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 6
JULY 1, 2014 – JUNE 30, 2015
Cooperative Agreement No. 2009-ST-061-CI0001

PURDUE
UNIVERSITY™

Table of Contents

I. Summary

A. 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 grant managed by Purdue University. The education and Minority Serving Institution missions are directed by Purdue University with partners Jackson State University, Florida International University, Bethune-Cookman University, and Morgan State University providing critical input.

The VACCINE team is currently comprised of the following 29 entities with the associated Principal Investigator listed for each school:

University	*PI*
Arizona State University	Dr. Ross Maciejewski
Bethune-Cookman University	Dr. Raphael Isokpehi
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
Georgia Institute of Technology	Dr. Alexander Endert
Jackson State University (MSI)	Dr. Richard Alo
Morgan State University (MSI)	Dr. Timothy Akers
Ontario Institute of Technology, CA	Dr. Christopher Collins
Pennsylvania State University	Dr. Alan MacEachren
Prairie View A&M University	Dr. Louis Ngamassi
Purdue University	Dr. David Ebert
Simon Fraser University, CA	Dr. Brian Fisher
Simon Fraser University, CA	Dr. John Dill
Stanford University	Dr. Pat Hanrahan
University of Calgary, CA	Dr. Sheelagh Carpendale
University of Maryland	Dr. Niklas Elmqvist

University	PI
Purdue University	Dr. Ed Delp
Oak Ridge National Labs	Dr. Robert Bridges
University of Manitoba	Dr. Pourang Irani
University of North Carolina, Charlotte	Dr. William Ribarsky
University of Notre Dame	Dr. Pat Flynn
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
University of Washington	Dr. Mark Haselkorn
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.

B. Accomplishments

Throughout Year 6, 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. The VACCINE team has licensed the technology to a startup, DaVista.

- **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 Sheriff'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 222 users of the system in Indianapolis, and 113 within Cook County. There are an additional 70 or so users testing from our own server and over 6,078 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 completed Phase II of the project in year 6.

- 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 and continued through the 2014 and 2015 years.

- 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. 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, Bethune-Cookman University in Florida. Florida International University continues to research and develop various visual analytics tools and systems for first responders in the Miami-Dade community.

- Hosted Air VACCINE was recently the host to three members of the United States Air Force Academy (USAFA) during their five-week summer research program. Cadets Billy Hatton and Bryan Park, alongside Professor Bradley Warner participated in the DHS Summer Research Team Program for Federal Service Academies sponsored by the Department of Homeland Security (DHS) Science and Technology (S&T) Directorate. The program aims to collaborate with the Department of Defense (DOD) through scientific and engineering research of mutual interest between DHS and DOD conducted by rising military leaders. The program allowed for rising senior cadets Hatton and Park to begin to learn about visual analytics through immersion in the VAST Challenge and VALET projects, respectively

- The **SMART** tool (for social media analysis) developed by Purdue University and our German partners at Stuttgart University is currently being used in an operational capacity by a number of agencies. The US Coast Guard has been one of the proponents for the tool – it was used in a number of maritime events for monitoring safety. Additionally, the Coast Guard routinely turns to VACCINE to utilize the tool for various cases across the country. SMART has also been used by the Maine State Police, the Purdue Police, and the Boy Scouts of America, and is regularly used by the Ohio State Highway Patrol. Finally, a version of the tool was utilized by USCIS to look at asylees.

- 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 Accomplishments (July 1, 2014 – June 30, 2015)	
Research Themes	21
Education Themes	4
Seed Projects Funded	3
Peer-reviewed/Refereed Journal Articles/Publications/Papers	41
Presentations	34
Other Reports	12
Scholarly Journal Citations of Published Reports	220
Student Theses	13
Patents (applied and awarded)	8
Graduate Students Participating in VACCINE Programs	495
Minority Students Participating in VACCINE Programs	31
HS-STEM Student Theses	0
HS-STEM Students Enrolled	10
K-12 Student Participation	0
VAST Challenge 2015 Award	2
Period 6 Base Funding	$1,742,539.
Additional DHS Funding (BOA, Supplemental, etc.)	$628,326.
Funding from other Agencies Leveraged	$759,336.
VACCINE, Limited Liability Corp. Funding	$69,461.99.
Total of all Funding	3,199,662.99

Figure 2: Summary of VACCINE Accomplishments

C. 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.
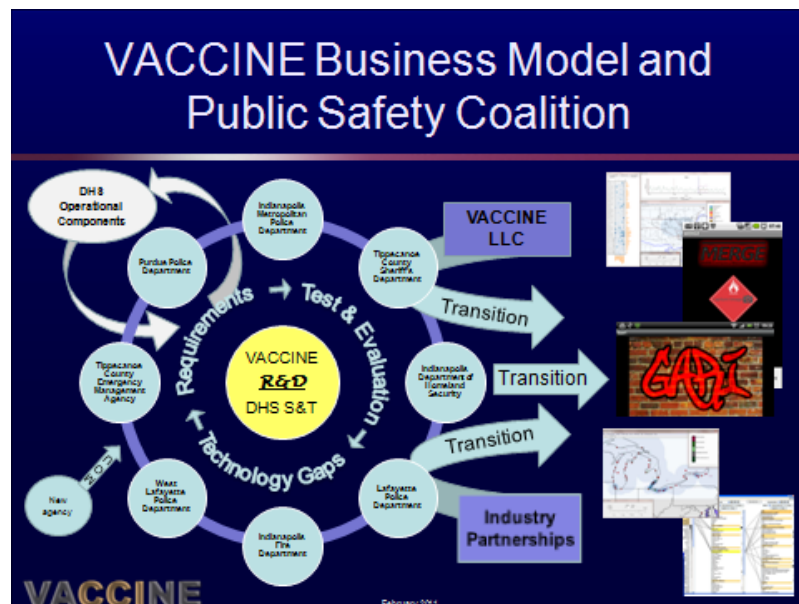

Figure 3: VACCINE Business Model

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, research scientist, 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 state-of-the-art in analyzing massive, heterogeneous, incomplete, and 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 analytical tools that enable interactive visual analysis for comprehension and provide critical insights from this sea of data. This problem has often 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'* 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 led 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 multivariate, and multisource 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 analytic 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.

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 6. Detailed descriptions of individual research projects can be found in Part V, 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.

- VACCINE developed a campus safety and security application for police departments that utilizes existing CCTV camera resources and suggests improved allocation schemes based on blind spots and crime data. The application also provides tools that generate safe paths for pedestrians on the basis of maximizing monitoring areas. The tool is currently being evaluated and refined by the Purdue University police department.

- VACCINE is currently developing an officer performance application for law enforcement agencies to assist them with designing effective metrics to evaluate the performance of their officers. This project entails creating a visual analytics system that enables supervisors to interactively develop metrics in order to evaluate the performance of officers, understand officer patterns and trends, and assist them in their operational decision making. The project is currently under development and is being tailored for the Lafayette, IN police department.

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)** continues to gain popularity with several new agencies that have requested the tool. It is currently being used by the USCG, CBP, as well as the American Red Cross. The USCG, for example, used 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 USCG also used SMART at the Major League Baseball All-Star Game that was held in Cincinnati, OH to monitor the events for any threats.

- We engaged with the **United States Citizenship and Immigration Services (USCIS)** on a project that involves integrating news sources into the SMART toolkit to provide contextual information on their refugee and asylum cases.

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 used to consider 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 developed 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 smart grid, 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

VACCINE's mission is to educate current homeland security stakeholders and the next generation of talent in effective development and use of visual analytics systems. Our educational initiatives span the career development pipeline ranging from undergraduate and graduate level work to professional education and training programs. Our goal is to build a diverse, highly capable, technical workforce for the Department of Homeland Security enterprise by administering various programs and initiatives at our center, partner research institutions, and minority-serving institutions.

During Year 6, VACCINE's educational initiatives maintained focus on undergraduate and graduate level work (including work with Minority Serving Institutions), professional education and training programs.

Undergraduate Programs

A. SURF Program

Every year VACCINE participates in the SURF Program. This year, the VACCINE lab was home to 5 students for the summer as a part of Purdue University's SURF (Summer Undergraduate Research Fellowships) Program. The 10 week program allows students to conduct research and work closely with our graduate students and research assistants in the VACCINE research laboratory, and it gives them the ability to explore, discover, and transform

ideas into reality. The SURF program gives undergraduate students with interest in engineering, science, and technology the opportunity to get hands-on with research and work side-by-side with faculty members, graduate students, and other researchers throughout the summer. Students worked on VACCINE projects and technology throughout their summer fellowship, which concluded with a poster presentation of their summer's research at the annual SURF Symposium on August 6th. For Mahesh Babu Gorantla, this poster presentation proved rewarding, as his poster was selected among the top ten posters of all the Purdue SURF research projects. Gorantla worked closely with other students in the VACCINE lab to come up with a solution for the VAST Challenge, a competition that involves finding visual analytic approaches to solve to hypothetical, real-world problems. "The best resource I had was the students and the team I work with every day. They have provided me the most immense support of anywhere I have ever seen or worked. That is one of the things I will always be appreciative of VACCINE for," says Gorantla.

B. Summer Research Team Program for Minority Serving Institutions

In an effort to engage faculty and students from minority serving institutions with the science of visual analytics, VACCINE offers summer research opportunities that allow students and faculty to conduct research on campus at our Center of Excellence. Sponsored by DHS, ORAU, & ORISE, VACCINE hosted Prairie View A&M University this 10 week summer program, and was represented by Dr. Louis Ngamassi, a College of Business professor at Prairie View. Ngamassi's 10-week long visit with VACCINE was in conjunction with the Department of Homeland Security (DHS) Summer Research Team for Minority Serving Institutions program, which seeks to enhance the leadership at minority serving institutions in subject areas that relate to DHS goals. Ngamassi has done extensive research about disaster management and international humanitarian organizations and sought to explore how visual analytics could aid in processing and disseminating disaster social media data. In addition to adding to his own research, Ngamassi also was able to learn more about visual analytics and how he could educate others at his institution about the science of visual analytics. "Some of the things I have learned here will help to develop a course. I have the opportunity to teach a new course entitled 'Crisis Informatics,' and one important component of this course will be visual analytics. Some of the things I am learning here will directly go into that course syllabus," says Ngamassi, adding, "It is especially important to study visual analytics in this era of big data."

C. Summer Research Team Program for Federal Service Academies

The Department of Homeland Security Science and Technology Directorate (DHS S&T) and the Department of Defense (DOD) partnered to create a program that fosters a research environment for future military leaders. The program is exclusive to DOD faculty, rising senior cadets, and midshipmen.

VACCINE was recently the host to three members of the United States Air Force Academy (USAFA) during their five-week summer research program. Cadets Billy Hatton and Bryan

Park, alongside Professor Bradley Warner participated in the DHS Summer Research Team Program for Federal Service Academies sponsored by the Department of Homeland Security (DHS) Science and Technology (S&T) Directorate. The program aims to collaborate with the Department of Defense (DOD) through scientific and engineering research of mutual interest between DHS and DOD conducted by rising military leaders.

The program allowed for rising senior cadets Hatton and Park to begin to learn about visual analytics through immersion in the VAST Challenge and VALET projects, respectively. This gave them the opportunity to study processes and approaches that will help them during their senior capstone projects at USAFA this upcoming school year, as well as provide Professor Warner the ability to develop future curriculum for students at his institution involving the science of visual analytics. "We had some ideas before coming out about what visual analytics consisted of. We had tried a few things, but after coming here, it kind of opened our eyes to different aspects," says Warner. "It opened my eyes to new ways of bringing this into the classroom."

Hatton completed his research through participation in the VAST Challenge, a competition that poses hypothetical, real-world problems to teams of individuals who must then seek to solve the problem using visual analytic approaches. Park conducted research for one of VACCINE's tools, VALET (Visual Analytics Law Enforcement Toolkit) that gave him the chance to find solutions to practical problems as well.

Graduate Programs

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. Monthly HS STEM lunches are provided in order to offer learning and networking opportunities for students with various disciplines, but who all share an interest in Homeland Security. This is a time for students to discuss where they 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, encourages the HS STEM Fellows to serve as research assistants in the VACCINE lab if they are so qualified. This began in the fall of 2014, and it is expected they will have a more direct understanding of Homeland Security as a result. The following is a brief description of each HS STEM Fellow:

Phillip Forsberg was very active as a representative of his program, serving as the President of the Nuclear Engineering Graduate Organization, President of Alpha Nu Sigma (Nuclear Engineering Honor's Society), Representative of Nuclear Engineering at the Graduate Student Advisory Council, Treasurer of the American Nuclear Society, Executive Board Member of Purdue Pugwash (promotes social responsibility for scientists), treasurer of the Institute of Nuclear Materials Management (INMM), and a Nuclear Engineering Ambassador. He continued his research, which uses Geant-4 to simulate using muon tomography to image

nuclear spent fuel casks for non-proliferation and safety purposes, which he presented at the American Nuclear Society Conference in San Antonio. He also passed his PhD qualifying exams this year. Phillip is currently completing his year of service through the National Nuclear Security Administration's Nuclear Graduate Fellowship Program, where he works in Defense Programs at the NNSA in the Department of Energy Building in Washington, DC.

Scott Carr was a teaching assistant for Language-based Systems Software Security during the fall of 2014 and continued his research on Data Confidentiality and Integrity in systems software. In spring 2015, he continued his research on the same topic and attended the IEEE Symposium on Security and Privacy where he presented a poster. In summer 2015, he interned at Microsoft Research in Redmond, WA where he researched and developed a static analyzer for System Verilog which is a hardware design language.

Jeff Avery received his Master's Degree in computer science after completing the necessary coursework during the fall of 2014. He also received an internship at Sypris Electronics, LLC where he still is today. He has continued his research in phishing defense as well as started research in deception. He contributed to three paper submissions as well as one grant proposal that was funded. He is currently an RA with Prof. Spafford in Computer Science.

Whitney Huang has focused this last year on two projects that deal with spatial data sets. The first one is about the detection of climate changes due to increasing atmospheric CO_2 concentrations. We (collaborate with people in University of Chicago) have come up with a very useful graphical approach that make use of extreme value statistics to convey "how" the climate extremes may change under future climate states. The second project is a collaborative work with people in Forestry and Natural Resources. This project is an attempt to uncover the interactions between invasive and native species in a spatial heterogeneity region. He successfully reconciled the contradicting results due to the spatial heterogeneity by a spatial mixed effects model.

Rachel Sitarz is a recent VACCINE HS-STEM alumni, who was recognized for her cyber forensics research by the cloud-based security provider DuoSecurity. Sitarz has worked as a Criminal Intelligence Analyst for the Indiana State Police and is a member of the Internet Crimes Against Children Task Force, which helped her stand out among her competition due to the real-world implications in her research.

Kelly Cole is currently working on her dissertation proposal and is on track to graduate in 2017 in the field of Cyber Forensics. She has published 2 – 3 papers in the past year and had an internship opportunity at Sandia National Labs. She has participated in several research studies including an Email Scam Awareness, A Review of Current Case Law Related to Digital Forensics.

Thomas Gorko has been working towards his MS in computer science by taking courses during fall 2014 and spring 2015. He is also a research assistant at the VACCINE Center

Research Lab for the past year working on the Soundscapes project. The Soundscapes project is a website where we look at sounds people upload along with location data, the time it was uploaded, and some information about the sound and we make visualizations of that information to help people to explore it.

Brian Olsen worked in the fall of 2014 on a database research project where he reviewed papers regarding spatiotemporal datamining techniques and relayed it to his team. He completed a compilers qualifier that will count towards a PhD. He also assisted other grad students in the lab on the cgSARVA and SMART project. During the spring of 2015 he started development for a web framework to move some of the current technology to a web-based platform. He mentored undergraduate students to help guide them for their research projects. He also completed the database qualifier that will count towards a PhD. During the summer the he mentored undergraduate students in the SURF program in research and development projects in the lab. He completed a research course taken with Dr. Ebert (the PI of the lab) that involved doing a literature review for web-based graphics. This ultimately aided in furthering the development of our web-based system.

David Wiszowaty has worked all year on a system designed for law enforcement agencies. He improved the performance and scalability of the system by designing a server client architecture, along with improving certain analytical tools used in the system. Over the summer he collaborated with USCIS to develop a new visual analytics tool on news article data. This tool would allow users to gain more knowledge on certain topics from major news sources.

Kevin XU has been continuously working on database and programming languages which he is working towards submitting a short paper on. He worked on the SMART tool in an attempt to improve the real time query response time with our research scientist and grad students.

Professional Development

Webinar Series with American Military University

VACCINE and American Military University are collaborating to present a bi-monthly webinar series to launch in Year 7. The webinars are in coordination with the framework of The National Conversation on Homeland Security Technology that was created by the Department of Homeland Security Science and Technology Directorate (DHS S&T). Each webinar will focus on a specific structured dialogue topic related to homeland security technology in an effort to get people talking about problems, challenges, and solutions to keep our country safe. The first topic will be on Decision-Making and Counter Terrorism: How the Visual Analytics of Data Can Help Save Lives. The webinar series will launch on Friday July 31, 2015 and will be presented by one of VACCINE's PI's Dr. Dennis Thom from University of Stuttgart, and Dr. James Hess from AMU. The second webinar is currently in development and scheduled for Wednesday September 30th.

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 demonstrations 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 useful feedback. Further, some of the tools already have completed training videos and others are still in production. Additionally, during the VACCINE Annual Meeting in October 2014, law enforcement officers and first responders were trained on a number of the VACCINE tools. Trainings were conducted for use of VALET/iVALET, SMART, and GARI. Quick reference guides were created and distributed for ease of use for each tool. VACCINE trained several officers from the Lafayette, Indiana police department on the use of our VALET and SMART systems in April 2015. VACCINE also conducted a training session on VALET for the Evansville, IN Police department in September 2014 at their premises, and conducted another follow on training via webinar in January 2015.

Minority Serving Institution Partners (MSI)

VACCINE has a number of MSI partners which include Florida International University, Morgan State University, Jackson State University, Bethune-Cookman University and Prairie View A&M 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 6 of the VACCINE center, there were numerous engagement and learning activities conducted with our MSI partners. These activities are mentioned below:

- Our third annual MSI Faculty workshop was held at Bethune-Cookman University during the summer of 2015. The response was very positive with an enrollment of 24 faculty members. Faculty instructors Abish Malik, Research Scientist, VACCINE Center, Ross Maciejewski, Ph.D., Arizona State, and Alex Endert, Ph.D., Georgia Tech, gave a two day summary of visual analytics applications and content, how that can apply to various disciplines, and how to successfully integrate VA into their course curriculum. The attendees were other faculty members from MSIs who do not have familiarity with visual analytics. We had several offers of interested schools to host the next MSI workshop.
- As mention previously, VACCINE hosted a DHS Summer Research Team Program for Minority Serving Institutions who participated in a research project with a VACCINE faculty members Center Director David Ebert and Research Scientist Abish Malik for the summer of 2016.

- VACCINE had six Morgan State University undergrads come to Purdue's campus for a one 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.
- Prairie View A&M University has expressed interest in becoming an MSI partner of VACCINE, and would like to host the next summer MSI Faculty Workshop. They are working to develop a specialty in visual analytics and have recognized the expertise of the VACCINE team.

IV. Technology Transition

Critical progress was made in the area of transition with the formation of a separate start-up technology company to which the IP associated with two VACCINE tools has been licensed. The start-up company known as DaVista Technologies was founded by four of the current members of the VACCINE management team in 2015, and this was a significant time investment as well as a personal financial investment to get the company officially and legally formed. Once the company was legally formed, the partners in DaVista invested the time and energy in the very lengthy process of getting the licensing agreement approved by Purdue University. This was achieved through a close working relationship with Purdue's Office of Technology Commercialization as well as Purdue's entrepreneurial resource center known as the Foundry. The group engaged its own corporate attorney. The team of business experts at the Foundry assigned DaVista an entrepreneur-in-residence to regularly assist with business plan development, marketing strategy, milestone creations, financial forecasts, as well as completion of the actual licensing agreement. The result of these efforts is that DaVista now has a licensing agreement in place for VALET (now being marketed at Visdom) and SMART. These were the two technologies that were initially approved in the first round of licensing agreements with the university, with the idea being that this new startup company is now the portal through which additional VACCINE technologies will be licensed. The value and strength of DaVista is that it provides a tangible and easy way to now move existing technologies from the VACCINE lab and advance them further along the commercialization pipeline. This was a substantial milestone in 2015.

DaVista has been simultaneously exploring a number of different options for how to best commercialize Visdom and SMART. DaVista has had numerous active discussions with interested companies/investors that range from sub-license agreements, outright purchases, project-for-hire scenarios, building the company from the ground up, as well as angel investors. The company has acquired space and has begun to put in place other initial marketing items including communication pieces, a website, business cards, etc. The founding partners believe strongly in the technologies and are committed to making them a success. The group makes pitches to external funding sources and applies for outside grants and funding opportunities specific to start-up companies.

While these substantial and impactful transition steps in company formation and commercialization were taking place, the VACCINE lab continued to play a vital role in the transition process through ongoing market readiness. As the number of interested companies in the technology grows, so does the importance of improvements made in the VACCINE lab to get the product ready for market. Initial discussions took place about how to integrate SMART with Visdom, and an outline of additional VACCINE tool integrations was reviewed so that priorities on transition activity can be appropriately allocated for the coming fiscal year.

Based on multiple reviews of the DaVista technologies by interested companies, we know that the intellectual property (IP) has value and could have a sustainable future out of the laboratory setting and find its rightful place in the $14 billion dollar "business intelligence" market. It is now DaVista's role to invest the time to research, select, and execute the best opportunity to make that happen.

DaVista and its competitors:

	Davista	Palantir	Domo BI	SAS	MS Power BI	Tibco Spotfire	Tableau	ESRI
Advanced Geospatial Mapping	✓	✓	✓					✓
Geosptial Forecasting	✓			✓				✓
Temporal Modeling	✓	✓		✓		✓	✓	
Spatiotemporal Clustering	✓							
Spatiotemporal Resource Allocation	✓	✓		✓		✓		
Interactive Visual Analytics	✓		✓		✓	✓	✓	
Geospatial Analytics	✓	✓		✓				✓
Easy Integrations	✓	✓	✓	✓	✓	✓	✓	✓
Price	Annual subscription	Perpetual: $150,000 +$266,600 /year	SaaS: $3,000 /user/year +$25,000 install charge	Basic $10,540 Advanced $140,000 /user/year	$52 /user/month	Desktop: $1,999/user Cloud: $2,000/year	Desktop: $1,999/user	Basic $8,000/user Server: $42,643/year

Additional research continued on other tools from the VACCINE lab that possess a high technology readiness level (TRL) with the purpose of technology transition and market preparation. VACCINE's ongoing relationships with its end users continued to provide invaluable feedback and insight into what changes and improvements need to be made on these tools in order to increase this readiness level. VACCINE recognizes the need for significant end-user-in-the-loop involvement in the entire life cycle development process. Some of these additional tools to be moved in the future under the DaVista group include: GARI, MERGE, JIGSAW, and MADIS. Having multiple tools and IP strengthens the DaVista portfolio and ultimately its chances of success in finding sustainable solutions to former VACCINE-based technologies.

Additional transition updates/status on other VACCINE tools include:

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

- 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.

- Transition plan in part of work plan for year 7

VALET (Visdom) – spatiotemporal visual analytics tool (initially examining crime data)

- 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.
- FBI expressing interest in hosting the tool

cgSARVA - Coast Guard Search and Rescue Visual Analytics

- Deployed for Operational Use – USCG LANT – 2010
- Phase II completed

MERGE - Mobile Emergency Response Guide

- Initial Prototype deployed May 2011
- Indianapolis Fire, Lafayette Fire
- Exploring deployment to iTunes and Android App store

SMART – Social Media Analysis Reporting Toolkit

- Still in testing and evaluating with a number of police and federal agencies.
- Additional developments needed to compete with commercial products:
    - Language
    - Geo location without lat long information included in tweet
- IP agreed upon between Purdue at University of Stuttgart

MADIS - Multimedia-Aided Disaster Information Integration System

- Prototype developed to analyze reports, pictures, text from the field and link to relevant multimedia content
- (iOS) operating system; also runs on iPad tablets
- Tested by Miami-Dade Department of Emergency Management
- Explored securing additional end users and/or possible commercialization to the broader emergency management community

GeoTxt- Web Service to Geo-Locate Places in Microblog Posts and Other Textual Information Sources

- The API is designed to be integrated into the development of dynamic, map-based, visual analytical interfaces, specifically in the context of crisis management and emergency response.
- GeoTxt now provides place recognition, disambiguation, and geolocation for SensePlace 2 (a situational awareness monitoring application developed in the GeoVISTA Center at Penn State). Possible implementation into other Center tools being explored.

Arizona

State

University

VACCINE Annual Report – Year 6

Please complete **ALL** fields.
This form must be emailed to Mary Padget at padget@purdue.edu and
Heather Trueblood at htrueblo@purdue.edu **by July 30, 2015.**
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: WDYTYA: The Uncertainty of Identity

Academic Disciplines: Computer Science

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
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 6

Students Supported on Project

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

Yafeng Lu, Computer Science, Arizona State University

Undergraduate supported students (need number only) | 4 |

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).**

Our goal is to link information pertaining to real and virtual worlds in order to better manage the uncertainties inherent in establishing human identity. Our basic premise is that uncertainty in identifying and characterising individuals may be managed and understood by: (a) exploring and analysing spatio-temporal profiles of lifestyles and activity patterns; (b) concatenating and conflating detailed but under-exploited datasets in the virtual and real domains; and, more speculatively (c) seeking and analysing crowd sourced volunteered data that link physical and virtual identities. Through these actions it will be possible to improve our ability to characterize and validate an individual's identity, to devise improved profiles of individuals and groups that bridge the real and virtual domains, and to document and manage the uncertainties inherent in these tasks.

VACCINE Annual Report – Year 6

Please complete **ALL** fields.
This form must be emailed to Mary Padget at padget@purdue.edu and
Heather Trueblood at htrueblo@purdue.edu **by July 30, 2015.**
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
	Sampling
x	Statistical Analysis
	Other:

Nature of Research

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

VACCINE Annual Report – Year 6

Please complete **ALL** fields.
This form must be emailed to Mary Padget at padget@purdue.edu and
Heather Trueblood at htrueblo@purdue.edu **by July 30, 2015.**
If any item does not apply to your project, please indicate "NA" under the heading.

Deliverables (other than publications and reports listed below)

NA

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

NA

VACCINE Annual Report – Year 6

Please complete **ALL** fields.
This form must be emailed to Mary Padget at padget@purdue.edu and
Heather Trueblood at htrueblo@purdue.edu **by July 30, 2015.**
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)

This is an interdisciplinary project from Computer Science (St. Andrews), Engineering (City University) and Geography (UCL), in partnership with experts in Visual Analytics at Arizona State University in the United States

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.

NA

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)

VACCINE Annual Report – Year 6

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:
Feng Wang, Shehzad Afzal, Paulo Shakarian, David S. Ebert, Ross Maciejewski. A Variable Edege Bandwidth for Kernel Density Estimation in Geographic Network Space, *ACM SIGSPATIAL*, 2015.

Accepted:
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*, 20(12): 1863-1872, 2014

Yafeng Lu, Feng Wang, Ross Maciejewski. Business Intelligence from Social Media: A Study from the VAST Box Office Challenge. *IEEE Computer Graphics and Applications*, 34(5): 58-70, 2014

Yafeng Lu, Robert Kruger, Dennis Thom, Feng Wang, Steffen Koch, Thomas Ertl, Ross Maciejewski. Integrating Predictive Analytics and Social Media. *Proceedings of the IEEE Conference on Visual Analytics Science and Technology*, 2014

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.

Maciejewski, R., "Integrating a Visual Analytics Curriculum Into Your Own Classroom," Bethune Cookman University, Florida, June 2015.

Patents/Copyrights (List names)

Applications:

Awarded:
Maciejewski, R., Hafen, R., Rudolph, S., Cleveland, W., Ebert, D., "Forecasting hotspots using predictive visual analytics approach," U. S. Patent 8,924,332 B2 issued on Dec. 30, 2014.

Ebert, D. S., Maciejewski, R., Tyner, B., Jang, Y., Cleveland, W., Amass, S., "Animal Symptom Visual Analytics," U. S. Patent 8,882,664 B2 issued on November 11, 2014.

Ebert, D. S., Collins, T., Maciejewski, R., Malik, A., "Visual Analytics Law Enforcement Tools," U. S. Patent 8,849,728 B2 issued on September 30, 2014.

Please complete **ALL** fields.
This form must be emailed to Mary Padget at padget@purdue.edu and
Heather Trueblood at htrueblo@purdue.edu **by July 30, 2015.**
If any item does not apply to your project, please indicate "NA" under the heading.

Summary of Outcomes and Impact of Project

Currently, ASU has partnered with the UK group to focus directly on exploring representative social network data for understanding issues of identity. Representative social network data are notoriously difficult to assemble, manage and analyse, and there are important ethical issues concerning their use. What we have done is begun developing incetivised social network tools to install on users' Facebook accounts and that will profile each of their contacts using statistics arising from their names and geographic residence. Similar approaches have been used in the past by market research agencies to popularise their geodemographic systems, but the innovation here is that the application will harvest names based indicators of ethnicity, age and socio-economic status, alongside approximate geographic coordinates of residence. In exchange for this, respondents will receive reports that characterize their own social networks (along with assurances that individual reports will not be shared with third parties and will only be used in aggregate in the research). Analysed in conjunction with geodemographic profiling, the result may be the first representative linkage of virtual and real communities in time and (international) space. We are in the process of creating a number of different systems that will both emphasise different applications as well as longer or shorter term dynamics of behaviour change. The work will help to establish the degree of connectedness between different physically separate communities – and the receptiveness of different cybergeodemographic types to social issues of the day, changes in fashion and more broadly based secular changes. Our view is that online and conventional profiles need to be developed hand in hand, since all social interactions also take place in a physical setting, and it is simply makes no sense to consider one in isolation of the other.

Impact or success story associated with project

NA

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

Georgia

Institute

of Technology

VACCINE Annual Report – Year 6

Please complete **ALL** fields.
This form must be emailed to Mary Padget at padget@purdue.edu and
Heather Trueblood at htrueblo@purdue.edu **by July 30, 2015.**
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 6

Please complete **ALL** fields.
This form must be emailed to Mary Padget at padget@purdue.edu and
Heather Trueblood at htrueblo@purdue.edu **by July 30, 2015.**
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)
Alex Godwin, Georgia Tech, School of Interactive Computing
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) | 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).**

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.

VACCINE Annual Report – Year 6

Please complete **ALL** fields.
This form must be emailed to Mary Padget at padget@purdue.edu and
Heather Trueblood at htrueblo@purdue.edu **by July 30, 2015.**
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
	Statistical Analysis
XXX	Other:

Nature of Research

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

VACCINE Annual Report – Year 6

Please complete **ALL** fields.
This form must be emailed to Mary Padget at padget@purdue.edu and
Heather Trueblood at htrueblo@purdue.edu **by July 30, 2015.**
If any item does not apply to your project, please indicate "NA" under the heading.

Deliverables (other than publications and reports listed below)

We have made the Jigsaw system available on the internet for anyone to download. It is a java-based application. We also are working on a version that runs on a web browser. It is not quite ready yet to be made available to all.

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 6

Please complete **ALL** fields.
This form must be emailed to Mary Padget at padget@purdue.edu and
Heather Trueblood at htrueblo@purdue.edu **by July 30, 2015.**
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.

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

Andrew Tammaro, Homeland Security Investigations, DHS ICE, Andrew.Tammaro@ice.dhs.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.

NA

Project Period (only complete if different than 4/1/12-6/30-13)   7/1/14 – 6/30/15

VACCINE Annual Report – Year 6

Please complete **ALL** fields.
This form must be emailed to Mary Padget at padget@purdue.edu and
Heather Trueblood at htrueblo@purdue.edu **by July 30, 2015.**
If any item does not apply to your project, please indicate "NA" under the heading.

<u>Project Outcomes</u> **(**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, Zhicheng Liu, and John Stasko, "Reflections on the Evolution of the Jigsaw Visual Analytics System", Information Visualization, Vol. 13, No. 4, Oct. 2014, pp. 336-345.

Jaegul Choo, Yi Han, Mengdie Hu, Hannah Kim, James Nugent, Francesco Poggi, Haesun Park, John Stasko, "Exploring Anomalies in GAStech", Proceedings of IEEE VAST '14 (VAST Challenge paper), Paris, France, Nov. 2014, pp. 347-348.

Alex Godwin, Anand Sainath, Sanjay Obla Jayakumar, Vivek Nabhi, Sagar Raut, John Stasko, "Exploring Spatio-Temporal Data as Personal Routes" (Poster), IEEE Information Visualization Conference, Paris, France, Nov. 2014.

John Stasko, "Value-Driven Evaluation of Visualizations", Proceedings of BELIV 2014, Paris, France, November 2014, pp. 46-53.

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.

"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, Vancouver, B.C.

"The Value of Visualization for Exploring and Understanding Data", John Stasko, August 2014, Boeing Data Analytics Community of Excellence, Web forum.

"The Value of Visualization for Understanding Data and Making Decisions", John Stasko, September 2014, Keynote lecture at the IEEE Joint Intelligence & Security Informatics Conference (JISIC 14), The Hague, Netherlands.

"Value-Driven Evaluations of Visualizations", John Stasko, October 2014, Paper presented at the ACM BELIV '14 Workshop, Paris, France.

"Data Visualization Principles (Some Things I've Learned)", John Stasko, March 2015, Keynote lecture at the Visualizing Biological Data Conference (VIZBI '15), Boston, MA.

VACCINE Annual Report – Year 6

Please complete **ALL** fields.
This form must be emailed to Mary Padget at padget@purdue.edu and
Heather Trueblood at htrueblo@purdue.edu **by July 30, 2015.**
If any item does not apply to your project, please indicate "NA" under the heading.

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 did not add new functionality to the system per se, but we made a number of bug fixes and updates. We likely average about 5 downloads of the system per day. Also, a student has been working on a new version of the system that runs native in a web browser. It is not quite ready to release yet, but we hope to be able to do that soon. In the last year, we published an article in the journal *Information Visualization* (October 2014) that reflects on the design and development of the system.

Dr. Stasko was invited to give three Keynote lectures in the past year at the 2014 Canadian Visual Analytics Summer School (CANVAS), at the IEEE Joint Intelligence & Security Informatics Conference (JISIC 14), and at the Visualizing Biological Data (VIZBI '15) Conference.

This grant also has supported new research of a PhD student exploring geospatial visual analytics including pen- and touch-based interaction. We have submitted a poster to InfoVis '15 about this new work.

Impact or success story associated with project

We have had over 5000 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. (We do not formally track who is using it and how they are using.)

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.

JACKSON STATE UNIVERSITY

VACCINE Annual Report – Year 6

Please complete **ALL** fields.
This form must be emailed to Mary Padget at padget@purdue.edu and
Heather Trueblood at htrueblo@purdue.edu **by July 30, 2015.**
If any item does not apply to your project, please indicate "NA" under the heading.

Institution: Jackson State University

PI and/or Co-PI: Richard Alo and Sudha Yerramilli

Project Name: <u>Visual Analytics tool for Hurricane track Prediction (Funding decision: pending)</u>

Academic Disciplines: Geospatial sciences

Keywords associated with project: GIS, HURRICANE TRACK PREDICTION, MODEL BUILDER

<u>Theme for Research Projects</u> (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
X	Event Evacuations
	Visual Analytics for Security Applications
	International Collaborations
	N/A

<u>Theme for Education Projects</u> (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

Students Supported on Project

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

Undergraduate supported students (need number only)

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 proposed model is based on the premise that hurricanes have a natural trend as evident from the historical data and quick exploration of all the past hurricanes with similar characteristics may prove valuable to have track guidance almost on real time. The basis of the methodology is to use analog techniques, based on the climatologically nature of the movement of the global tropical cyclone systems, for identifying all the past hurricanes similar to the in situ hurricane considering the parameters of location and time of the year. This model uses historical hurricane track data over the Atlantic Ocean available as IBTrACS. This model can be run at frequent intervals to update the predicted path and landfall point and so help to redefine the management plans along with the progress of the hurricane system. The proposed GIS model, a simulation proxy, can generate the output on hurricane track within two minutes as compared to few hours with dynamical model prediction, thus providing valuable lead-time for disaster planning and mitigation measures.

Project Goals

- To assist emergency managers/DHS official, by providing a visual analytic tool, to input active hurricane location and foresee the landfall point.
- To provide a tool to identify potential storm surge regions based on the predicted landfall point
- To provide visual analytic interface to aid emergency managers visual interpretation in making

---

VACCINE Annual Report – Year 6

Please complete **ALL** fields.
This form must be emailed to Mary Padget at padget@purdue.edu and
Heather Trueblood at htrueblo@purdue.edu **by July 30, 2015.**
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
X	Modeling
	Sampling
X	Statistical Analysis
	Other:

Nature of Research

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

Please complete **ALL** fields.
This form must be emailed to Mary Padget at padget@purdue.edu and
Heather Trueblood at htrueblo@purdue.edu **by July 30, 2015.**
If any item does not apply to your project, please indicate "NA" under the heading.

Deliverables (other than publications and reports listed below)

The proposal aims to develop a Visual Analytics for Hurricane track Prediction (VAHTP), to integrate the geospatial model (Hurricane track prediction) and SLOSH model to provide the user 'a comprehensive tool' to identify potential landfall point and subsequent flood-affected communities.

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 6

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)

Funding decision Pending!!

VACCINE Annual Report – Year 6

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)

GIS for monitoring of Hurricanes and Cyclones(book chapter), Encyclopedia of Natural Hazards, Taylor and Francis, 2014 (under review)

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 6

Please complete **ALL** fields.
This form must be emailed to Mary Padget at padget@purdue.edu and
Heather Trueblood at htrueblo@purdue.edu **by July 30, 2015.**
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.

10-Dec-2014

VACCINE Year 6 project Status

Jackson State University, on behalf of Dr. Richard Alo's team, has submitted a proposal for the Year-6 of VACCINE program and is being considered for funding. The project is expected to start soon.

Project Details: Visual Analytics tool for Hurricane track Prediction

The proposed model is based on the premise that hurricanes have a natural trend as evident from the historical data and quick exploration of all the past hurricanes with similar characteristics may prove valuable to have track guidance almost on real time. The basis of the methodology is to use analog techniques, based on the climatologically nature of the movement of the global tropical cyclone systems, for identifying all the past hurricanes similar to the in situ hurricane considering the parameters of location and time of the year. This model uses historical hurricane track data over the Atlantic Ocean available as IBTrACS. This model can be run at frequent intervals to update the predicted path and landfall point and so help to redefine the management plans along with the progress of the hurricane system. The proposed GIS model, a simulation proxy, can generate the output on hurricane track within two minutes as compared to few hours with dynamical model prediction, thus providing valuable lead-time for disaster planning and mitigation measures.

Project Goals

- To assist emergency managers/DHS official, by providing a visual analytic tool, to input active hurricane location and foresee the landfall point.
- To provide a tool to identify potential storm surge regions based on the predicted landfall point
- To provide visual analytic interface to aid emergency managers visual interpretation in making any decisions.

Morgan State University

VACCINE Annual Report – Year 6

Please complete **ALL** fields.
This form must be emailed to Mary Padget at padget@purdue.edu and
Heather Trueblood at htrueblo@purdue.edu **by July 30, 2015.**
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 6

Please complete **ALL** fields.
This form must be emailed to Mary Padget at padget@purdue.edu and
Heather Trueblood at htrueblo@purdue.edu **by July 30, 2015.**
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)

Roberta Virgil, Morgan State University, Department of Electrical and Computer Engineering

Undergraduate supported students (need number only) `5`

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).**

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 6

Please complete **ALL** fields.
This form must be emailed to Mary Padget at padget@purdue.edu and
Heather Trueblood at htrueblo@purdue.edu **by July 30, 2015.**
If any item does not apply to your project, please indicate "NA" under the heading.

<u>Technical Approach</u> (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
	Consultation
	Coordination/Integration
	Education
	Hybrid Basic—Applied
	Hybrid Applied—Consultation

VACCINE Annual Report – Year 6

Deliverables (other than publications and reports listed below)

- Graduate & 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
- Exchange meetings with campus police that ensure product is aligned to the department's needs

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

MSU applied to the Maryland Innovation Initiative (MII) program to seek funds to commercialize the iLEAPS project. 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. Even though the reviewers felt that the technology developed was significant, some believed that the barrier to entry for other corporations would not be significantly high to provide an award for commercialization. Nonetheless, the project is moving on to full scale trials on MSU's campus and the program director will continue to seek additional funding to expand the use of the product to other institutions and governmental agencies.

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

VACCINE Annual Report – Year 6

Please complete **ALL** fields.
This form must be emailed to Mary Padget at padget@purdue.edu and
Heather Trueblood at htrueblo@purdue.edu **by July 30, 2015.**
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.

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

VACCINE Annual Report – Year 6

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:

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: Native Code Development for the iLaw Enforcement App for Students
Present: Leonardo Ferreira
Date: 6/30
Meeting: Summer Research Symposium
Location: Morgan State University

Patents/Copyrights (List names)

Applications:

Awarded:

VACCINE Annual Report – Year 6

Please complete **ALL** fields.
This form must be emailed to Mary Padget at padget@purdue.edu and
Heather Trueblood at htrueblo@purdue.edu **by July 30, 2015.**
If any item does not apply to your project, please indicate "NA" under the heading.

Summary of Outcomes and Impact of Project

Five additional students (1 graduate and 4 undergraduate) have been trained to conduct mobile development. Specifically, the students have learned to continue the development of iLEAPS using the Android Software Development Kit, and XCode for iOS development. Students have also learned how to great hybrid apps that use HTML 5, CSS, JavaScript, JQuery , PHP and MySQL to great the web content that is wrapped in native code for GPS, notification and camera support. Students have added new capabilities to extend the utility of iLEAPS. These capabilities include native notifications (which enable students and police to receive notifications when incidents are sent or resolved even when the phone is off), ability to send pictures, and for dispatch to see the location of all officers on campus.

Impact or success story associated with project

After a demonstration, Police Chief Hatcher has called for a meeting in August where the entire police force will be introduced to iLEAPS at a meeting where President Wilson will be in attendance as well.

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.

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

Pennsylvania State University

VACCINE Annual Report – Year 6

Please complete **ALL** fields.
This form must be emailed to Mary Padget at padget@purdue.edu and
Heather Trueblood at htrueblo@purdue.edu **by July 30, 2015.**
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: GeoTxt: Corpora builder, validation, scaling, and extensions

Academic Disciplines: Geography, Information Science & Technology

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 6

Please complete **ALL** fields.
This form must be emailed to Mary Padget at padget@purdue.edu and
Heather Trueblood at htrueblo@purdue.edu **by July 30, 2015.**
If any item does not apply to your project, please indicate "NA" under the heading.

Ryan S. MullinsStudents
Supported on Project

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

Morteza Karimzadeh (Penn State, PhD candidate, Geography)

Undergraduate supported students (need number only)

Other **Graduate Students** (non-supported) involved in project (need number only) | 1 |

Other Undergraduate Students (non-supported) involved in project (need number only) | 1 |

Student Thesis in 2014 (include name, thesis title, university, department, degree, date)

Funded partially through DHS-VACCINE COE on earlier research, not related to GeoTxt:

Wie Luo, GEOVISUAL ANALYTICS APPROACHES FOR THE INTEGRATION OF GEOGRAPHY AND SOCIAL NETWORK CONTEXTS, The Pennsylvania State University, Department of Geography, PhD, December, 2014.

Raechel Anne Bianchetti, LOOKING BACK TO INFORM THE FUTURE: THE ROLE OF COGNITION IN FOREST DISTURBANCE CHARACTERIZATION FROM REMOTE SENSING IMAGERY, The Pennsylvania State University, Department of Geography, PhD, December, 2014.

Ryan S. Mullins, INTERPRETIVE UNCERTAINTY AND THE EVALUATION OF SYMBOLS AND A TAXONOMY OF SYMBOL EVALUATION METHODS AND MOBILE EVALUATION TOOL, The Pennsylvania State University, Department of Geography, MS, December, 2014.

VACCINE Annual Report – Year 6

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 application programming interface (API) that other applications use to recognize place references in microblog posts and in other text documents, disambiguate the places, and geolocate those places; the full process is referred to here as "geoparsing". GeoTxt also supports an associated visual web interface that enables users to extract and locate place references from individual documents submitted to the interface and to provide feedback to the system on result accuracy. A key challenge in geoparsing is lack of "gold standard" corpora with which to train computational mehods and against which to test them. The focus of work this year has been on building visual analytics methods and tools that support geoparsing corpus construction, application of those methods and tools to building a corpus of geoparsed tweets, and use of that corpus to train and text GeoTxt capabilities for geoparsing streaming tweets related to crisis and other events.

VACCINE Annual Report – Year 6

Please complete **ALL** fields.
This form must be emailed to Mary Padget at padget@purdue.edu and
Heather Trueblood at htrueblo@purdue.edu by **July 30, 2015.**
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: HPC to support query to streaming APIs

Analytic Methods

X	Case Studies
	Modeling
X	Sampling
X	Statistical Analysis
	Other:

Nature of Research

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

VACCINE Annual Report – Year 6

Please complete **ALL** fields.
This form must be emailed to Mary Padget at padget@purdue.edu and
Heather Trueblood at htrueblo@purdue.edu **by July 30, 2015.**
If any item does not apply to your project, please indicate "NA" under the heading.

Deliverables (other than publications and reports listed below)

- The improved *GeoTxt* API, available on request to DHS partners and other collaborators.
- The improved *GeoTxt* web interface that enables users to process individual documents by hand.
- The *GeoCorpora – Geocoder* web interface that support the geo-location component of text corpus building

---

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

GeoTxt has been 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 6

Please complete **ALL** fields.
This form must be emailed to Mary Padget at padget@purdue.edu and
Heather Trueblood at htrueblo@purdue.edu **by July 30, 2015.**
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.

None at this time

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 adapted GeoTxt to support processing of large volumes of streaming microblog posts and provided access to the GeoTxt API to the Purdue VACCINE group.

PI MacEachren met with the UNCC VACCINE Team in Charlotte and discussed strategies to utilize GeoTxt within the UNCC topic modeling-based for multiscale extraction of topics and exploration of topic development over time and across geographic space.

Project Period: 7/1/2014-6/30/2014

VACCINE Annual Report – Year 6

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:

(in progress; to be submitted by Sept. 1, 2015) Wallgrün, J.O., Karimzadeh, M., MacEachren, A.M., Pezanowski, S., Hardisty, F. GeoCorpora: Corpus and Corpus Building tools for the Evaluation and Training of Microblog/Twitter Geoparsers

Accepted (published):

Wallgrün, J.O., Karimzadeh, M., MacEachren, A.M., Hardisty, F., Pezanowski, S. and Ju, Y. 2014: Construction and First Analysis of a Corpus for the Evaluation and Training of Microblog/Twitter Geoparsers. In Purves, R. and Jones, C., editors, GIR'14: 8th ACM SIGSPATIAL Workshop on Geographic Information Retrieval, Dallas, TX: ACM.

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

Not funded by, but derived from GeoTxt research: MacEachren, A.M. 2014: Place Reference in Text as a Radial Category: A Challenge to Spatial Search, Retrieval, and Geographical. Position paper for the 2014 Specialist Meeting — Spatial Search, Santa Barbara, CA: UCSB Center for Spatial Studies. Page 48-51 in: http://spatial.ucsb.edu/wp-content/uploads/smss2014-All_Position_Papers.pdf

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.

(presented by Karimzadeh) Wallgrün, J.O., Karimzadeh, M., MacEachren, A.M., Hardisty, F., Pezanowski, S. and Ju, Y. 2014: Construction and First Analysis of a Corpus for the Evaluation and Training of Microblog/Twitter Geoparsers. In Purves, R. and Jones, C., editors, GIR'14: 8th ACM SIGSPATIAL Workshop on Geographic Information Retrieval, Dallas, TX: ACM.

Patents/Copyrights (List names)

NA

VACCINE Annual Report – Year 6

Please complete **ALL** fields.
This form must be emailed to Mary Padget at padget@purdue.edu and
Heather Trueblood at htrueblo@purdue.edu **by July 30, 2015.**
If any item does not apply to your project, please indicate "NA" under the heading.

Summary of Outcomes and Impact of Project

The primary goal for this stage of GeoTxt research has been to build and apply a "gold standard" corpus of tweets for which place references are identified and geolocated; the corpus supports both training and testing of computational geoparsing methods. The research had five primary outcomes. First, a systematic process was developed for text corpus building using crowd-sourcing. Second, two applications were designed and implemented to support this process: (a) a visual web-interface for place entity recognition in tweets (and other short text) for use within Amazon Mechanical Turk (AMTurk) and (b) a visual web-based interface to support gelocation of identified place references and Twitter profile locations. Third, we analyzed causes of disagreement by AMTurk workers about place references in tweets and used results to refine computational methods for automatic place entity recognition. Fourth the gold standard corpus created consists of 6000 tweets relevant to events (related to public health, protests and violence, and natural disasters) for which place references are recognized and georeferenced. Approximately 30% of the tweets contain at least one place name and 60% of tweets include identifiable profile places. Fifth, we implemented high performance computing methods to support real-time processing of streaming data using the GeoTxt API.

Impact or success story associated with project

GeoTxt is now fully integrated into the dataflow pipeline of SensePlace 3 to support space-time analysis of microblog posts about natural disasters and other events relevant to security. As noted above, development for SensePlace 2, was initiated with DHS support, then subsequent work including the next phase as SensePlace 3 was 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 challenging. To create a gold standard that is useful beyond our project (to DHS CEOs and elsewhere), we opted to develop a crowd-sourcing approach that leverages Amazon Mechanical Turk. It took a substantial amount of time to create the process, but we are now in a good position to do similar corpus building quickly in the future as well as to document the process for others to follow.

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
- A video tutorial to GeoCorpora:GeoCoder (the geolocation interface) is posted at: https://youtu.be/5K2C0BsGqpg

Purdue

University

VACCINE Annual Report – Year 6

Please complete **ALL** fields.
This form must be emailed to Mary Padget at padget@purdue.edu and
Heather Trueblood at htrueblo@purdue.edu **by July 30, 2015.**
If any item does not apply to your project, please indicate "NA" under the heading.

Institution: Purdue University

PI and/or Co-PI: Edward J. Delp

Project Name: GARI: Gang Graffiti Recognition and Analysis

Academic Disciplines:

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
XX	N/A

VACCINE Annual Report – Year 6

Please complete **ALL** fields.
This form must be emailed to Mary Padget at padget@purdue.edu and
Heather Trueblood at htrueblo@purdue.edu **by July 30, 2015.**
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)

   See attached

Undergraduate supported students (need number only) | 4 |

O**ther Graduate Students** (non-supported) involved in project (need number only) | 2 |

Other Undergraduate Students (non-supported) involved in project (need number only) | 2 |

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

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).**

See attached

VACCINE Annual Report – Year 6

Please complete **ALL** fields.
This form must be emailed to Mary Padget at padget@purdue.edu and
Heather Trueblood at htrueblo@purdue.edu **by July 30, 2015.**
If any item does not apply to your project, please indicate "NA" under the heading.

<u>**Technical Approach**</u> (Check all that apply)
Data Collection Methods

	Compiling & Sorting DB
	Data Mining
	Expert Consultation
	Field Monitors
	Survey
XX	Other: Image data collection and analysis

Analytic Methods

	Case Studies
	Modeling
	Sampling
	Statistical Analysis
XX	Other: Image analysis

Nature of Research

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

VACCINE Annual Report – Year 6

Please complete **ALL** fields.
This form must be emailed to Mary Padget at padget@purdue.edu and
Heather Trueblood at htrueblo@purdue.edu **by July 30, 2015.**
If any item does not apply to your project, please indicate "NA" under the heading.

Deliverables (other than publications and reports listed below)

We have delivered to both InGang and the Cook Sheriff Department the GARI system.

We are in the process of discussing the delivering GARI to several other law enforcement agencies.

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

We have had several discussions with the Purdue Foundary on commercialization efforts of GARI. We are discussing forming a company.

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

---

VACCINE Annual Report – Year 6

Please complete **ALL** fields.
This form must be emailed to Mary Padget at padget@purdue.edu and
Heather Trueblood at htrueblo@purdue.edu **by July 30, 2015.**
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.

See attached list

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.

See attached list

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

VACCINE Annual Report – Year 6

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 attached list

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)

Applications:

Awarded:

VACCINE Annual Report – Year 6

Please complete **ALL** fields.
This form must be emailed to Mary Padget at padget@purdue.edu and
Heather Trueblood at htrueblo@purdue.edu **by July 30, 2015.**
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.

Edward J. Delp
July 24, 2015
VACCINE Year 6 Report

Ph.D. Thesis

Albert Parra Pozo, August 2014, "Integrated Mobile Systems Using Image Analysis With Applications In Public Safety"

Bin Zhao, December 2014, "Image Analysis Using Visual Saliency with Applications in Hazmat Sign Detection and Recognition."

Conference Papers

J. Ribera, K. Tahboub and E. J. Delp, "Automated crowd flow estimation enhanced by crowdsourcing," *Proceedings of the IEEE National Aerospace and Electronics Conference (NAECON)*, June 2014, Dayton, OH.

B. Delgado, K. Tahboub and E. J. Delp, "Automatic detection of abnormal human events of train platforms," *Proceedings of the IEEE National Aerospace and Electronics Conference (NAECON)*, June 2014, Dayton, OH.

B. Zhao and E. J. Delp, "Visual Saliency Models Based on Spectrum Processing," *Proceedings of the IEEE Winter Conference on Applications of Computer Vision*, January 2015, Hawaii, pp. 976-981.

K. Tahboub, N. Gadgil, J. Ribera, B. Delgado, and E. J. Delp, "An Intelligent Crowdsourcing System for Forensic Analysis of Surveillance Video," *Proceedings of the IS&T/SPIE Conference on Video Surveillance and Transportation Imaging Applications*, vol. 9407, San Francisco, February 2015.

J. Kim, A. Parra, H. Li, E. J. Delp, "Efficient Graph-Cut Tattoo Segmentation," *Proceedings of the IS&T/SPIE Conference on Visual Information Processing and Communication*, vol. 9410, San Francisco, February 2015.

J. Ribera, K. Tahboub, and E. J. Delp, "Characterizing The Uncertainty of Classification Methods and Its Impact on the Performance of Crowdsourcing," *Proceedings of the IS&T/SPIE Conference on Imaging and Multimedia Analytics in a Web and Mobile World*, vol. 9408, San Francisco, February 2015.

Visits/Talks

February 2014, GARI Tutorial Training at the Cook County Sheriff Department, Chicago, Il.

Visit to Greater Cleveland Region Transit Authority to Report on work on EBOLO – April 2015

Presentation at the Indiana State Police InGang training – August 2014

Other

Participation in the NIST/FBI Tattoo contest – Tatt-C –report and presentation at NIST June 2015 workshop

We have had more than 40 requests for information about GARI – Kaethe has the list

Project Description
Name: GARI: Gang Graffiti Recognition and Analysis

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.

Joint Center Project

The EBOLO project is a joint project between ALERT and VACCINE.

The goal of this project is to investigate methods for re-identifying subjects as they appear in surveillance video at the Greater Cleveland Regional Transit Authority (GCRTA). The GCRTA has expressed interest in tools that will allow them to identify subjects as they re-appear in their surveillance system. In many cases a subject who has previously committed a crime will re-enter the system hours or days later and appear in GCRTA surveillance video. The GCRTA would like to re-identify (re-id) that subject so they can be apprehended after their re-entry to the system. In some sense, what the GCRTA would like to create is an automatic or electronic "be on the lookout" (BOLO) system. We call this system EBOLO.

We envision the EBOLO system would be one where the subject to be added to a BOLO would be manually highlighted by the GCRTA from surveillance video of an incident. The system would then use computer vision and image processing techniques to create features of the subject from the surveillance video. One could think of these features as the subject's "EBOLO fingerprint." We then use these features to continuously monitor the video surveillance system to determine when that subject reappeared in the video. The systems would then flag or alarm that the subject has reappeared and where they are located.

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

Collaborating End-Users

GARI:

InGang

Captain Scott Beamon
INGangNetwork Project Manager
Indiana Intelligence Fusion Center
302 W. Washington Street
Room W198
Indianapolis, Indiana 46204
sbeamon@iifc.in.gov
tel: 317-233-6045

Cook County Sheriff

John Blair
Deputy Chief, Intelligence and Investigations
Cook County Sheriff's Police Department
Office: 773 674-4775
Cellular: 312 515-0004
E-Mail: john.blair@cookcountyil.gov

EBOLO: The Greater Cleveland Regional Transit Authority (GCTRA)

John P. Joyce
Chief of Police / Director of Security
216 575-3910 office
216 575-3892 fax
jpjoyce@gcrta.org

VACCINE Annual Report – Year 6

Please complete **ALL** fields.
This form must be emailed to Mary Padget at padget@purdue.edu and
Heather Trueblood at htrueblo@purdue.edu **by July 30, 2015.**
If any item does not apply to your project, please indicate "NA" under the heading.

Institution: Purdue University

PI and/or Co-PI: Edward J. Delp

Project Name: Chicago LTE Pilot Project

Academic Disciplines:

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
XX	N/A

VACCINE Annual Report – Year 6

Students Supported on Project

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

Khalid Tahboub, 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) | 1 |

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

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 goals of this project were to test the viability and performance of the LTE National Public Safety Broadband Network (NPSBN) with respect to transport of video imagery. One cell using the NPSBN was installed in Chicago at the Chicago Police Department District 7. We conducted a test plan to characterize the performance of the network and analyzed the data collected. The test plan consisted of three parts: First, objective perceptual video quality tests designed to measure the video quality when video is streamed in real-time over the LTE network were conducted. Second, subjective measurements were conducted to characterize the performance of applications of interest under various test conditions. Third, network performance metrics were obtained to test the key performance indicators associated with the network. Based on the analysis of the data collected during our testing it was concluded that a PSBN LTE network provides an unprecedented opportunity to increase the capacity and to meet the needs and requirements of public safety with respect to video delivery. Careful analysis should be used for Quality of Service (QoS), prioritization and Radio Frequency (RF) planning when designing a NPSBN LTE system. It was also noted that adaptive video coding methods, used in many video systems, might not suit public service operational scenarios. System designer should also take into consideration video usage in a task-based approach.

VACCINE Annual Report – Year 6

Please complete **ALL** fields.
This form must be emailed to Mary Padget at padget@purdue.edu and
Heather Trueblood at htrueblo@purdue.edu **by July 30, 2015.**
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
XX	Field Monitors
	Survey
XX	Other: Objective perceptual video quality assessment, network performance test

Analytic Methods

	Case Studies
	Modeling
	Sampling
	Statistical Analysis
XX	Other: Image and video analysis

Nature of Research

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

VACCINE Annual Report – Year 6

Deliverables (other than publications and reports listed below)

An application server was installed and integrated into the network to host some of the services required for testing, such as an FTP and video streaming servers.

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 6

Please complete **ALL** fields.
This form must be emailed to Mary Padget at padget@purdue.edu and
Heather Trueblood at htrueblo@purdue.edu **by July 30, 2015.**
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)

Motorola Solutions

Office of Emergency Management and Communications (OEMC), Chicago Police Department

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

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 6

<u>**Project Outcomes**</u> **(**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)

    Chicago LTE Pilot Project Final Report
    DHS Center For Visual Analytics for Command, Control, and Interoperability Environments (VACCINE)
    Video and Image Processing Laboratory (VIPER)
    Purdue University
    West Lafayette, Indiana
    Khalid Tahboub and Edward J. Delp
    Version 1.4
    August 25, 2015

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: none

    Awarded: none

VACCINE Annual Report – Year 6

Please complete **ALL** fields.
This form must be emailed to Mary Padget at padget@purdue.edu and
Heather Trueblood at htrueblo@purdue.edu **by July 30, 2015.**
If any item does not apply to your project, please indicate "NA" under the heading.

Summary of Outcomes and Impact of Project

The outcome of the project is a lessons-learned document supported by testing results. The recommendations are based on our observations and testing results to meet the special needs required by public safety.

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.

Our initial test plan intended to conduct subjective assessments of non-video applications used by the CPD such as RTVI, CAD, VidSys and Shotspotter. However, due to operational issues and requirements by the CPD, only subjective assessment of RTVI was conducted.

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

Submission Report

The Tattoo Recognition Technology-Challenge (Tatt-C)

Tattoo Identification & Region of Interest

Test Cases

05/02/2015

Submitted by Purdue University

Edward J. Delp

Video and Image Processing Laboratory (VIPER)
School of Electrical and Computer Engineering
Purdue University
West Lafayette, Indiana

Telephone: 765-494-3351
Email: ace@ecn.purdue.edu

Overview

The Tattoo Recognition Technology-Challenge (Tatt-C) is a competition for academic and commercial developers to test image-based tattoo matching technology. This challenge will assess the capability of tattoo recognition methods to detect and retrieve tattoos. The goals are to determine which are most effective methods for the following operation use-cases:

- Tattoo Similarity – matching visually similar or related tattoos from different subject
- Tattoo Identification – matching different instances of the same tattoo images from the same subject over time
- Region of Interest – matching a small region of interest that is contained in a larger image
- Mixed Media – matching visually similar or related tattoos using different types of images (e.g., sketches, scanned 99 print, computer graphics, or natural images)
- Tattoo Detection – detecting whether an image contains a tattoo or not

In this challenge, there are two phases. Our team at Purdue University participated tattoo identification in phase one. In phase two, our team is participating tattoo identification and region of interest.

Our Approach

Tattoo Identification

We propose to use local shape context combined with SIFT descriptors for local features of a tattoo object. We introduce a multiple bin polar histogram based local shape context (MHLC) with a visual saliency map (GBVS) for robustness of translation, scale, rotation and shape distortions. We also propose adaptive weight image matching method depending on the number of extracted SIFT feature points. We conducted several experiments using our approach on the dataset provided and were able to attain a high "hit rate" as shown in our CMC graphs. Below is a block diagram of our proposed system.
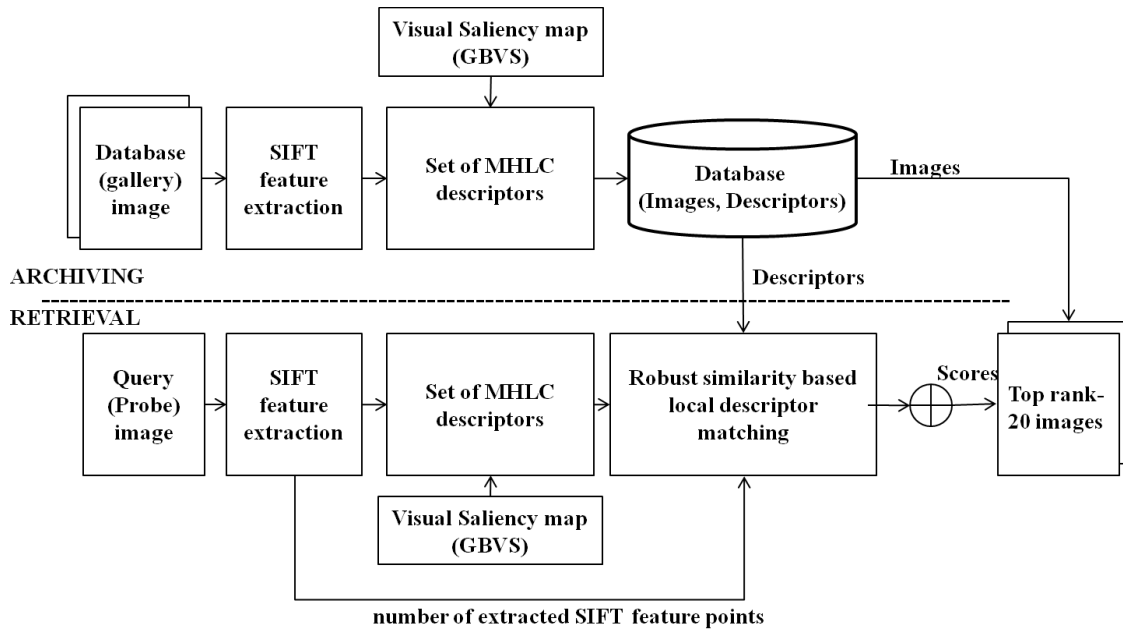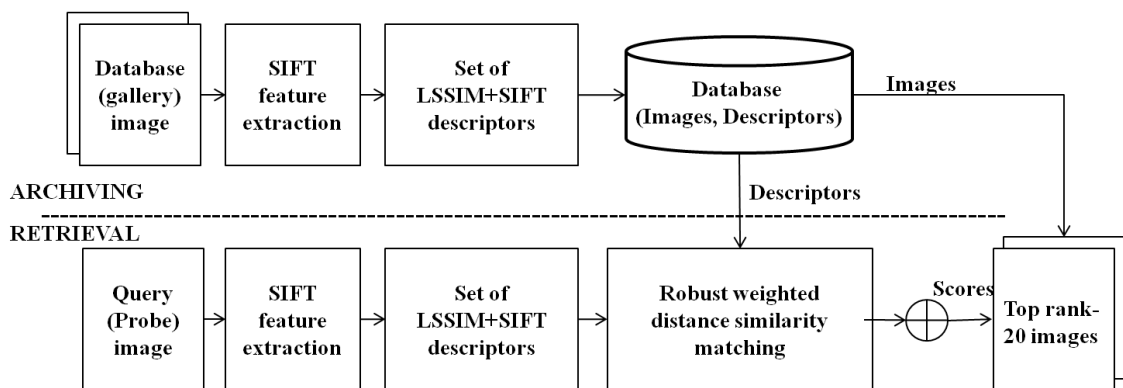
Fig. 1. Block Diagram (Tattoo Identification)

Region of Interest

We propose a new image descriptor to combine local self-similarity (LSSIM) descriptor and SIFT descriptor for Region of Interest dataset. Since the MHLC descriptor used in Tattoo Identification is not robust when an image resolution is very low, the new descriptor combining LSSIM descriptor and SIFT descriptor is proposed instead. Additionally, we also propose robust weighted distance similarity matching method. We conducted several experiments using our approach on the dataset provided. We were able to attain a high "hit rate" as shown in our CMC graphs. Below is the block diagram of our proposed system

Fig. 2 Block Diagram (Region of Interest)

Results

We conducted several experiments to test our methods on various test cases. In the tattoo identification challenge, we have used two test cases, ID-1 and ID-2. Each test case contains five subsets. We determined five-folded cross validation in each test case. ID-1 only contains original images and ID-2 contains both original images and cropped background images. We obtained 10 CMC graphs based on the results we obtained from the subsets.

In the region of interest, we have used two test cases, ROI-1 and ROI-2. Each test case contains five subsets. We determined five-folded cross validation in each test case. ROI-1 only contains original images and ROI-2 contains both original images and cropped background images. We obtained 10 CMC graphs based on result from the subset. All CMC graphs are attached in the Appendix and as separate PDF files in our submission package.

The horizontal axis indicates the rank and the vertical axis is the "hit rate" or "CMC". In ID-1, the average hit rate in all five subsets reached 99.38% in top 1 rank and 99.38% in top 10 rank. In ID-2, the average hit rate in all five subsets reached 96.15% in top 1 rank and 98.71% in top 10 rank. In ROI-1, the average hit rate in all five subsets reached 96.62% in top 1 rank and 98.65% in top 10 rank. In ROI-2, the average hit rate in all five subsets reached 91.56% in top 1 rank and 94.25% in top 10 rank.

Submission Package

The package we are submitting contains the following files in the " Tatt-C_Phase2_Submission.zip" file:

- Submission Report (this document, pdf)
- Tattoo Identification test case
    - 10 CMC graphs (pdf)
    - Candidate list (text file)
- Region of Interest test case
    - 10 CMC graphs (pdf)
    - Candidate list (text file)

Appendix

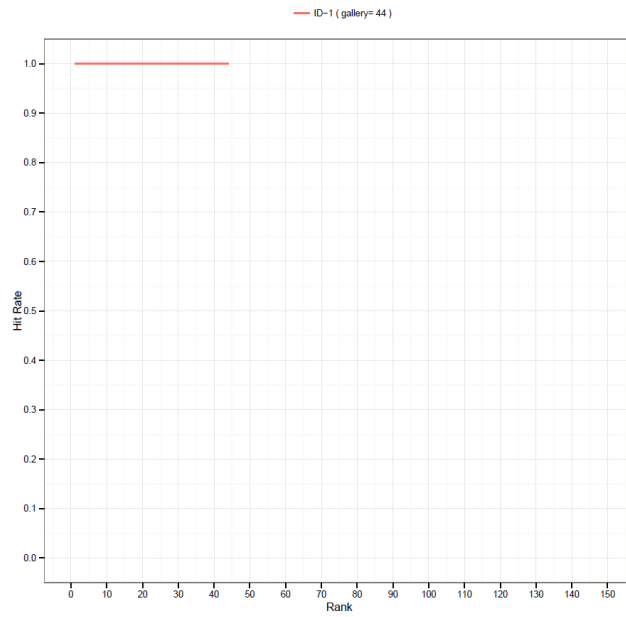## - Tattoo Identification test case
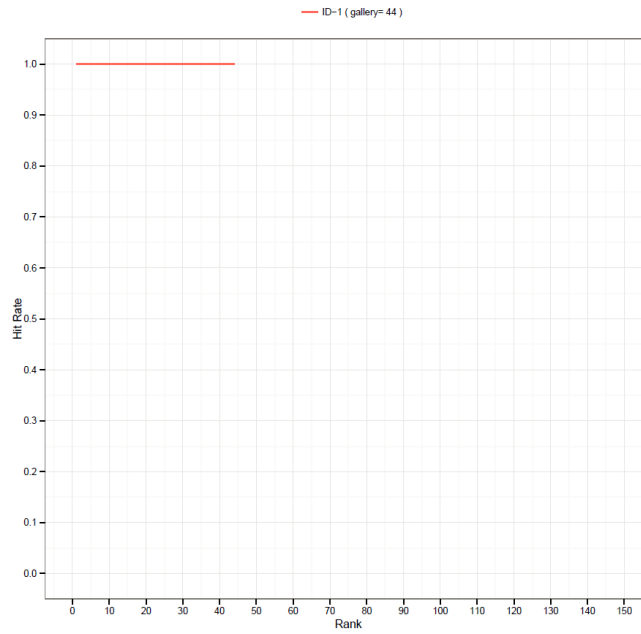
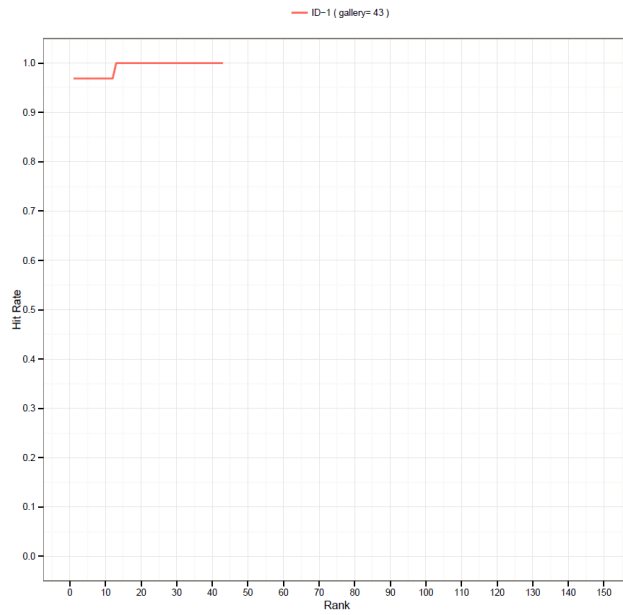**Fig. 3. CMC plot for ID-1 subset 1**

Fig. 4. CMC plot for ID-1 subset 2

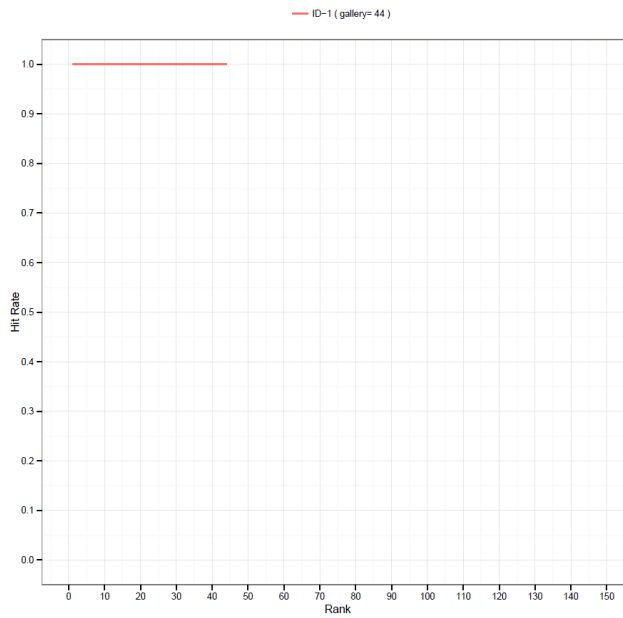**Fig. 5. CMC plot for ID-1 subset 3**

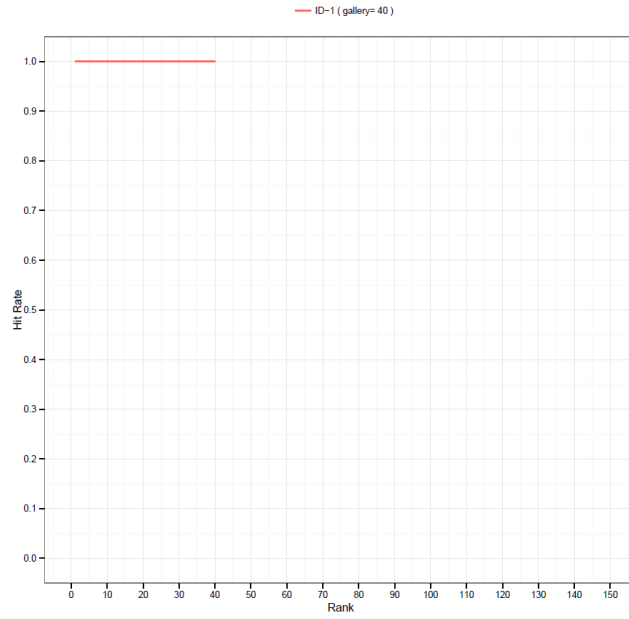**Fig. 6. CMC plot for ID-1 subset 4**
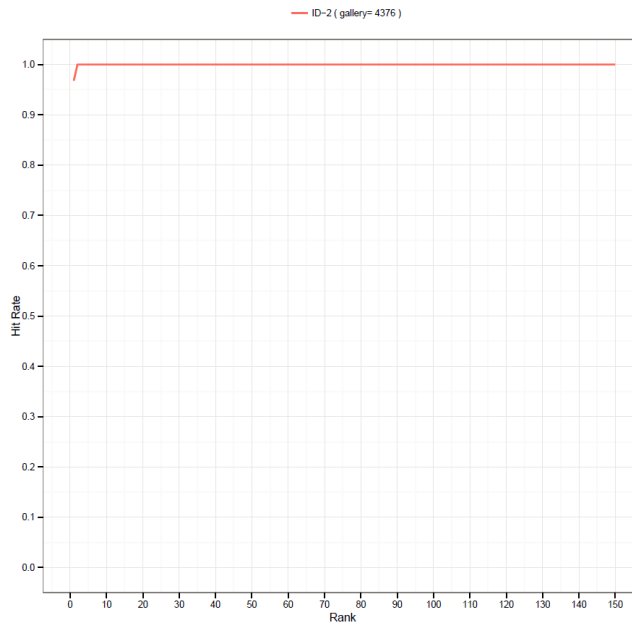
Fig. 7. CMC plot for ID-1 subset 5

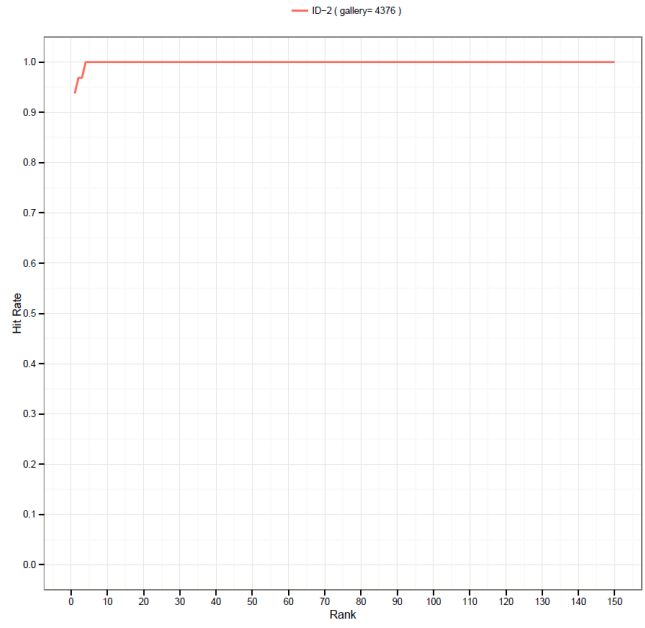**Fig. 8. CMC plot for ID-2 subset 1**

Fig. 9. CMC plot for ID-2 subset 2
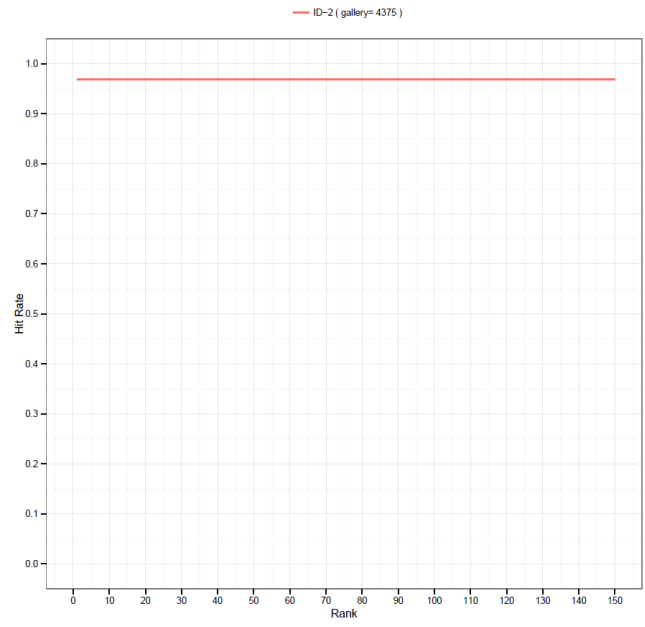
Fig. 10. CMC plot for ID-2 subset 3
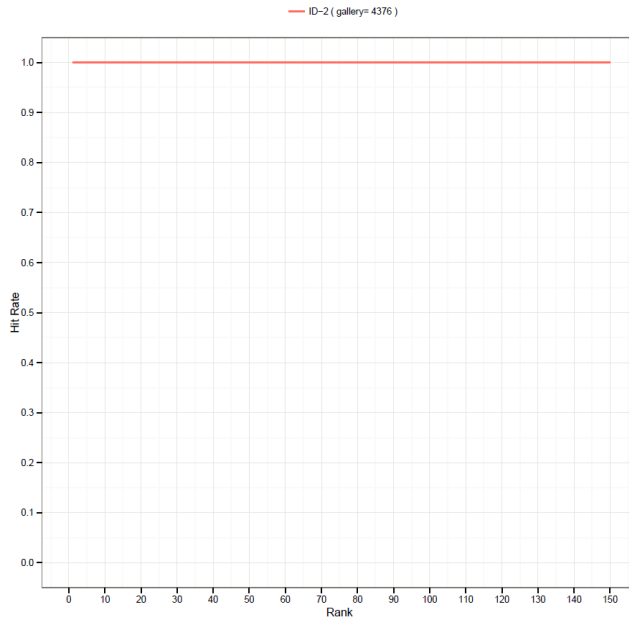
Fig. 11. CMC plot for ID-2 subset 4
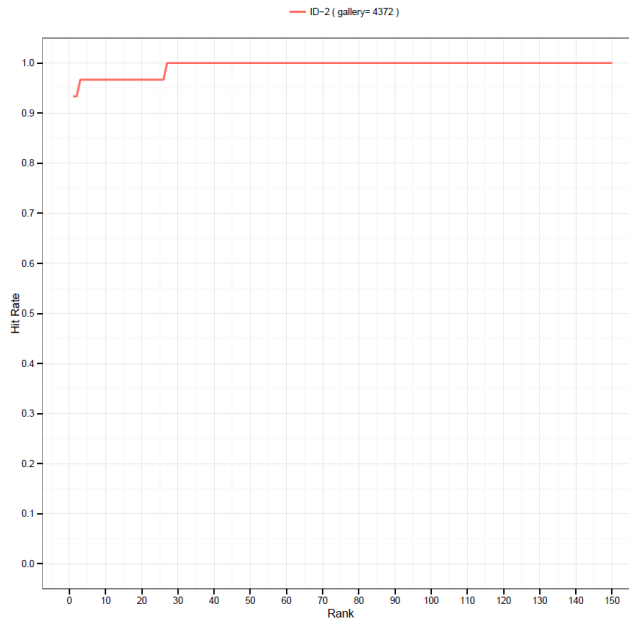
Fig. 12. CMC plot for ID-2 subset 5
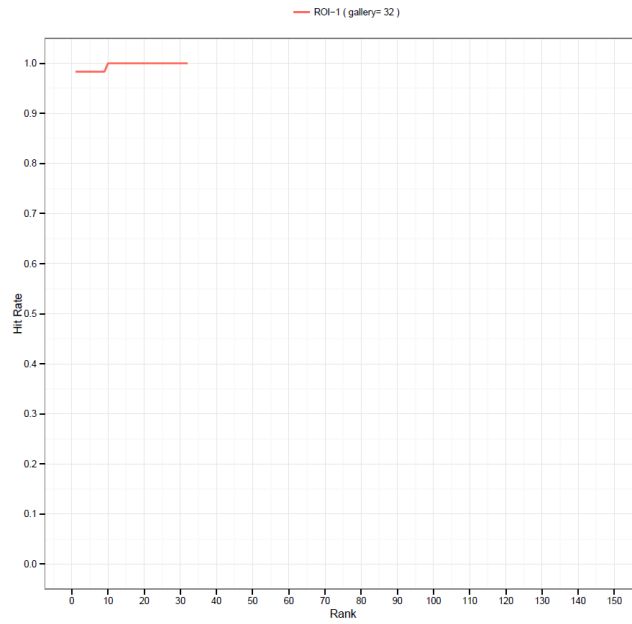
- Region of Interest test case

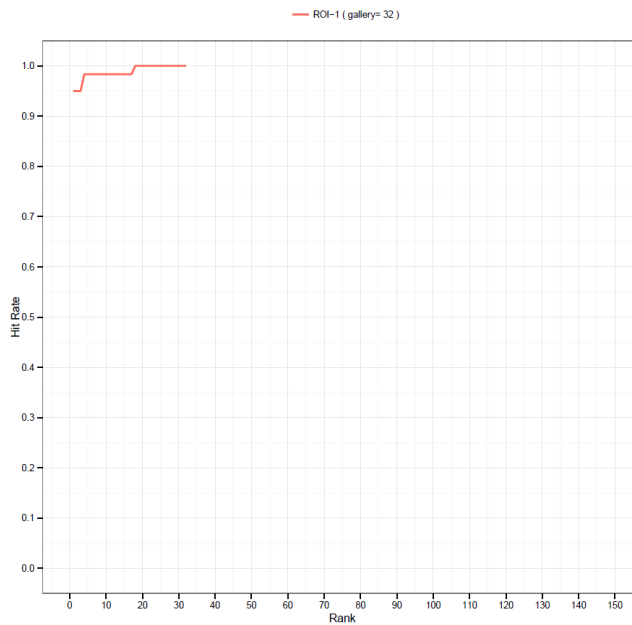**Fig. 13. CMC plot for ROI-1 subset 1**

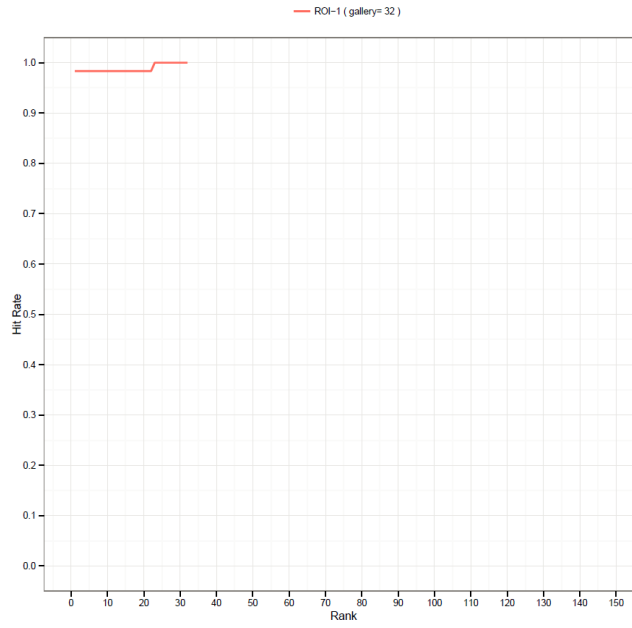**Fig. 14. CMC plot for ROI-1 subset 2**

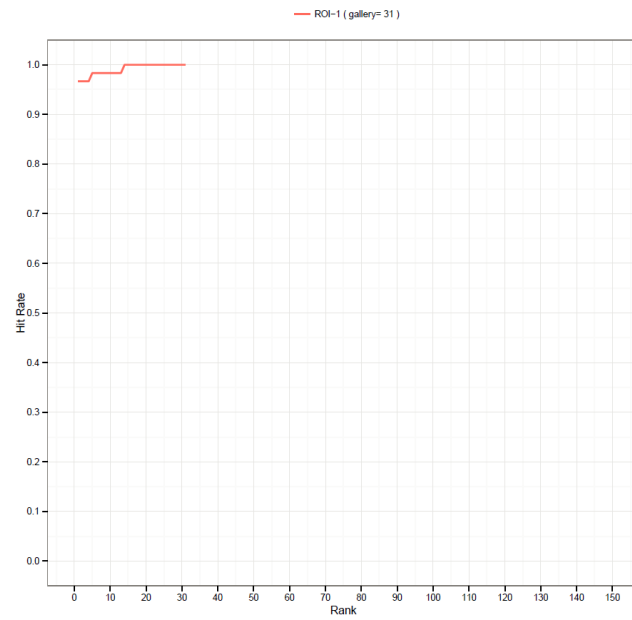**Fig. 15. CMC plot for ROI-1 subset 3**

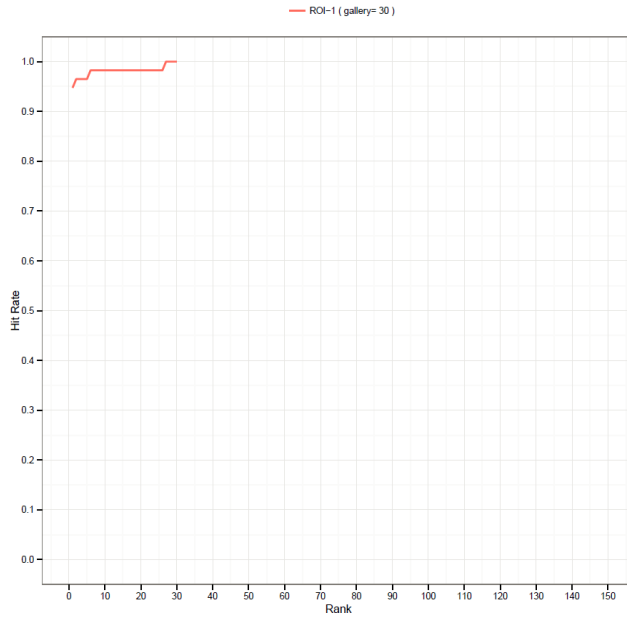**Fig. 16. CMC plot for ROI-1 subset 4**

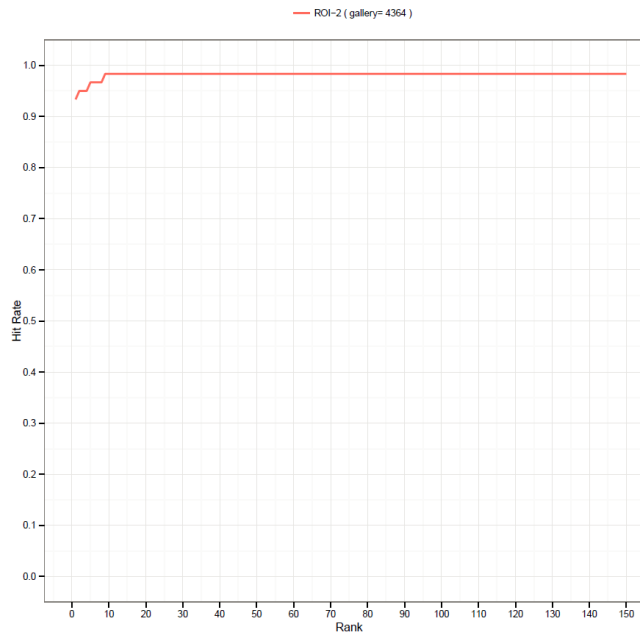**Fig. 17. CMC plot for ROI-1 subset 5**

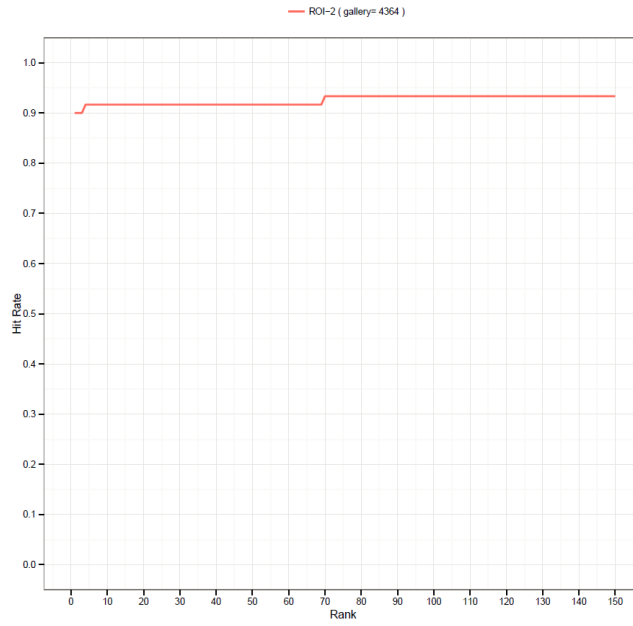**Fig. 18. CMC plot for ROI-2 subset 1**

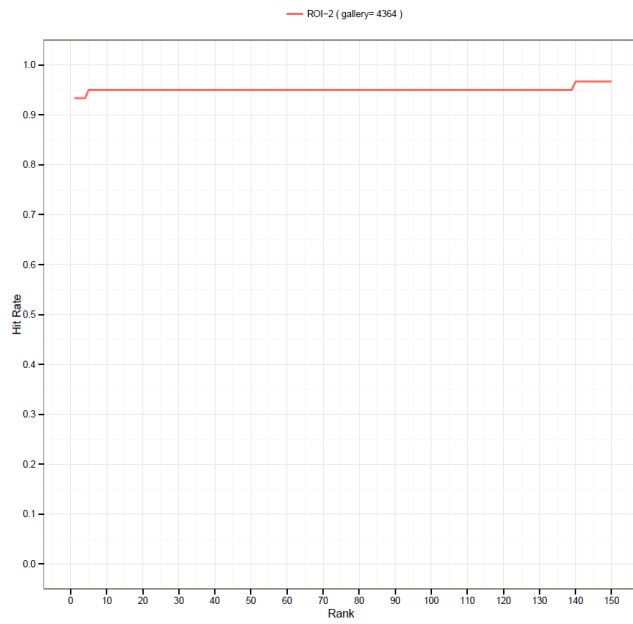**Fig. 19. CMC plot for ROI-2 subset 2**
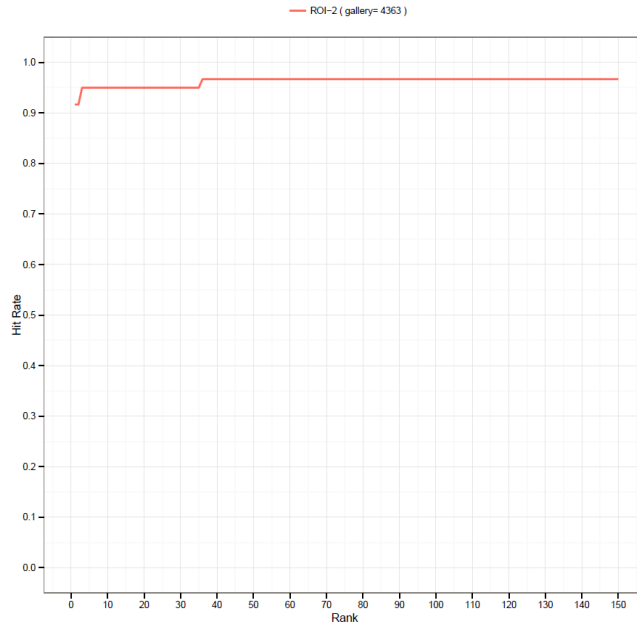

Fig. 20. CMC plot for ROI-2 subset 3

Fig. 21. CMC plot for ROI-2 subset 4
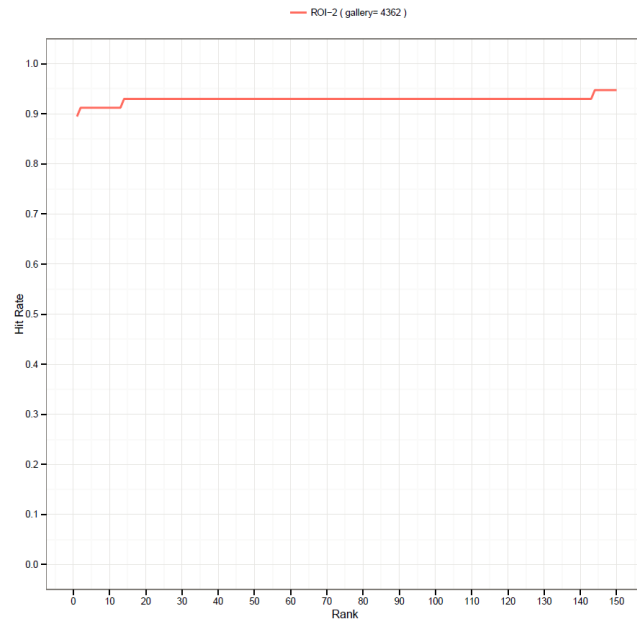
Fig. 22. CMC plot for ROI-2 subset 5

Purdue

University

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

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

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 2014 (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).**

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.

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.

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

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

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:

N/A

     Accepted:

Sungahnn Ko, Shehzad Afzal, Simon Walton, Yang Yang, Junghoon Chae, Abish Malik, Yun Jang, Min Chen and David Ebert, "Analyzing High-dimensional Multivariate Network Links with Integrated Anomaly Detection, Highlighting and Exploration," In Proceedings of IEEE Visual Analytics Science and Technology, p83-92, 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

120

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 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

Institution: Purdue University

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

Project Name: Officer Performance

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

Students Supported on Project

Graduate Research Assistants (include name(s), university and department)
Jieqiong Zhao, Purdue University, Electrical and Computer Engineering
Hanye Xu, Purdue University, Electrical and Computer Engineering
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 Officer Performance project to gamify the performance of police officers in Lafayette Police Department for better performance comparison and for motivating maximized performance.

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

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

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.
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

: 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

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

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

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

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)

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.

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.

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

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

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:
Hanye Xu; Tay, J.; Malik, A.; Afzal, S.; Ebert, D.S., "Safety in view: A public safety visual analytics tool based on CCTV camera angles of view," in Technologies for Homeland Security (HST), 2015 IEEE International Symposium on, vol., no., pp.1-6, 14-16 April 2015

Accepted:

Hanye Xu; Tay, J.; Malik, A.; Afzal, S.; Ebert, D.S., "Safety in view: A public safety visual analytics tool based on CCTV camera angles of view," in Technologies for Homeland Security (HST), 2015 IEEE International Symposium on, vol., no., pp.1-6, 14-16 April 2015

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

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

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

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
David Wiszowaty, MS, Purdue University, Computer Science

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.

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 and Riverboat festival in 2014 and 2015. They also used our system to monitor All-Star Baseball game in 2015.

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

USCIS used our system to monitor Twitter around Syria in western Asia in 2015.

St. Clair County in Michigan used our email alerts function in 2015.

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

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.

US Coast Guard, Darrell Eaton, darrell.l.eaton@uscg.mil

Purdue Police Department, John Cox, jkcox@purdue.edu

USCIS, Markus Montezemolo,

markus.k.montezemolo@uscis.dhs.gov,

Derrick Swift, derrick.swift@uscis.dhs.gov

Ohio State Highway Patrol, Tom Gerber, thjgerber@dps.ohio.gov

Saint Clair County (MI) DHS, Jeff Friedland,

jfriedland@stclaircounty.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).

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

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:
Zhang, J., Afzal, S., Chae, J., Wang, G., Thom, D., Matei, 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., Cui, Y., Jang, Y., Wang, G., Malik, A., Ebert, D., "Trajectory-based Visual Analytics for Anomalous Human Movement Analysis using Social Media," Eurovis Workshop on Visual Analytics, 2015.

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)

Zhang, Jiawei; Chae, Junghoon; Afzal, Shehzad; Malik, Abish; Thom, Dennis; Jang, Yun; Ertl, Thomas; Matei, Sorin A.; Ebert, David S.: Visual Analytics of User Influence and Location-Based Social Networks. In: Sorin Matei, Martha Russell, Elisa Bertino: Transparancy in Social Media. Heidelberg: Springer, 2015.

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

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

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

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.

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.

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

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.
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:

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

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

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

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

Students Supported on Project

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

Abish Malik, Purdue University, Electrical and Computer Engineering
David Wiszowaty, Purdue University, Computer Science
Guizhen Wang, Purdue University, Electrical and Computer Engineering
Hanye Xu, Purdue University, Electrical and Computer Engineering
Siqiao Chen, 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.

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

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

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

Evansville Police, IN. POC: Alan Yeager, AYeager@evansvillepolice.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.

N/A

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

N/A

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:

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.

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.

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: "Proactive Spatiotemporal Resource Allocation and Predictive Visual Analytics", Provisional, Filed: Nov. 13, 2014

Awarded: "Visual Analytics Law Enforcement Tools", Patent. No.: U.S. 8,849,728, Issue date: Sept. 2014

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 6

Please complete **ALL** fields.
This form must be emailed to Mary Padget at padget@purdue.edu and
Heather Trueblood at htrueblo@purdue.edu **by July 30, 2015.**
If any item does not apply to your project, please indicate "NA" under the heading.

Institution: Purdue University

PI and/or Co-PI: David Ebert

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.

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

Please complete **ALL** fields.
This form must be emailed to Mary Padget at padget@purdue.edu and
Heather Trueblood at htrueblo@purdue.edu **by July 30, 2015.**
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, Electrical and Computer Engineering, Purdue University
Sungahn Ko, 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. VASA is a visual analytics platform targeting this setting and consists 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. Each component encapsulates high-fidelity simulation models that together form an asynchronous simulation pipeline: a system of systems of individual simulations with a common data and parameter exchange format.

VACCINE Annual Report – Year 6

Please complete **ALL** fields.
This form must be emailed to Mary Padget at padget@purdue.edu and
Heather Trueblood at htrueblo@purdue.edu **by July 30, 2015.**
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
X	Sampling
X	Statistical Analysis
	Other:

Nature of Research

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

VACCINE Annual Report – Year 6

Please complete **ALL** fields.
This form must be emailed to Mary Padget at padget@purdue.edu and
Heather Trueblood at htrueblo@purdue.edu **by July 30, 2015.**
If any item does not apply to your project, please indicate "NA" under the heading.

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.

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 6

Please complete **ALL** fields.
This form must be emailed to Mary Padget at padget@purdue.edu and
Heather Trueblood at htrueblo@purdue.edu **by July 30, 2015.**
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)

Shaun Kennedy (University of Minnesota), Bill Ribarsky (University of North Carolina at Charlotte), Kelly Gaither (University of Texas at Austin), Tom Ertl (University of Stuttgart, Germany), Daniel Keim (University of Konstanz, Germany), 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).

Dr. Gaither at University of Texas at Austin: Providing historical and simulated hurricane paths and attributes.

Drs. Ribarsky and Tolone 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

International partners: additional testbeds.

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

VACCINE Annual Report – Year 6

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:

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, 20 (12):1853-1862, 2014

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.

"Interactive Computational Steering of Large Asynchronous Simulation Pipelines for Societal Infrastructure" Dr. Niklas Elmqvist and Dr. David Ebert. IEEE VIS 2014 conference paper presentation session, 11/13/2014, Paris, France.

Patents/Copyrights (List names)

Applications:

Awarded:

Please complete **ALL** fields.
This form must be emailed to Mary Padget at padget@purdue.edu and
Heather Trueblood at htrueblo@purdue.edu **by July 30, 2015.**
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

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 (presented November 2014 at IEEE VAST) 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.

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

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 |

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)

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 optimization of the computation to assign cases to nearest stations measured by the coastline avoidant distances instead of the straight distances. Finding the nearest station for every case is a time consuming process. The optimization algorithm proposes a spatial structure to organize cases so that cases that are close to each other will share the same nearest station finding process. The optimization also propose a spatial structure to organize stations to speed up the nearest station finding process.

Some 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.

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).

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

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

* Thomas Rader

* 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

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.

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

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

128

University

of

North Carolina

at Charlotte

VACCINE Annual Report – Year 6

Please complete **ALL** fields.
This form must be emailed to Mary Padget at padget@purdue.edu and
Heather Trueblood at htrueblo@purdue.edu **by July 30, 2015.**
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, financial analytics, 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
X	Undergraduate and Graduate Education Program
X	Professional Education and In-Service Programs
	N/A

VACCINE Annual Report – Year 6

Please complete **ALL** fields.
This form must be emailed to Mary Padget at padget@purdue.edu and
Heather Trueblood at htrueblo@purdue.edu **by July 30, 2015.**
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, UNC Charlotte, Computer Science

Thomas Kraft, UNC Charlotte, Computer Science

David Burlinson, UNC Charlotte, 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 have been developed to build 3D routing networks for large buildings on the fly without CAD data or architectural plans. 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 6

 Please complete **ALL** fields.
This form must be emailed to Mary Padget at padget@purdue.edu and
Heather Trueblood at htrueblo@purdue.edu **by July 30, 2015.**
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
	Other:

Nature of Research

	Applied
	Basic
	Consultation
X	Coordination/Integration
	Education
X	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. Consultation on tools with Charlotte Mecklenburg EMS.
- New tools for rapid creation of 3D routes in buildings using on-hand materials (e.g., evacuation maps).
- 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 6
 Please complete **ALL** fields.
This form must be emailed to Mary Padget at padget@purdue.edu and
Heather Trueblood at htrueblo@purdue.edu **by July 30, 2015.**
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)

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 new capability to rapidly create 3D routes in buildings has been developed. This capability uses a mobile (iPad) interface plus on-hand materials (e.g., posted evacuation plans). This substantially augments our previous 3D route creation plan, which uses CAD files or architectural plans (which may not be available and also require post-processing).

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. Visual interfaces in use include desktop, laptop, and mobile (iPad). The modeling system then provides delayed but more accurate and detailed simulations as directed by the visual interface.

A partnership with the Electric Power Research Institute (EPRI) has begun. The main focus is to develop a situationally aware control and analysis system for the distribution system of the future (DSOF). The DSOF will be very sensor-rich with new opportunities to analyze and control at all levels (including at the home or business site). Our critical infrastructure work contributes to this work. We will be setting up to respond to the effects of large storms. The new sensor data will give us data to extend our critical infrastructure model deep into the distribution system and to prepare for response under the DSOF. Funding from the Department of Energy and other sources is being sought.

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

William Ribarsky and Wenwen Dou, $150,000 Army Research Office, through May 14, 2016.

Wenwen Dou and William Ribarsky, $59,000, NIH, through August 31, 2015.

William Tolone, William Ribarsky, Wenwen Dou, and Xiaoyu Wang, USSOCOM, $300,000 so far through March, 2015. A substantial longer term project is being planned.

William Ribarsky, $20,000, EPRI, through September 30, 2015.

Please complete **ALL** fields.
This form must be emailed to Mary Padget at padget@purdue.edu and
Heather Trueblood at htrueblo@purdue.edu **by July 30, 2015.**
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, University of Maryland, elm@umd.edu
Shaun Kennedy, University of Minnesota, Shaun.Kennedy@ncfpd.umn.edu
Chris Sechrest, Duke Energy, Chris.Sechrest@duke-energy.com
Kelly Gaither, U. Texas, kelly@tacc.utexas.edu
Douglas Dorr, EPRI, ddorr@epri.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.

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

Jon Studnek, Charlotte-Mecklenburg Emergency Management System, jonst@medic911.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).

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

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 6

Please complete **ALL** fields.
This form must be emailed to Mary Padget at padget@purdue.edu and
Heather Trueblood at htrueblo@purdue.edu **by July 30, 2015.**
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. Shehzad Afzal, Isaac Cho, Calvin Yau, Junghoon Chae, Sungahn Ko, Abish Malik, Kaethe Beck, William Ribarsky, and David Ebert. Anomaly Exploration and Visual Analytics of Financial Data. Submitted to IEEE VAST 2015.
2. Todd Eaglin, Xiaoyu Wang, and William Ribarsky. Interactive Visual Analytics in Support of Image-Encoded LIDAR Analysis. Submitted to IEEE Symposium on Large Data Analysis and Visualization (LDAV 2015).
3. Shehzad Afzal, Isaac Cho, et al. A Survey of Visual Analysis Approaches for Financial Data Exploration. Submitted to IEEE Transaction on Visualization and Computer Graphics.

Accepted:
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, Xiaoyu Wang, William Ribarsky, and William Tolone. Ensemble Visual Analysis Architecture with High Mobility for Large-Scale Critical Infrastructure Simulations. IS&T/SPIE VDA 2015, Vol.9397-3, pp. 1-15.
3. Wenwen Dou, Li Yu, Thomas Kraft, William Ribarsky, and Xiaoyu Wang. DemographicVis: Analyzing Demographic Information based on User Generated Content. To be published. IEEE VAST 2015.
4. 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. IEEE Transactions on Visualization and Computer Graphics (IEEE VAST, November, 2014), 20(12), pp. 1853-1862.

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. Invited speaker, "Solved Problems in Visualization," IEEE VIS 2015 Panel.

Patents/Copyrights (List names)

Applications:

Awarded:

VACCINE Annual Report – Year 6

Please complete **ALL** fields.
This form must be emailed to Mary Padget at padget@purdue.edu and
Heather Trueblood at htrueblo@purdue.edu **by July 30, 2015.**
If any item does not apply to your project, please indicate "NA" under the heading.

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. 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 developed a new capability to rapidly create 3D routes in buildings has been developed. This capability uses a mobile (iPad) interface plus on-hand materials (e.g., posted evacuation plans). This substantially augments our previous 3D route creation plan, which uses CAD files or architectural plans (which may not be available and also require post-processing).

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. These data plus the critical infrastructure modeling environment are now being used on a new project with EPRI to create capabilities for the distribution system of the future.
- We have written joint papers on the collaborations with German and American VASA partners.
- 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 an MS Degree in Data Science and Business Analytics (launched 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.