, local law enforcement, fire, emergency management, etc.)

Please provide name of agency, contact name and email address.

Ohio Homeland Security. POC: Thomas J. Gerber, Deputy Chief of Operations (Law Enforcement), ThJGerber@dps.state.oh.us

Lafayette Police, IN. POC: Pat Flannelly, Chief of Police, pjflannelly@lafayette.in.gov

Purdue Police, West Lafayette, IN. POC: John Cox, Chief of Police, jkcox@purdue.edu

Collaboration with other VACCINE project teams, national labs, and other Homeland Security Centers of Excellence (CREATE, NCFPD, START, PACER, ALERT, NCBSI, MIREES, ZADD, CHC and NTSCOE).

Describe purpose and nature of the collaboration and any follow-up to the discussion, if applicable.

N/A

Project Period (only complete if different than 7/1/13-6/30/14)

N/A

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If any item does not apply to your project, please indicate "NA" under the heading.

Project Outcomes (Publications, Presentations, etc., based on this VACCINE-funded project)

Peer-Reviewed/Refereed Publications, Journals, Conferences: list only citation below, must also provide/attach electronic copy of all individual publications to VACCINE

If additional space is needed, please attach a separate Word document listing relevant materials.

Submitted:

Abish Malik, Ross Maciejewski, Sean McCullough, Sherry Towers, David S. Ebert. Proactive Spatiotemporal Resource Allocation and Predictive Visual Analytics for Community Policing and Law Enforcement. IEEE Transactions on Visualization and Computer Graphics.

Accepted:

A. M. M. Razip, A. Malik, S. Afzal, S. Joshi, R. Maciejewski, Y. Jang, N. Elmqvist, and D. S. Ebert. A Mobile Visual Analytics Approach for Situational Awareness and Risk Assessment. Proceedings of IEEE PacificVis, 2014.

Other Reports (including white papers, book chapters, manuscripts submitted, in revision or accepted/in press [not including those in preparation], other publications)

N/A

Presentations (include title, presenter, date, meeting, location. Attach PowerPoint if available). If additional space is needed, please attach a separate Word document listing relevant materials.

N/A

Patents/Copyrights (List names)

Applications: U.S. Patent application #: U.S. 13/291,761. Visual Analytics Law Enforcement Tools

Awarded:

VACCINE Annual Report – Year 5

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If any item does not apply to your project, please indicate "NA" under the heading.

Summary of Outcomes and Impact of Project

The VALET application has been deployed to several law enforcement agencies, and we keep getting more requests from other users as well.

N/A

Impact or success story associated with project

N/A

Issues Encountered, if applicable: intellectual property, data sensitivity, publication of high risk/sensitive/proprietary findings, institutional collaboration and relationships, etc.

N/A

Changes in research plans, if applicable: describe any major changes in the project's plans or objectives, such as initiatives added or omitted, compared to those outlined in the original, funded proposal.

N/A

Supporting Documentation: list items and attach electronically, including survey instruments, photos, models, letters to participants, or other unique documentation.

N/A

VACCINE Annual Report – Year 5

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If any item does not apply to your project, please indicate "NA" under the heading.

Institution: Purdue University

PI and/or Co-PI: Dr. David S. Ebert

Project Name: VASA: Visual Analytics for Security Applications

Academic Disciplines:

Keywords associated with project:

Theme for Research Projects (Check all that apply)

If this is not a research project, indicate "NA" below.

X	Public Safety Coalition Projects (state or local law enforcement, fire, emergency management, etc.)
	Federal Operating Component Projects (TSA,FEMA, Secret Service, ICE, CBP, USCIS, Coast Guard)
	Enterprise Resiliency Environments
	Event Evacuations
X	Visual Analytics for Security Applications
	International Collaborations
	N/A

Theme for Education Projects (Check all that apply)

If this is not an education project, indicate "NA" below.

	Minority or Underserved Programs
	Undergraduate and Graduate Education Program
	Professional Education and In-Service Programs
X	N/A

VACCINE Annual Report – Year 5

Please complete **ALL** fields.
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If any item does not apply to your project, please indicate "NA" under the heading.

Students Supported on Project

Graduate Research Assistants (include name(s), university and department)
Sungahn Ko, Electrical and Computer Engineering, Purdue University
Jieqiong Zhao, Electrical and Computer Engineering, Purdue University
Shehzad Afzal, Electrical and Computer Engineering, Purdue University

Undergraduate supported students (need number only)	0
O**ther Graduate Students** (non-supported) involved in project (need number only)	0
Other Undergraduate Students (non-supported) involved in project (need number only)	0

Student Thesis in 2013 (include name, thesis title, university, department, degree, date)

Research Problem /Abstract (in 200 words or less, provide a summary of the project goals and objectives, **in simple language understandable to someone outside the project's field).**

Effective analysis for emergency situations caused by severe weather conditions and natural disasters requires understanding of a comprehensive set of data, including weather, critical infrastructures, and transportation network logistics. However, both civic and business analysts often encounter difficulty in estimating the impact of an event, forecasting damage, and discovering optimal solutions from various resources due to incomplete sets of data, lack of reliable simulation models, and no exiting environments for decision-making. We are designing and developing a visual analytics system that provides this environment for analysts and decision-makers.

In order to provide awareness of current and forecasted impact caused by the natural events, our system presents historical and simulated events (e.g. hurricanes, tornadoes, blizzards) where users can instantly consider various scenarios, alternative and operational and simulation attributes. Based on these decisions and parameters, new simulations maybe run to explore the effects on multiple critical infrastructures. (e.g. power, computer networks, water, transportation, sewer) and the effectiveness of contingency plans and mitigation strategies.

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If any item does not apply to your project, please indicate "NA" under the heading.

Technical Approach (Check all that apply)

Data Collection Methods

	Compiling & Sorting DB
	Data Mining
	Expert Consultation
	Field Monitors
	Survey
X	Other:

Analytic Methods

X	Case Studies
X	Modeling
X	Sampling
X	Statistical Analysis
	Other:

Nature of Research

	Applied
	Basic
	Consultation
	Coordination/Integration
	Education
X	Hybrid Basic—Applied
	Hybrid Applied—Consultation

Deliverables (other than publications and reports listed below)

We developed a visual platform consisting of a desktop application, a component model, and a suite of distributed simulation components for modeling the impact of societal threats such as weather, food contamination, and traffic on critical infrastructure such as supply chains, road networks, and power grids.

N/A

VACCINE Annual Report – Year 5

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If any item does not apply to your project, please indicate "NA" under the heading.

Technology Transitions (describe any products/technologies in process or that have completed transition to commercialization; include actions and progress to date)

N/A

Additional Funding Sources Leveraged: include amount, source of funding, PI and period of performance

N/A

VACCINE Annual Report – Year 5

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If any item does not apply to your project, please indicate "NA" under the heading.

Collaborating Partners (academic Co-PI's, businesses, or other government funding agencies)

Dr. Kennedy, University of Minnesota,

Dr. Ribarsky, University of North Carolina at Charlotte

Dr. Gaither, University of Texas at Austin

Collaborating End-Users (specific DHS operating components such as FEMA, TSA, Coast Guard or federal, state, local law enforcement, fire, emergency management, etc.)

Please provide name of agency, contact name and email address.

N/A

Collaboration with other VACCINE project teams, national labs, and other Homeland Security Centers of Excellence (CREATE, NCFPD, START, PACER, ALERT, NCBSI, MIREES, ZADD, CHC and NTSCOE).

Dr. Gaither at University of Texas at Austin: Providing historical and simulated hurricane paths and attributes.

Dr. Ribarsky at University of North Carolina at Charlotte: Providing damages on critical infrastructures (e.g., water, power, transportation, and sewer).

Dr. Kennedy at University of Minnesota: Providing re-routing results based on damages on roads and infrastructures

VACCINE Annual Report – Year 5

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If any item does not apply to your project, please indicate "NA" under the heading.

Project Outcomes (Publications, Presentations, etc., based on this VACCINE-funded project)

Peer-Reviewed/Refereed Publications, Journals, Conferences: list only citation below, must also provide/attach electronic copy of all individual publications to VACCINE

If additional space is needed, please attach a separate Word document listing relevant materials.

Submitted:

Accepted:
Sungahnn Ko, Jieqiong Zhao, Jing Xia, Shehzad Afzal, Xiaoyu Wang, Greg Abram, Niklas Elmqvist,, Len Kne, David Van Riper, Kelly Gaither, Shaun Kennedy, William Tolone, William Ribarsky, David S. Ebert, "VASA: Interactive Computational Steering of Large Asynchronous Simulation Pipelines for Societal Infrastructure," IEEE Transactions on Visualization and Computer Graphics, 2014

Other Reports (including white papers, book chapters, manuscripts submitted, in revision or accepted/in press [not including those in preparation], other publications)

N/A

Presentations (include title, presenter, date, meeting, location. Attach PowerPoint if available). If additional space is needed, please attach a separate Word document listing relevant materials.

N/A

Patents/Copyrights (List names)

Applications: N/A

Awarded: N/A

VACCINE Annual Report – Year 5

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If any item does not apply to your project, please indicate "NA" under the heading.

Summary of Outcomes and Impact of Project

Our system presents historical and simulated events (e.g., hurricanes, tornadoes, blizzards) in which users can instantly consider various scenarios, alternative and operational and simulation attributes. Based on these decisions and parameters, new simulations may be run to explore the effects of events on multiple critical infrastructures (e.g., power, computer networks, water, transportation and sewer) and the effectiveness of contingency plans and mitigation strategies. Thus, our system can reduce the time it takes for analysts for interpreting the data in the events of disasters and increase accuracy of decisions made with the proposed effective environment providing different types of reliable information on weather and critical infrastructures.

Feedback from regional Federal Emergency Management Agency (FEMA) personnel is that this system is novel in that it could enable unprecedented work within their organization: visual investigation on large multiple simulation runs and instance approximations under severe weather conditions. They noted that the system enables "The Whole Community" approach to meet the actual needs of residents, emergency managers, organizational and community leaders, government officials, and the general public when extreme weather impacts various societal infrastructures. They felt that the VASA tool would enable each community to make informed and timely decisions about how to manage throughout an extreme weather event.

Impact or success story associated with project

N/A

Issues Encountered, if applicable: intellectual property, data sensitivity, publication of high risk/sensitive/proprietary findings, institutional collaboration and relationships, etc.

N/A

Changes in research plans, if applicable: describe any major changes in the project's plans or objectives, such as initiatives added or omitted, compared to those outlined in the original, funded proposal.

N/A

VACCINE Annual Report – Year 5

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If any item does not apply to your project, please indicate "NA" under the heading.

Institution: Purdue University

PI and/or Co-PI: Niklas Elmqvist

Project Name: VASA – Visual Analytics for Security Applications

Academic Disciplines: Advanced Data Analysis and Visualization

Keywords associated with project: visual analytics, critical infrastructure, simulation, weather, food distribution, food protection

Theme for Research Projects (Check all that apply)
If this is not a research project, indicate "NA" below.

	Public Safety Coalition Projects (state or local law enforcement, fire, emergency management, etc.)
	Federal Operating Component Projects (TSA,FEMA, Secret Service, ICE, CBP, USCIS, Coast Guard)
	Enterprise Resiliency Environments
	Event Evacuations
X	Visual Analytics for Security Applications
	International Collaborations
	N/A

Theme for Education Projects (Check all that apply)
If this is not an education project, indicate "NA" below.

	Minority or Underserved Programs
	Undergraduate and Graduate Education Program
	Professional Education and In-Service Programs
X	N/A

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Please complete **ALL** fields.
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If any item does not apply to your project, please indicate "NA" under the heading.

Students Supported on Project

Graduate Research Assistants (include name(s), university and department)

Jieqiong Zhao, School of Electrical and Computer Engineering, Purdue University (advised by David Ebert)

Undergraduate supported students (need number only)	0
O**ther Graduate Students** (non-supported) involved in project (need number only)	0
Other Undergraduate Students (non-supported) involved in project (need number only)	0

Student Thesis in 2013 (include name, thesis title, university, department, degree, date)

Research Problem /Abstract (in 200 words or less, provide a summary of the project goals and objectives, **in simple language understandable to someone outside the project's field).**

The VASA project is concerned with applying visual analytics to critical infrastructure management including aspects such as security, weather, emergencies and their impact on food distribution and safety, critical infrastructure, and public safety. The idea is to couple interactive visual representations with discrete simulation of event sequences, both natural and man-made, and study their impact on other simulations for food distribution, transportation, power management, and similar. While VASA is a large project with many investigators and partners, Co-PI Elmqvist's role in the project is the development of a common spatiotemporal visual analytics tool that binds together multiple data sources and simulation models to provide a decision-making platform for stakeholders in critical infrastructure management.

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If any item does not apply to your project, please indicate "NA" under the heading.

Technical Approach (Check all that apply)

Data Collection Methods

	Compiling & Sorting DB
X	Data Mining
X	Expert Consultation
	Field Monitors
	Survey
	Other:

Analytic Methods

X	Case Studies
X	Modeling
	Sampling
X	Statistical Analysis
	Other:

Nature of Research

X	Applied
	Basic
	Consultation
	Coordination/Integration
	Education
X	Hybrid Basic—Applied
	Hybrid Applied—Consultation

Deliverables (other than publications and reports listed below)

The current objective for deliverables in the VASA project is a prototype of the visual analytics tool—called the VASA Workbench—as well as a set of distributed simulation components for weather, critical infrastructure, routing, and supply chain simulation. The initial versions of these deliverables were made available in June 2014.

VACCINE Annual Report – Year 5

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If any item does not apply to your project, please indicate "NA" under the heading.

Technology Transitions (describe any products/technologies in process or that have completed transition to commercialization; include actions and progress to date)

Ongoing technology transition with various interested stakeholders in both industry (fast food restaurant chain) as well as regional FEMA personnel.

Additional Funding Sources Leveraged: include amount, source of funding, PI and period of performance

None.

VACCINE Annual Report – Year 5

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If any item does not apply to your project, please indicate "NA" under the heading.

Collaborating Partners (academic Co-PI's, businesses, or other government funding agencies)

David Ebert (Purdue University), Shaun Kennedy (University of Minnesota), Xiao Wang (UNC Charlotte), Bill Ribarsky (UNC Charlotte), Tom Ertl (University of Stuttgart, Germany), Daniel Keim (University of Konstanz, Germany), Kelly Gaither (UT Austin), William Tolone (UNC Charlotte)

Collaborating End-Users (specific DHS operating components such as FEMA, TSA, Coast Guard or federal, state, local law enforcement, fire, emergency management, etc.)

Please provide name of agency, contact name and email address.

Name and contact information of end-users not known.

Collaboration with other VACCINE project teams, national labs, and other Homeland Security Centers of Excellence (CREATE, NCFPD, START, PACER, ALERT, NCBSI, MIREES, ZADD, CHC and NTSCOE).

Describe purpose and nature of the collaboration and any follow-up to the discussion, if applicable.

NCFPD (Shaun Kennedy) for food distribution simulation models used in the visual analytics tool.

Project Period (only complete if different than 4/1/12-6/30-13)

VACCINE Annual Report – Year 5

Please complete **ALL** fields.
This form must be emailed to Mary Padget at padget@purdue.edu **by July 18, 2014.**
If any item does not apply to your project, please indicate "NA" under the heading.

Project Outcomes (Publications, Presentations, etc., based on this VACCINE-funded project)

Peer-Reviewed/Refereed Publications, Journals, Conferences: list only citation below, must also provide/attach electronic copy of all individual publications to VACCINE

If additional space is needed, please attach a separate Word document listing relevant materials.

Submitted:

None.

Accepted:

S. Ko, J. Zhao, J. Xia, X. Wang, S. Afzal, G. Abram, N. Elmqvist, S. Kennedy, K. Gaither, W. Tolone, W. Ribarsky, D. Ebert, D. Riper, L. Kne. VASA: Interactive Computational Steering of Large Asynchronous Simulation Pipelines for Societal Infrastructure. *IEEE Transactions on Visualization & Computer Graphics* (Proc. IEEE VAST/InfoVis/SciVis 2014), to appear, 2014.

Other Reports (including white papers, book chapters, manuscripts submitted, in revision or accepted/in press [not including those in preparation], other publications)

N/A

Presentations (include title, presenter, date, meeting, location. Attach PowerPoint if available). If additional space is needed, please attach a separate Word document listing relevant materials.

None.

Patents/Copyrights (List names)

Applications:

Awarded:

VACCINE Annual Report – Year 5

Please complete **ALL** fields.
This form must be emailed to Mary Padget at padget@purdue.edu **by July 18, 2014.**
If any item does not apply to your project, please indicate "NA" under the heading.

Summary of Outcomes and Impact of Project

From Co-PI Elmqvist's perspective, the outcome of the project is to integrate a large number of heterogeneous simulation and data sources into a coherent and comprehensive decision-making tools that leverages visual representations and analytics methods to allow stakeholders to explore different scenarios and ask hypothetical questions about critical infrastructure management. The impact of such a tool would be potentially far-reaching: it could point to a common methodology for integrating multiple simulation models into a comprehensive platform that many other agencies might find useful.

Impact or success story associated with project

The German side of this project has already deployed and demonstrated their work to stakeholders in the German authorities. Their demonstration was very effective and well-received.

The current VASA system (to be presented in an accepted IEEE VAST paper) is the first large-scale asynchronous simulation steering system that integrates visual analytics.

Issues Encountered, if applicable: intellectual property, data sensitivity, publication of high risk/sensitive/proprietary findings, institutional collaboration and relationships, etc.

None.

Changes in research plans, if applicable: describe any major changes in the project's plans or objectives, such as initiatives added or omitted, compared to those outlined in the original, funded proposal.

None.

Supporting Documentation: list items and attach electronically, including survey instruments, photos, models, letters to participants, or other unique documentation.

None.

University of California San Diego

VACCINE Annual Report – Year 4

Please complete **ALL** fields.

This form must be emailed to Mary Padget at padget@purdue.edu **by July 15, 2013.**

If any item does not apply to your project, please indicate "NA" under the heading.

Institution: Morgan State University

PI and/or Co-PI: Dr. Kofi Nyarko / Dr. Timothy Akers

Project Name: iLaw Enforcement Apps Assistance Program for Students (iLEAPS)

Academic Disciplines: Electrical & Computer Engineering & Computer Science

Keywords associated with project: Campus Security, Safety, Mobile Apps, Android, iOS

Theme for Research Projects (Check all that apply)

If this is not a research project, indicate "NA" below.

X	Public Safety Coalition Projects (state or local law enforcement, fire, emergency management, etc.)
	Federal Operating Component Projects (TSA,FEMA, Secret Service, ICE, CBP, USCIS, Coast Guard)
	Enterprise Resiliency Environments
	Event Evacuations
X	Visual Analytics for Security Applications
	International Collaborations
	N/A

Theme for Education Projects (Check all that apply)

If this is not an education project, indicate "NA" below.

	Minority or Underserved Programs
	Undergraduate and Graduate Education Program
	Professional Education and In-Service Programs
X	N/A

VACCINE Annual Report – Year 4

Please complete **ALL** fields.
This form must be emailed to Mary Padget at padget@purdue.edu **by July 15, 2013.**
If any item does not apply to your project, please indicate "NA" under the heading.

Students Supported on Project

Graduate Research Assistants (include name(s), university and department)

None

Undergraduate supported students (need number only)	8
O**ther Graduate Students** (non-supported) involved in project (need number only)	0
Other Undergraduate Students (non-supported) involved in project (need number only)	0

Student Thesis in 2013 (include name, thesis title, university, department, degree, date)

None

Research Problem /Abstract (in 200 words or less, provide a summary of the project goals and objectives, **in simple language understandable to someone outside the project's field).**

On most college and university campuses, students, faculty and staff are not aware of the telephone number for the campus police and often resort to dialing 911 when an incident occurs on campus. When the police dispatch receives these calls, they often redirect them to campus police, since the city's police forces are unfamiliar with the physical layout of college campuses. Valuable time can be lost due to lack of geographic familiarity and communication delays. To address this problem, MSU has created a campus security system, comprising of mobile apps and a web service that provides students, staff, and faculty with a means to easily contact campus police and dispatch when help is needed. Dispatch and police are then able to efficiently coordinate a response. The use of this system will expedite responses to potential threat areas on a college campus with the added benefit of mitigating additional harm due to late responses by police. Moreover, the commercialization potential for other college campuses to utilize this system is significant, as it has the potential to be easily replicated to other academic venues by simply incorporating their campus maps and dispatch telephone call-in-numbers and operational procedures.

VACCINE Annual Report – Year 4

Please complete **ALL** fields.
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If any item does not apply to your project, please indicate "NA" under the heading.

Technical Approach (Check all that apply)

Data Collection Methods

	Compiling & Sorting DB
	Data Mining
	Expert Consultation
	Field Monitors
X	Survey
X	Other: Data is acquired from mobile apps; processed/stored/retrieved in/from a database

Analytic Methods

	Case Studies
	Modeling
	Sampling
	Statistical Analysis
X	Other: Use of full SDLC, design/functionality changes driven by surveys from alpha/beta testers

Nature of Research

X	Applied
	Basic
	Consultatio
	n
	Coordination/Integration
	Education
	Hybrid Basic—Applied
	Hybrid Applied—Consultation

Deliverables (other than publications and reports listed below)

- Undergraduate students trained in various methods of mobile app development, requirements analysis, data collection and analysis, and documentation/technical writing
- Mobile campus security app for the end user (students/admin/faculty)
- Mobile campus security app for police officers
- Campus security web service for dispatch to coordinate activity between both mobile apps
- Surveys from beta testers consisting of project steak holders (students, faculty, campus security)

VACCINE Annual Report – Year 4

Please complete **ALL** fields.
This form must be emailed to Mary Padget at padget@purdue.edu **by July 15, 2013.**
If any item does not apply to your project, please indicate "NA" under the heading.

Technology Transitions (describe any products/technologies in process or that have completed transition to commercialization; include actions and progress to date)

MSU considers the iLEAPS project a good candidate for the Maryland Innovation Initiative (MII) program. The MII was created as a partnership between the State of Maryland and five Maryland academic research institutions (Johns Hopkins University, Morgan State University, University of Maryland College Park, University of Maryland Baltimore and University of Maryland Baltimore County.) The program is designed to promote commercialization of research conducted in the partnership universities and leverages each institution's strengths. The Program was created to foster the transition of promising technologies having significant commercial potential from Qualifying Universities, where they were discovered, to the commercial sector, where they can be developed into products and services that meet identified market needs. MSU will present the iLEAPS program in September of 2013 as a candidate project for this program.

Additional Funding Sources Leveraged: include amount, source of funding, PI and period of performance

VACCINE Annual Report – Year 4

Please complete **ALL** fields.
This form must be emailed to Mary Padget at padget@purdue.edu **by July 15, 2013.**
If any item does not apply to your project, please indicate "NA" under the heading.

Collaborating Partners (academic Co-PI's, businesses, or other government funding agencies)

None

Collaborating End-Users (specific DHS operating components such as FEMA, TSA, Coast Guard or federal, state, local law enforcement, fire, emergency management, etc.)

Please provide name of agency, contact name and email address.

Morgan State Campus Police
Deputy Chief of Police Lance Hatcher
lance.hatcher@morgan.edu

Collaboration with other VACCINE project teams, national labs, and other Homeland Security Centers of Excellence (CREATE, NCFPD, START, PACER, ALERT, NCBSI, MIREES, ZADD, CHC and NTSCOE).

Describe purpose and nature of the collaboration and any follow-up to the discussion, if applicable.

Received training for Purdue's VALET software as part of a plan to implement the software on the campus of Morgan State University to help the police department better understand crime statistics on campus. In addition, data obtained from the iLEAPS project would feed into the VALET software for visual analysis of crime trends.

Project Period (only complete if different than 4/1/12-6/30-13)

VACCINE Annual Report – Year 4

Please complete **ALL** fields.
This form must be emailed to Mary Padget at padget@purdue.edu **by July 15, 2013.**
If any item does not apply to your project, please indicate "NA" under the heading.

Project Outcomes (Publications, Presentations, etc., based on this VACCINE-funded project)

Peer-Reviewed/Refereed Publications, Journals, Conferences: list only citation below, must also provide/attach electronic copy of all individual publications to VACCINE

If additional space is needed, please attach a separate Word document listing relevant materials.

Submitted:

None

Accepted:

None

Other Reports (including white papers, book chapters, manuscripts submitted, in revision or accepted/in press [not including those in preparation], other publications)

None

Presentations (include title, presenter, date, meeting, location. Attach PowerPoint if available). If additional space is needed, please attach a separate Word document listing relevant materials.

Title: iLEAPS
Presenters: Benjamin Hall, Nathan Scott, Kendric Squire, Alfred Shoetan, Vladimir Celestin
Date: February 28, 2013
Meeting: Morgan Innovation Day 2013
Location: Annapolis, Maryland

Title: iLEAPS Radio Interview
Interviewees: Dr. Kofi Nyarko, Benjamin Hall
Date: March 19, 2013
Station: WEAA 88.9 FM
Location: Baltimore, MD

Patents/Copyrights (List names)

Applications: Copyright application for iLEAPS submitted to MSU's technology transfer office

Awarded: None

VACCINE Annual Report – Year 4

Please complete **ALL** fields.
This form must be emailed to Mary Padget at padget@purdue.edu **by July 15, 2013.**
If any item does not apply to your project, please indicate "NA" under the heading.

Summary of Outcomes and Impact of Project

Students have undergone hands on training for various web and mobile application technologies while continuously developing the various components of the iLEAPS system through the use of the Software Development Lifecycle. All three interfaces of the project (user, officers, and dispatch) have been developed and demonstrated. Three beta testing sessions were planned, of which two have been fully executed. The first session involved 10 students from the School of Engineering. The second sessions involved 10 pre-freshmen students and 10 undergraduate students across several disciplines. The last session, which is planned for the end of July, will involve the campus security (including the Deputy Chief of Police) as well as faculty members from several schools.

Impact or success story associated with project

After the radio interview conducted in March, several MSU students, faculty and individuals from the community expressed an interest in following the development of this project and even volunteered to participate in the project. The university Site Miner for the Maryland Innovation Commercialization Program has indicated that the project would be a good candidate for commercial transition.

Issues Encountered, if applicable: intellectual property, data sensitivity, publication of high risk/sensitive/proprietary findings, institutional collaboration and relationships, etc.

None

Changes in research plans, if applicable: describe any major changes in the project's plans or objectives, such as initiatives added or omitted, compared to those outlined in the original, funded proposal.

None

Supporting Documentation: list items and attach electronically, including survey instruments, photos, models, letters to participants, or other unique documentation.

- Survey Instruments for beta tests
- Radio interview

VACCINE Annual Report – Year 5

Please complete **ALL** fields.
This form must be emailed to Mary Padget at padget@purdue.edu **by July 18, 2014.**

Institution: UCSD

PI and/or Co-PI: Prof David Kirsh, Prof Ed Delp

Project Name: Combining Crowdsourcing technology with machine learning to do visual analytics on big qualitative data (video datasets).

Academic Disciplines: Cognitive Science

Keywords associated with project: Crowd Sourcing, automated video coding, activity identification

Theme for Research Projects (Check all that apply)
If this is not a research project, indicate "NA" below.

X	Public Safety Coalition Projects (state or local law enforcement, fire, emergency management, etc.)
	Federal Operating Component Projects (TSA,FEMA, Secret Service, ICE, CBP, USCIS, Coast Guard)
	Enterprise Resiliency Environments
	Event Evacuations
	Visual Analytics for Security Applications
	International Collaborations
	N/A

Theme for Education Projects (Check all that apply)
If this is not an education project, indicate "NA" below.

X	Minority or Underserved Programs
X	Undergraduate and Graduate Education Program
	Professional Education and In-Service Programs
	N/A

VACCINE Annual Report – Year 5

Please complete **ALL** fields.
This form must be emailed to Mary Padget at padget@purdue.edu **by July 18, 2014.**

Students Supported on Project

Graduate Research Assistants (include name(s), university and department)

Undergraduate supported students (need number only)	1
O**ther Graduate Students** (non-supported) involved in project (need number only)	0
Other Undergraduate Students (non-supported) involved in project (need number only)	4

Student Thesis in 2013 (include name, thesis title, university, department, degree, date)

Research Problem /Abstract (in 200 words or less, provide a summary of the project goals and objectives, **in simple language understandable to someone outside the project's field).**

Our project has both practical and theoretical concerns. On the practical side we have been designing and implementing a system that supports crowd sourcing video to subjects who are trained to identify phenomena of interest in the video. These phenomena might be illegal behavior such as vandalism, theft, assault, drunken and disorderly behavior, etc, or they might be Find Waldo type problems where the goal is to locate a missing person etc. To implement such a system a number of work flow problems have to be overcome including tracking and evaluating the expertise level of turkers, since they improve with practice; provide efficient initial training in phenomena identification; design an easy to use video annotation system that allows automatic comparison of annotations by different people, and develop a just management system for rewarding good performance and withholding reward for weak or bad performance.

On the theoretical side there are a set of basic questions about the sort of problems and tasks that Turkers can be used for. For instance, can they be used to review video in real-time; how should they be rewarded; what sort of team composition (novices, intermediates, experts) are needed to get reliable answers to different decision problems?

VACCINE Annual Report – Year 5

Please complete **ALL** fields.

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Technical Approach (Check all that apply)

Data Collection Methods

x	Compiling & Sorting DB
	Data Mining
x	Expert Consultation
	Field Monitors
	Survey
	Other:

Analytic Methods

	Case Studies
	Modeling
x	Sampling
	Statistical Analysis
x	Other:

Nature of Research

	Applied
x	Basic
	Consultatio
	n
	Coordination/Integration
x	Education
	Hybrid Basic—Applied
	Hybrid Applied—Consultation

Deliverables (other than publications and reports listed below)

- Pilot design of system for annotating video online
- Meeting with police to define the problem and develop gold standards for the video based predictors of illegal or dangerous action, abnormal social behavior in crowds, and suspicious conduct after hours.
- Pilot implementation system for annotation
- Pilot implementation of distribution system
- Test our crowd sourcing system on UCSD students

VACCINE Annual Report – Year 5

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Technology Transitions (describe any products/technologies in process or that have completed transition to commercialization; include actions and progress to date)

Additional Funding Sources Leveraged: include amount, source of funding, PI and period of performance

VACCINE Annual Report – Year 5

Please complete **ALL** fields.
This form must be emailed to Mary Padget at padget@purdue.edu **by July 18, 2014.**

Collaborating Partners (academic Co-PI's, businesses, or other government funding agencies)

Collaborating End-Users (specific DHS operating components such as FEMA, TSA, Coast Guard or federal, state, local law enforcement, fire, emergency management, etc.)

Please provide name of agency, contact name and email address.

The Indianapolis Police Department and Purdue University Police departments: contacts available through Professor Edward Delp at Purdue University used for his gang graffiti project (GARI).

Collaboration with other VACCINE project teams, national labs, and other Homeland Security Centers of Excellence (CREATE, NCFPD, START, PACER, ALERT, NCBSI, MIREES, ZADD, CHC and NTSCOE).

Describe purpose and nature of the collaboration and any follow-up to the discussion, if applicable.

Prof Delp has provided us with video and have been working on a more user friendly and comprehensive application appropriate for crowd sourcing. Prof Delp's team has been working on machine learning regions of interest and related topics.

VACCINE Annual Report – Year 5

Please complete **ALL** fields.
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Project Outcomes (Publications, Presentations, etc., based on this VACCINE-funded project)

Peer-Reviewed/Refereed Publications, Journals, Conferences: list only citation below, must also provide/attach electronic copy of all individual publications to VACCINE

If additional space is needed, please attach a separate Word document listing relevant materials.

Submitted:

Accepted:

Other Reports (including white papers, book chapters, manuscripts submitted, in revision or accepted/in press [not including those in preparation], other publications)

White paper on division of labor in crowd sourcing and the nature of corwd sourceable decision problems.

Presentations (include title, presenter, date, meeting, location. Attach PowerPoint if available). If additional space is needed, please attach a separate Word document listing relevant materials.

Patents/Copyrights (List names)

Applications:

Awarded:

VACCINE Annual Report – Year 5

Please complete **ALL** fields.
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Summary of Outcomes and Impact of Project

The project to date has been distributed between Prof Delp at Purdue and Prof Kirsh at UCSD. Prof Kirsh's role has been on the design of a user friendly system that is easy to manage at the back-end and easy to work in on the client side. Our pilot work has shown that students find it natural to work in the client. Annotation of intervals of interest – the main output of turkers - is possible and not effortful. We are currently re-implementing the system to increase robustness and to accommodate user feedback.

We have also found that small teams of turkers can produce better quality results than single turkers, but the team size needed for adequate reliability varies with the complexity of the targets and turker training/rating. This means that Turker expertise can not always be compensated for by increasing turker team size, as is often assumed. It also means that better tracking of turker expertise is required and more attention to turker team composition is needed.

The impact of the project is that a crowd sourcing based system for identifying regions and intervals of interest in video is a viable method for handling large videosets. More research is needed to better determine the cost structure of scaling up to larger video sets and to real-time analysis and reporting.

The practical value of this system depends on the reason a group might want it. Police need to review video to document reports and provide evidence. Crowd sourcing can save time in that task. Our original goal remains to provide real time assistance for monitoring thousands of video in real-time. That application is of value in hundreds of scenarios, including police surveillance, search and rescue and border crossing.

Impact or success story associated with project

Not yet.

Issues Encountered, if applicable: intellectual property, data sensitivity, publication of high risk/sensitive/proprietary findings, institutional collaboration and relationships, etc.

University

of

North Carolina at Charlotte

VACCINE Annual Report – Year 5

Please complete **ALL** fields.
This form must be emailed to Mary Padget at padget@purdue.edu **by July 18, 2014.**
If any item does not apply to your project, please indicate "NA" under the heading.

Institution: University of North Carolina at Charlotte

PI and/or Co-PI: William Ribarsky, PI; Xiaoyu Wang, co-PI; William Tolone, co-PI

Project Name: Multimedia, Social Media, Text, and Emergency Response Analytics

Academic Disciplines: Visual analytics, unstructured content analysis, decision-making, social analysis

Keywords associated with project: interaction, visualization, analytics, critical infrastructure, social networks, social media, emergency response and planning, sensemaking

Theme for Research Projects (Check all that apply)
If this is not a research project, indicate "NA" below.

X	Public Safety Coalition Projects (state or local law enforcement, fire, emergency management, etc.)
X	Federal Operating Component Projects (TSA,FEMA, Secret Service, ICE, CBP, USCIS, Coast Guard)
X	Enterprise Resiliency Environments
X	Event Evacuations
X	Visual Analytics for Security Applications
X	International Collaborations
	N/A

Theme for Education Projects (Check all that apply)
If this is not an education project, indicate "NA" below.

	Minority or Underserved Programs
	Undergraduate and Graduate Education Program
X	Professional Education and In-Service Programs
	N/A

VACCINE Annual Report – Year 5

Please complete **ALL** fields.
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If any item does not apply to your project, please indicate "NA" under the heading.

Students Supported on Project

Graduate Research Assistants (include name(s), university and department)
Todd Eaglin UNCC Computer Science
Thomas Kraft UNCC Computer Science
Jeffrey Delawder—UNCC—Computer Science
Hossein Hematialam—UNCC—Computer Science

Undergraduate supported students (need number only)	1
O**ther Graduate Students** (non-supported) involved in project (need number only)	
Other Undergraduate Students (non-supported) involved in project (need number only)	

Student Thesis in 2013 (include name, thesis title, university, department, degree, date)

Research Problem /Abstract (in 200 words or less, provide a summary of the project goals and objectives, **in simple language understandable to someone outside the project's field).**

The project applies visual analytics methods to a range of problems of significance to DHS. In each case one or more tools or products are produced. In several instances, the tools are deployed to stakeholders. Capabilities produced include:

- Mobile emergency response and emergency evacuation tools for urban environments have been developed and deployed. These tools are situationally aware; they can be updated immediately based on blocked exits, blocked paths, unexpected distribution of people, etc. Search, apprehension, and rescue tasks can be carried out where the command center and deployed officers are in full communication as to position and actions. This year new capabilities to build the 3D routing networks for large buildings have been developed. A novel capability has been developed to provide decision support to commanders in complex emergency response situations as they evolve.
- A system of systems model has been set up for investigating an urban electric smart grid infrastructure under duress from natural or man-made disasters. This system can investigate weak points and cascading effects due to failures in an overall infrastructure including electrical, water, transportation, food distribution, and other components. A Web service was set up so that onsite managers could access the results of these large scale simulations on mobile devices such as a laptop or tablet computer, providing the capability to determine what will happen, when and where it will occur, and who and what infrastructures will be affected so that immediate, appropriate action can be taken. Work is being done with European partners and VACCINE colleagues.

VACCINE Annual Report – Year 5

Please complete **ALL** fields.
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If any item does not apply to your project, please indicate "NA" under the heading.

Technical Approach (Check all that apply)

Data Collection Methods

X	Compiling & Sorting DB
X	Data Mining
X	Expert Consultation
	Field Monitors
X	Survey
	Other:

Analytic Methods

X	Case Studies
X	Modeling
	Sampling
X	Statistical Analysis
X	Other: Time-dependent event and probabilistic modeling

Nature of Research

	Applied
	Basic
	Consultatio
X	n
	Coordination/Integration
X	Education
	Hybrid Basic—Applied
	Hybrid Applied—Consultation

Deliverables (other than publications and reports listed below)

- Modeling system for time-dependent, cascading critical infrastructure outages at the front of large scale weather events (e.g., hurricanes)
- Complete set of data for critical infrastructure, including vulnerable public facilities, in North Carolina and northern South Carolina. Ensemble of critical infrastructure simulation results for a large set of hurricane paths giving thorough coverage across the states so that preliminary results can be brought forth in real-time. All these results have been shared with the VASA partners.
- Insertion of critical infrastructure simulation plus the ensemble results data as a module in the VASA Workbench, which brings together critical infrastructure, hurricane simulation, and food distribution network simulations into one system to give a comprehensive view of unfolding, large scale emergencies.
- Evacuation decision support tool to UNC Charlotte Police and Public Safety Department
- Urban Emergency Response search and command center tools to UNC Charlotte Police and Public Safety Department
- Building 3D routing database and tools for DHS and police force exercises exercises
- A set of social media visual analytics tools to investigate the narrative arc of social movements by following relevant topics, events, and social networks.

VACCINE Annual Report – Year 5

Please complete **ALL** fields.
This form must be emailed to Mary Padget at padget@purdue.edu **by July 18, 2014.**
If any item does not apply to your project, please indicate "NA" under the heading.

Technology Transitions (describe any products/technologies in process or that have completed transition to commercialization; include actions and progress to date)

Our critical infrastructure modeling system plus our collection of cascading breakdown results for a large ensemble of hurricane paths have been inserted into the VASA Workbench, which integrates simulations and visual analysis capabilities from Purdue, UNC Charlotte, U. Texas, and U. Minnesota. The ensemble results are organized in a proxy server for interactive recall and immediate display in the visual interface. The modeling system then provides delayed but more accurate and detailed simulations as directed by the visual interface.

A desktop version of the command interface for our mobile emergency response and evacuation system was deployed to the UNC Charlotte Police Chief and has now been extended. With the system, the Chief can immediately see the distribution of people at any time in any building in campus and determine routes to get to any point in those buildings. This system gives the Chief constant situation awareness should an emergency occur. In addition, a similar system has been deployed to Provost's office to help determined optimal movement of students, faculty, and staff between buildings on campus.

Additional Funding Sources Leveraged: include amount, source of funding, PI and period of performance

Xiaoyu Wang, Wenwen Dou, and William Ribarsky, $150,000 Army Research Office, through May 14, 2016.

William Ribarsky, $65,000, NIH, through August 31, 2014.

William Tolone, William Ribarsky, Wenwen Dou, and Xiaoyu Wang, USSOCOM, $300,000 so far through February 28, 2015. A substantial longer term project is being planned.

VACCINE Annual Report – Year 5

Please complete **ALL** fields.
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If any item does not apply to your project, please indicate "NA" under the heading.

Collaborating Partners (academic Co-PI's, businesses, or other government funding agencies)

David Ebert, Purdue University, ebertd@ecn.purdue.edu

Daniel Keim, University of Konstanz, keim@uni-konstanz.de

Thomas Ertl, University of Stuttgart, Thomas.Ertl@vis.uni-stuttgart.de

Niklas Elmqvist, Purdue University, elm@purdue.edu

Shaun Kennedy, University of Minnesota, Shaun.Kennedy@ncfpd.umn.edu

Ted Thomas, Duke Energy, Ted.Thomas@duke-energy.com

Kelly Gaither, U. Texas, kelly@tacc.utexas.edu

Collaborating End-Users (specific DHS operating components such as FEMA, TSA, Coast Guard or federal, state, local law enforcement, fire, emergency management, etc.)
Please provide name of agency, contact name and email address.

Chief Jeffrey Baker, UNC Charlotte Police, 704-687-8300, jbaker88@uncc.edu

Jeff Stovall, CIO, City of Charlotte, jstovall@charlottenc.gov

Henry James, Associate Vice Chancellor for Risk Management, Safety & Security, UNC Charlotte, 704-687-8454, hjames1@uncc.edu

Brent Herron, Associate Vice President for Campus Safety and Emergency Operations, University System of North Carolina, 919-962-4594, bherron@northcarolina.edu

Heidi Preuss, Environmental Policy Administrator, Mecklenburg County, 704-336-5597, Heidi.Pruess@mecklenburgcountync.gov

Seth Norris, Director Environmental Health, Safety, and Emergency Management, Appalachian State University, 828-262-8081, norrissa@appstate.edu

Guenther Hartfeil, BB&T, Head of Information Management, ghartfeil@BBandT.com

David Joffe, Quantitative Research Executive, Bank of America, david.n.joffe@bankofamerica.com

Michael Bess, Critical Infrastructure Protection, Charlotte-Mecklenburg Police Dept., 704-614-2610, mbess@cmpd.org

Collaboration with other VACCINE project teams, national labs, and other Homeland Security Centers of Excellence (CREATE, NCFPD, START, PACER, ALERT, NCBSI, MIREES, ZADD, CHC and NTSCOE).

Shaun Kennedy, University of Minnesota, National Center for Food Protection and Defense, kenne108@umn.edu, placing the food network into the overall infrastructure as part of the VASA project.

VACCINE Annual Report – Year 5

Please complete **ALL** fields.

This form must be emailed to Mary Padget at padget@purdue.edu **by July 18, 2014.**

Project Outcomes (Publications, Presentations, etc., based on this VACCINE-funded project)

Peer-Reviewed/Refereed Publications, Journals, Conferences: list only citation below, must also provide/attach electronic copy of all individual publications to VACCINE

If additional space is needed, please attach a separate Word document listing relevant materials.

Submitted:

1. Sebastian Mittelstaedt, Xiaoyu Wang, Todd Eaglin, Dennis Thom, Daniel A. Keim, Thomas Ertl, William Tolone, and William Ribarsky. An Integrated In-Situ Approach to Impacts from Natural Disasters on Critical Infrastructures. Submitted to HICSS 2015.
2. Todd Eaglin, William Tolone, William Ribarsky, and Xiaoyu Wang. Mobile Ensemble Visual Analysis Architecture for Large-Scale Critical Infrastructure Simulations. Submitted to IS&T/SPIE VDA 2015.
3. Dominik Jäckle, Florian Stoffel, Bum Chul Kwon, Xiaoyu Wang, Dominik Sacha, Todd Eaglin, Andreas Stoffel, William Ribarsky, and Daniel A. Keim. ClusterRim: Maintaining Context-Awareness via Aggregated Off-Screen Visualization. Submitted to the Information Visualization Journal.

Accepted:

1. Sungahn Ko, Jieqiong Zhao, Jing Xia, Xiaoyu Wang, Greg Abram, Niklas Elmqvist, Shaun Kennedy, Kelly Gaither, William Tolone, William Ribarsky, and David S. Ebert. VASA: Interactive Computational Steering of Large Asynchronous Simulation Pipelines for Critical Infrastructure. To be published. IEEE VAST 2014.
2. Wenwen Dou, Li Yu, Xiaoyu Wang, Zhiqiang Ma, and William Ribarsky. Hierarchical Topics: Visually Exploring Large Text Collections Using Topic Hierarchies. IEEE Transactions on Visualization and Computer Graphics 19(12), pp. 2002-2011 (VAST 2013).
3. Jack Guest, Todd Eaglin, KR Subramanian, and William Ribarsky. Interactive Analysis and Visualization of Situationally Aware Building Evacuations. Information Visualization Journal. doi: 10.1177/1473871613516292.
4. William Tolone, Xiaoyu Wang, and William Ribarsky. Making Sense of the Operational Environment through Interactive, Exploratory Visual Analysis. NATO/OTAN Symposium on Visual Analytics. IST-116/RSY-028.
5. William Ribarsky, Xiaoyu Wang, and Wenwen Dou. Social Media Analytics for Competitive Advantage. Invited paper. Computers & Graphics 38C (2014), pp. 328-331 (Special Issue on EuroVA 2013).
6. William Ribarsky, Xiaoyu Wang, Wenwen Dou, and William Tolone. Towards a Visual Analytics Framework for Handling Complex Business Processes. HICSS 2014. pp. 1374 – 1383. DOI 10.1109/HICSS.2014.177.

Other Reports (including white papers, book chapters, manuscripts submitted, in revision or accepted/in press [not including those in preparation], other publications)

Presentations (include title, presenter, date, meeting, location. Attach PowerPoint if available). If additional space is needed, please attach a separate Word document listing relevant materials.

1. Keynote Address, "Visual Analytics for Competitive Advantage," EG EuroVA 2013 (June, 2013).
2. Invited Workshop organizer, "Thinking with Visual Information Systems," Association for Psychological Science Annual Conference (May, 2014)
3. Invited Speaker, "Harnessing Knowledge Tools for Competitive Advantage," Harnessing the Power of Data Conference (Charlotte, May, 2014).

Patents/Copyrights (List names)

VACCINE Annual Report – Year 5

Please complete **ALL** fields.
This form must be emailed to Mary Padget at padget@purdue.edu **by July 18, 2014.**

Summary of Outcomes and Impact of Project

- We have collected and integrated a large amount of infrastructure data for North and South Carolina (electrical, water, roads, key buildings, etc.). We have run ensembles of simulations for different hurricane paths with a distribution of widths, strengths, and detailed paths. This permits a probabilistic analysis of outcomes and identification of parts of the infrastructure plus key served components (e.g., schools, hospitals, etc.) that are most at risk. We have developed a set of visual interfaces that run on a range of devices, including iPads. The goal is to provide emergency responders or planners at any level a picture of what will happen, when it will happen, and at what locations. We have integrated this system of simulations and results with the food distribution network models of Shaun Kennedy, the hurricane simulations of Kelly Gaither, and the visual analysis capabilities of David Ebert and his group. This comprehensive system, call the Visualization Workbench, permits the overall modeling, analysis, and development of actionable knowledge for large scale weather disasters.
- Through the VASA project we collaborated with the European team led by Daniel Keim of U. Konstanz and Thomas Ertl of U. Stuttgart. As a result, we collaborated on two research papers (listed above). The first paper (led by Mittelstaedt) is systems paper where we bring together the Konstanz visualization of interdependent infrastructures with our visualizations of severe storm ensembles (especially in the mobile environment). The second paper (led by Jackle) looks at the issues and affordances in bringing together a mobile (tablet or smart phone) interface with a large display (e.g., powerwall). These are key issues for the next generation of large command center environments.
- We developed very general text and event (location, time) analysis tools. The text tools can be applied to a variety of sources including collections of reports, research papers, books, and streaming media such as Twitter, Facebook, and online news feeds. Some results are described in the success stories below.
- We have developed a full narrative of the Occupy Wall Street Movement (via Twitter analysis) including all events of any import over its whole history. This provides not only events and topics, but organized discussion around each event and topic.

Impact or success story associated with project

- We have made the complete set of critical infrastructure data for North and South Carolina available to both German and American VASA partners.
- We have written joint papers on the collaborations with German and American VASA partners. In both cases, we are developing follow-on projects.
- Using the modeling environment we have set up for VASA, we have continued working with Envision Charlotte, a partnership of city, county, non-profits, Duke Energy, and other companies that is developing an urban sustainability and infrastructure resiliency effort for Charlotte. The model incorporates energy production and distribution, transportation, social models, and economic models.
- With our college and the College of Business, we have developed a MS Certificate in Data Science and Business Analytics and a new professional science masters degree (launching in Fall, 2014). Examples from this project will be used in the certificate and degree courses

Issues Encountered, if applicable: intellectual property, data sensitivity, publication of high risk/sensitive/proprietary findings, institutional collaboration and relationships, etc.
Changes in research plans, if applicable: describe any major changes in the project's plans or objectives, such as initiatives added or omitted, compared to those outlined in the original, funded proposal.

Supporting Documentation: list items and attach electronically, including survey instruments, photos, models,

University of Oxford

Institution: University of Oxford

PI and/or Co-PI: Professor Min Chen

Project Name: UKVAC II (WP1)

Academic Disciplines: Computer Science and Engineering

Keywords associated with project: visual analytics, flight data, and information theory

Theme for Research Projects (Check all that apply)
If this is not a research project, indicate "NA" below.

	Public Safety Coalition Projects (state or local law enforcement, fire, emergency management, etc.)
	Federal Operating Component Projects (TSA,FEMA, Secret Service, ICE, CBP, USCIS, Coast Guard)
	Enterprise Resiliency Environments
	Event Evacuations
X	Visual Analytics for Security Applications
X	International Collaborations
	N/A

Theme for Education Projects (Check all that apply)
If this is not an education project, indicate "NA" below.

	Minority or Underserved Programs
	Undergraduate and Graduate Education Program
	Professional Education and In-Service Programs
	N/A

Students Supported on Project

None

Graduate Research Assistants (include name(s), university and department)
Dr. Simon Walton, University of Oxford, Oxford e-Research Centre

Undergraduate supported students (need number only)	**0**
O**ther Graduate Students** (non-supported) involved in project (need number only)	**0**

None

Other Undergraduate Students (non-supported) involved in project (need number only)	**0**

None

Student Thesis in 2013 (include name, thesis title, university, department, degree, date)

N/A

Research Problem /Abstract (in 200 words or less, provide a summary of the project goals and objectives, **in simple language understandable to someone outside the project's field).**

The overall aim of the UKVAC project was to investigate into two grand challenge problems, namely the Nobel Laureates (NL) and the Flight Data (FD) problems. Five universities (Middlesex (lead partner), Bangor, Imperial, Oxford and UCL) tackled these two challenges from different angles. Oxford led work package 1, which focused on the FD Problem that is described below:

The flight data problem is about wanting answers to questions that could be contained in or constructed from the interrogation of 120 million records covering all commercial flights in the US from October 1987 to April 2008, about 12Gb of uncompressed data. Questions that could be asked include; when is the best time to fly to minimise delays? Can you detect cascading failures as delays in one airport create delays in others? Are there critical links in the system?

The objective for WP1 includes the following sub-objectives:

(a) To formulate an information-theoretic framework for visual analytics processes in a context exemplified by these two problems.
(b) To develop visual representations that depict information contained in a dataset as well as the uncertainty quantities and other probabilistically-derived qualities such as importance and value.
(c) To develop a prototype demonstration system for illustrating the potential use of information theoretic quantities in the process of hypothesis generation and evaluation.
(d) To compare the information-theoretic framework with captured user study data (WP4) and to offer an explanation about any correlation and inconsistency.
(e) To explore the application of the information-theoretic framework in interaction exploration (WP2), data management and data analysis (Objective 3), hierarchical decision models (WP5).

Technical Approach (Check all that apply)

Data Collection Methods

	Compiling & Sorting DB
	Data Mining
	Expert Consultation
	Field Monitors
	Survey
	Other:

Analytic Methods

	Case Studies
	Modeling
	Sampling
X	Statistical Analysis
	Other:

Nature of Research

	Applied
	Basic
	Consultation
	Coordination/Integration
	Education
X	Hybrid Basic—Applied
	Hybrid Applied—Consultation

Deliverables (other than publications and reports listed below)

D1.1 Information Theoretic Model Report (FD)

D1.2 Software Prototype and Report for Information Theoretic Model (FD)

Technology Transitions (describe any products/technologies in process or that have completed transition to commercialization; include actions and progress to date)

No action was taken for commercialization.

We are in the process of applying the developed technique to the CMU CERT dataset for emulating inside threats. We are working on a demonstrator to be delivered to the UK stakeholder in the context of the following project.

Additional Funding Sources Leveraged: include amount, source of funding, PI and period of performance

We have obtained a research grant on Corporate Inside Threat Detection.

http://www.cs.ox.ac.uk/projects/CITD/

The PI is Sadie Creese, and co-PIs are Min Chen, Michael Goldsmith, David Upton, Monica Whitty

The project is for the period of October 2012 and March 2015.

The funding for the visual analytics component (WP5) is for supporting a full-time research officer for the project period.

Collaborating Partners (academic Co-PI's, businesses, or other government funding agencies)

Professor B.L. William Wong, Middlesex University
Professor Ann Blandford, University College London
Professor Chris Hankin, Imperial College
Dr. Jonathan Roberts, University of Bangor

Collaborating End-Users (specific DHS operating components such as FEMA, TSA, Coast Guard or federal, state, local law enforcement, fire, emergency management, etc.)

Please provide name of agency, contact name and email address.

Collaboration with other VACCINE project teams, national labs, and other Homeland Security Centers of Excellence (CREATE, NCFPD, START, PACER, ALERT, NCBSI, MIREES, ZADD, CHC and NTSCOE).

Describe purpose and nature of the collaboration and any follow-up to the discussion, if applicable.

Professor David Ebert, Purdue University

The Oxford team and the Purdue team jointly developed a visual analytics demonstrator, for which the Oxford team provided the QCAT technique for anomaly detection and the Purdue team developed the coordinated multi-view interface for visualizing the FD dataset.

The main collaboration took place between May and December 2013, where there were a fair amount of continuing collaborative activities between January and July 2014 for preparing a joint publication.

Project Period (only complete if different than 4/1/12-6/30-13)

1 October 2012 - 31 December 2013

Project Outcomes (Publications, Presentations, etc., based on this VACCINE-funded project)

Peer-Reviewed/Refereed Publications, Journals, Conferences: list only citation below, must also provide/attach electronic copy of all individual publications to VACCINE

If additional space is needed, please attach a separate Word document listing relevant materials.

Submitted:

Accepted:

Sungahn Ko, Shehzad Afzal, Simon Walton, Yang Yang, Junghoon Chae, Abish Malik, Yun Jang, Min Chen, David Ebert, "Analyzing High-dimensional Multivariate Network Links with Integrated Anomaly Detection, Highlighting and Exploration,", to appear in *Proc. IEEE VAST 2014*, Paris, November 2014.

Other Reports (including white papers, book chapters, manuscripts submitted, in revision or accepted/in press [not including those in preparation], other publications)

Min Chen, Simon Walton, Summary Report, December 2013
Simon Walton and Min Chen, Technical Report, December 2013

Presentations (include title, presenter, date, meeting, location. Attach PowerPoint if available). If additional space is needed, please attach a separate Word document listing relevant materials.

Presentation 1: Survey, problem statement and technical plan. 11 January 2013 (presenter: Min Chen)
Presentation 2: Formulation of the QCAT technique. 31 May 2013 (presenter: Min Chen)
Presentation 3: Implementation of the QCAT technique. 6 September 2013 (Presenter: Simon Walton)
Presentation 4a: Overview. 13 December 2013 (Presenter: Min Chen)
Presentation 4b: Technical Report. 13 December 2013 (Presenter: Simon Walton)

Patents/Copyrights (List names)

Applications:

Awarded:

Summary of Outcomes and Impact of Project

We have completed the WP1 of the project with a number of concrete achievements.

(a) We have formulated an information-theoretic framework for anomaly detection. A relatively comprehensive literature study showed that the idea of using information theory for anomaly detection has been examined by many since the 1980s. No existing scheme was found to be identical as our proposal. It suggests a number of possibilities, including (i) our scheme is novel; (ii) the same scheme was proposed earlier but was not disclosed; (iii) the same scheme was proposed earlier but was discarded due to the lack of big data or a practical implementation (e.g., using visual analytics).

(b) We have conducted a study on the visual representations. We have identified the requirements for an effective visual design, including consistent visual cues across multiple views, and supporting both visualization and exploration. The current visual design was formulated based on an existing system that introduces many constraints such as the use of colours. We believe that the visual designs can be improved further if there is a flexibility to redesign the visual representations in different views.

(c) With the help of Purdue, we have delivered a prototype demonstration system for illustrating the potential use of information theoretic quantities in the visual analytics process for handling the FD data. This is partly one of the original objectives that were removed due to the budget reduction.

(d) We have formulated a high-level visual analytics cycle by dividing visual analytics tasks into three groups, monitoring, analysis and model refinement. This proposed cycle allows us to create, deploy, use, evaluate and improve automated detection techniques (e.g., information-theoretic anomaly detection) in different operational modes, by users at different skill-levels and in different numbers, and through different computational processes with different demands for database access and preprocessing. This high-level thinking was partly supported by the empirical studies carried at UCL (WP4).

Impact or success story associated with project

Issues Encountered, if applicable: intellectual property, data sensitivity, publication of high risk/sensitive/proprietary findings, institutional collaboration and relationships, etc.

We continue to gain new understandings about the QCAT technique developed in this project. In particular, we appreciate its strengths and weaknesses much better than in the UKVAC project period. We are developing new visual analytics methods for overcoming its weaknesses.

Changes in research plans, if applicable: describe any major changes in the project's plans or objectives, such as initiatives added or omitted, compared to those outlined in the original, funded proposal.

None.

Supporting Documentation: list items and attach electronically, including survey instruments, photos, models, letters to participants, or other unique documentation.

A zip file that contains 8 documents, including the VAST 2014 paper, 5 presentations and 2 reports.