

BTI Institute

Borders • Trade • Immigration

A Department of Homeland Security Center of Excellence

Lead Institution: University of Houston

Work Plan – Year 3
October 30, 2017

TABLE OF CONTENTS

A. INTRODUCTION	5
A.1. Mission	5
A.2 Vision	5
A.3. Research and Education Themes	6
A.3.a. Research Themes	6
A.3.b. Education Themes.....	6
B. PERSONNEL	6
B.1. Liaisons	10
C. COMMITTEES & COUNCILS	11
C.1 Research Committee	11
C.2 Transnational Trade & Supply Chain Management Council	12
C.3 Council of Territories	12
D. WORKING GROUPS	12
D.1. BTI Fellows	12
D.2. Border Security Unmanned Aerial Systems Working Group	13
D.3. Tunnel Detection Working Group	14
E. EXTERNAL ADVISORY BOARD	15
F. INSTITUTE MANAGEMENT ACTIVITIES	16
F.1. Tasks	16
F.2. Milestones	17
F.3. Outputs	18
F.4. Performance Metrics	18
G. PROJECT MANAGEMENT ACTIVITIES	21
G.1. Tasks	21
G.2. Milestones	22
G.3. Outputs	22
G.4. Performance Metrics	22
H. Training and Workforce Development	23
H.1. Training and Workforce Development Initiatives	23
H.1.a. Tasks.....	23
H.1.b. Tasks Contingent on Funding.....	24
H.1.c. Milestones	24
H.1.d. Outputs.....	24

H.1.e. Performance Metrics	25
H.2. Continuity of Operations (COOP) Train-the-Trainer Courses	25
H.2.a. Tasks.....	26
H.2.b. Milestones	27
H.2.c. Outputs	27
H.2.d. Performance Metrics	27
I. Transition Strategy	28
I.1. Transition Team.....	28
I.2 Phase 1 – Pre-Award	29
I.3. Phase 2 – Performance Period	31
I.4. Phase 3 – Post Award	32
I.5. Phase 4 - Transition Plan Development/Approval.....	32
I.6. Phase 5 - Implementation	33
I.7. Assessment of the Transition Process	33
J. Research Development.....	33
J.1 RFP	34
J.2 Process to Identify and Compete New Projects of Interest.....	35
J.2.a BTI Institute Stakeholder Engagement	35
J.2.b White Papers.....	36
J.2.c Project Funding	36
J.3 Process to Reallocate Project Funding.....	36
J.4. DHS Grant to Prepare Communities for a Complex Coordinated Terrorist Attacks (CCTA).....	37
L. MEDIA AND COMMUNICATIONS	38
L.1. Tasks	39
L.2. Milestones.....	41
L.3. Outputs	42
L.4. Performance Metrics	43
M. BTI Institute Speakers Program	43
N. BTI INSTITUTE PROJECTS	44
Central America’s Immigrant and Refugee Crisis: Limiting Unauthorized Migration through the Alliance for Prosperity and Reintegration Efforts	45
Uncovering Human Smuggling Patterns from Guatemala to the U.S.	57
Security Technologies Kitchen (STK)	64
Homeland Security Symposium Series	69

Image and Video Person Identification in an Operational Environment.....	76
A Systematic Process for Vulnerability Assessment of Biometric Systems at Borders	81
Modeling Methodology and Simulation of Port-of-Entry Systems.....	89
Modeling International Migrant Flows: Theory, Evidence and Forecasts	96
Missed Detections: From Data to Actionable Estimates	108
Participatory Operational Assessment (POA): evaluating and predicting the operational effectiveness of Cargo Security Processes at Ports of Entry	122
Secure and transparent cargo supply chain: enabling chain-of-custody with economical and privacy respecting biometrics, and blockchain technology	135
The Impact of Central American Child and Family Migration on U.S. Communities	152
Appendices	166
Appendix 1. White Paper.....	166
Appendix 2. Significant Activities Y3.....	168

A. INTRODUCTION

This document describes the work plan for the Borders, Trade, and Immigration (BTI) Institute for Budget Period III (7/1/2017 – 6/30/2018). The specific source of funding (CRADA or University of Houston) for personnel is described in the accompanying budget document.

The BTI Institute has been funded to “conduct research and education to enhance the Nation’s ability to support DHS and other agencies’ border security and immigration mission goals, including securing the border; facilitating lawful international trade and travel; effectively enforcing our immigration and customs laws; granting immigration and citizenship benefits; promoting an awareness and understanding of citizenship; and ensuring the integrity of our immigration system”.¹ The overarching goal of the Institute will be to “address the nation’s challenges as they relate to border control, customs, trade and travel facilitation, security and enforcement”.²

These areas are unified and systematized via the metaphor of *transnational flows*, i.e., the movement of people and goods across borders. The BTI Institute aims to develop knowledge and understanding of all different aspects that characterize this transnational flow, and to disseminate this knowledge within the homeland security enterprise (HSE). The ultimate goal is to enhance the ability of DHS stakeholders to perform in accordance with their mission and directives, while simultaneously advancing and evolving basic scientific understanding.

The primary purpose of the BTI Institute is to transform the study of translational flows to promote social, cultural, and economic development. The BTI Institute views security and facilitation as two sides of the same coin, and they are both integral to its approach. Similarly, policy and technology are intertwined in the BTI Institute’s approach. Policy decisions need to be driven by data analysis, and the impact of policies needs to be assessed through simulations and a systems approach. On the other hand, we often witness advancements in technologies when policy development is lagging behind. Thus, policy and technology are engaged in a feedback cycle. This approach is multi-disciplinary, problem-driven, and university-based, grounded in academic excellence. It is guided by the Core Values of Excellence, Impact, Integrity, Leadership, Respect, and Teamwork.

A.1. Mission

The BTI Institute’s mission is to conduct research, develop innovative solutions, and provide educational materials to enhance the nation’s ability to secure our borders, facilitate legitimate trade and travel, and ensure the integrity of our immigration system.

Through a multi-disciplinary team of national and international experts, the BTI Institute will deliver transformational technology-driven solutions, data-informed policies, and professional development opportunities for today’s Homeland Security Enterprise, and trans-disciplinary education for the next generation of homeland security experts.

A.2 Vision

The BTI Institute’s vision is to strengthen homeland security, social, and economic development as a world leader in research and education for transnational flows.

¹ FOA Number [DHS-14-ST-061-COE-002A](#), p. 10.

² FOA Number [DHS-14-ST-061-COE-002A](#), p. 11

A.3. Research and Education Themes

A.3.a. Research Themes

THEME 1. Enhance the U.S. Border Management Operations

- Promote International Partnerships for Prevention, Deterrence and Facilitation
- Improve the ability to prevent, deter, and counter the illegal activities of Transnational Criminal Organizations (TCOs)
- Improve the safety, efficiency and operational effectiveness of U.S. Border Operations

THEME 2. Enhance the Ability to Secure and Facilitate Transnational Flows of People

- Promote Prevention and Deterrence of Unauthorized Transnational Flows of People
- Facilitate Legitimate Travel

THEME 3. Enhance the Ability to Secure and Facilitate Transnational Flows of Goods

- Promote Deterrence of Unauthorized Transnational Flows of Goods
- Facilitate Legitimate Trade

THEME 4: Enhance the Ability to Promote the Integrity of the Immigration System within the U.S. Border

- Improve the understanding of the characteristics of the immigrant population in the U.S
- Improve the understanding of economic and societal impact of the immigrant population in the U.S
- Promote best practices in the administration of immigration
- Promote Immigrant Integration

THEME 5: Enhance the Ability to Secure and Facilitate Transnational Flows of Data and Financial Capital

- Promote Prevention and Deterrence of Unauthorized Transnational Flows of Data and Financial Capital
- Facilitate Transnational Flows of Data and Financial Capital

A.3.b. Education Themes

THEME 1: HSE Education

THEME 2: HSE Training

THEME 3: HSE Professional Development

B. PERSONNEL

This section lists the BTI Institute's personnel, their responsibilities, performance plans, percentage of effort, and expected outcomes for the forthcoming year. The percentage of funding of individual positions by DHS and the University of Houston is denoted in the BTI Institute's budget.

Director/PI: Ioannis A. Kakadiaris

The Director has overall technical and operational responsibility for this award, and chairs the BTI Institute's Research Committee. The Director actively engages DHS leadership, provides presentations, reports, and periodic updates to agency leadership, and builds close professional

relationships with agency executives and senior representatives from Customs and Border Protection, Immigration and Customs Enforcement, U.S Citizenship and Immigration Services, DHS Office of Biometric Identity Management, U.S. Coast Guard, and Transportation Security Administration, and other Department of Homeland Security and Department of Justice agencies and offices.

The Director is responsible for everything that occurs or fails to occur in ensuring the successful outcome of research and educational projects. The Director will participate in project kick-off meetings, assist in the engagement of project champions, review work plans, transition plans, progress reports, and annual reports. The Director will provide timely guidance and facilitate the support of BTI Institute staff and partner institutions to ensure an appropriate mix of interdisciplinary skill sets and partners to ensure the success of the research project.

Due to his acknowledged expertise and achievements in the area of biometric research, the Director will be an active participant in the CBP’s efforts in biometrics - assessing projects and initiatives, and providing recommendations. The Director will be responsible for the submission of no less than three proposals for biometrics research during this Work Year.

Associate Director, Project Management: Ioannis Konstantinidis

The BTI Institute’s Associate Director, Program Management, oversees the planning and administration of the Institute according to the strategic direction set by the leadership of the BTI Institute. He oversees, coordinates, and implements management activities related to annual work plan development, execution, and reporting. He also manages the Institute’s process for selecting and awarding new partners. The Associate Director assists the Research and Transition Committee in project management.

Associate Director, Project Management Projected Division of Effort – Y3 Work Plan		
%	Activity	Notes
16.6%	Research Development	Funded by UH funds
13.4%	Planning	
40%	Project Management	
20%	Reporting	
10%	Supporting Research and Transition Committees	

Executive Director, Strategic Partnerships: Kevin Clement

The Executive Director, Strategic Partnerships, plans, coordinates and conducts outreach to BTI Institute stakeholders at the federal, state, tribal, territorial and local stakeholders. He promotes the BTI Institute as a valued resource and highlights the Institute’s capabilities, capacity, and potential through direct contact, formation of relevant advisory committees, the creation/conduct of presentations, speeches, training, and webinars delivered at various conferences, symposiums, meetings, and events. He oversees the planning, coordination and conduct of BTI Institute events and communication efforts. The Executive Director, Strategic Partnerships is responsible for completing activities in accordance with specified objectives, as described in Sections K. Note: This position is funded by the University of Houston.

Executive Director, Strategic Partnerships Projected Division of Effort – Y3 Work Plan		
%	Activity	Notes
35%	Outreach / Stakeholder Engagement	
10%	Project Development	
10%	Planning <ul style="list-style-type: none"> - Events - Work Plan 4 	
10%	Project Management <ul style="list-style-type: none"> - CCTA Grant - Border Security UAS Working Group - Tunnel Detection Working Group 	
10%	Transition Team	
15%	Project: Unified Response to Complex Coordinated Terrorist Attack (SETRPC)	
5%	Communications	
5%	Instruction	

Program Director of Workforce and Education Initiatives: Tiffany Roosa

The Program Director of Workforce and Education Initiatives develops, coordinates, and implements workforce training and education opportunities to meet current and future HSE training needs. The Program Director is responsible for completing activities in accordance with specified objectives, as described in Sections H.1. Note: This position is funded by the University of Houston.

Program Director, Education and Workforce Development Initiatives Projected Division of Effort - Y3 Work Plan		
%	Activity	Notes
20%	Workforce Development Initiatives	
10%	Professional Development Initiatives	
25%	Executive Program Initiatives	
10%	Assessment	
25%	Proposal Development	
5%	BTI Student Summer Research Fellows	
5%	Summer Research Program	

Manager, Communications-Operations: (TBN)

The Manager, Communications-Operations leads the BTI Institute’s Communications Team. In coordination with the Communications Advisor, the Manager, Communications-Operations will implement the communications strategy for the BTI Institute (website, social media, print materials, photography, and videography), as described in Sections H.2 and L. Additionally, this individual assists in the planning, coordination and conduct of Institute events to include scheduled visits, meetings of the Executive Advisory Board, conferences, orientations, seminars, and workshops.

**Manager, Communications / Operations
Projected Division of Effort – Y3 Work Plan**

%	Activity	Notes
60%	Communications	Half of it Funded by UH funds
10%	Special Event Planning	Funded by UH funds
16.7%	Operations	Funded by UH funds
10%	Outreach / Stakeholder Engagement (Port Security and Coastal)	Funded by UH funds
3.3%	Request For Proposals	

Media and Communications Advisor: Lan Ni

The Media and Communications Advisor serves as an advisor to the BTI Institute’s Leadership and the BTI Institute’s Manager for Communications/Operations in all aspects of strategic communications, including planning, implementation, and measurement of activities to promote the Institute’s mission, research, and initiatives to key stakeholders. The Media and Communications Advisor oversees the BTI Institute’s website, media outreach, works with the Director and staff (in particular the Communications Manager) to develop and execute a digital dissemination strategy, as well as serves as a liaison to promote and advance the Institute’s brand and reputation, as described in Section L.

Communications Advisor Projected Division of Effort – Y3 Work Plan		
%	Activity	Notes
40%	Strategic Communications	
20%	Electronic Media operations	
20%	Social Media outreach	
5%	Request For Proposals	
15%	Liaison to UH and community	

Website Support Specialist: TBN

The Website Support Specialist is employed part-time to provide support for the BTI Institute web site.

Program Manager, Special Projects: (TBN)

The primary focus for the BTI Institute’s Program Manager is project management and development. This position oversees the Institute’s Distinguished Speakers Program, Prevention of Human Trafficking Initiative, special events, and other special projects. Management of the Request for Proposals (RFP) process includes initiating scientific review for all submissions; coordinating with the Research & Transition Committee, the Associate Director of Program Management, and the Director of the BTI Institute on activities and reporting; managing documented progress of projects; and preparing documentation for submission. This individual collaborates with the Executive Director of Strategic Partnerships and the Manager, Communication/Operations on outreach and stakeholder engagement and communications

activities including submissions for weekly/monthly updates and quarterly newsletters. The Program Manager develops, implements and maintains appropriate policies and procedures, assists with preparation of the annual Work Plan, and is tasked with preparing the BTI Institute's Annual Report. Additionally, the Program Manager assists in outreach to the Territorial Council. Note: This position is funded by the University of Houston.

Program Manager, Special Projects Projected Division of Effort – Y3 Work Plan		
%	Activity	Notes
35%	Project Management - Distinguished Speakers Program - Prevention of Human Trafficking Initiative - Special Events Special Projects	
25%	Research Development - RFP - Development of Concept Papers - Regularly Scheduled Reports	
25%	Planning - Lead the Annual Report Preparation - Assist on Work Plan	
10%	Outreach / Stakeholder Engagement (Territorial Council)	
5%	Communications	

Program Director of Business Operations and Administration: Rachel Brownlie

The Program Director of Business Operations and Administration manages employee travel, contracts, personnel actions, financial transactions, budget, and event scheduling in support of BTI Institute activities.

Director, Business Operations and Administration Projected Division of Effort – Y3 Work Plan		
%	Activity	Notes
25%	Program Management	
20%	Fiscal Management – procurement, monitoring expenditures	
15%	Contract development, implementation, maintenance	
10%	Travel Management	
15%	Policies & Procedures development, implementation, maintenance	
6.7%	Events Planning	

B.1. Liaisons

- BTI Institute Liaison to UH: Mary Ann Ottinger, Associate Vice President for Research (UH)
- BTI Institute Liaison to DHS Grants Office: Beverly Rymer, Executive Director, Office of Contracts and Grants (UH)

- BTI Institute Liaison to the UH Innovation Eco-System : Mark Clarke, Associate Provost, Faculty Development and Faculty Affairs (UH)

C. COMMITTEES & COUNCILS

C.1 Research Committee

The BTI Research Committee as a body will be responsible for providing input on the quality and promise of incoming projects, recommending improvements where possible. Once the projects commence, the Research Committee will monitor research progress through three mechanisms: deliverable sharing via an online platform; quarterly and annual reports; and quality tracking of resulting peer-review publications. Based on these monitoring mechanisms, the Research Committee members intervene where necessary during the course of the budget year to steer R&D on a productive path. The Research Committee members also prepare annual project evaluations and recommendations that are submitted to the BTI Institute governing bodies.

BTI Research Committee Members:

- Ioannis Pavlidis (UH)
 - Project: A Systematic Process for Vulnerability Assessment of Biometric Systems at Borders (Cukic – University of North Carolina-Charlotte)
 - Project: Image and Video Person Identification in an Operational Environment (Kakadiaris – University of Houston)
 - Project: Modeling Methodology and Simulation of Port-of-Entry Systems (Melamed – Rutgers Business School)
 - Security Technologies Kitchen (Shah – University of Houston)
- Shishir Shah (UH)
 - Project: Missed Detections: From Data to Actionable Estimates (Egan – CCICADA)
 - Project: Modeling International Migrant Flows: Theory, Evidence and Forecasts (Leblang – University of Virginia)
 - Project: Secure and Transparent Cargo Supply Chain: Enabling Chain-of-Custody with Economical and Privacy Respecting Biometrics, and Blockchain Technology (Shi – University of Houston and Texas A&M University)
 - Project: Participatory Technology Assessment (PTA): Evaluating and Predicting the Operational Effectiveness of Cargo Security Technologies (Burns – University of Houston)
 - Project: Homeland Security Series (Manjarrez – University of Texas – El Paso)
- Luis R. Torres (UH)
 - Project: Central America’s Immigrant and Refugee Crisis: Limiting Unauthorized Migration through the Alliance for Prosperity and Reintegration Efforts (Capps – Migration Policy Institute)
 - Project: The Impact of Central American Child and Family Migration on U.S. Communities (Hershberg – American University/University of Houston)
 - Project: Uncovering Human Smuggling Patterns from Guatemala to the U.S. (Hale – Voir Dire)

Member, Research Committee Projected Division of Effort – Y3 Work Plan		
%	Activity	Notes
60%	Project Review	

	<ul style="list-style-type: none"> - Review of Project Reports - Conduct Quarterly Reviews 	
25%	Reports <ul style="list-style-type: none"> - Annual Project Evaluations and Recommendations 	
15%	Communications <ul style="list-style-type: none"> - Provide input for newsletter, social media 	

The BTI Institute’s Research Committee provides feedback on the formulation of Project Principal Investigator (PPI) work plans in advance of the OUP Program Manager review. It will ensure that the PPIs’ work plans clearly identify a Homeland Security Enterprise problem or need. It may also assist in identification of a project Champion, and committed customer(s) and end-users.

The BTI Research Committee also convenes when new projects are approved to facilitate the onboarding process. In this effort, the Research Committee may help to identify potential issues and ensure that the PPI is adequately supported by the BTI Institute staff and the offices of the University of Houston and its partner institutions (e.g., university technology transfer offices, sponsored research offices, communications, etc.) necessary to achieve the project’s research objectives. The Research Committee reviews work plans, and provides feedback to the PPIs on stakeholder engagement, logic model development (tasks, milestones, outputs) and meaningful performance metrics.

The Research Committee is also decisively involved in advising and ensuring that the project’s transition plan, developed as an integral part of the project work plan, identifies a proposed transition pathway, and identifies the manner (mechanisms) and timing of engagement throughout the project by the PPI and staff with the project Champion, potential customers and active end-users.

C.2 Transnational Trade & Supply Chain Management Council

In 2018, the BTI Institute will form an Advisory Council on International Trade consisting of both public and private stakeholders with the intent to establish subcommittees in the domains of air, land, sea.

C.3 Council of Territories

The BTI Institute has established contacts with each of the territories of American Samoa, Guam, Northern Marianas, Puerto Rico and the U.S. Virgin Islands to discern their issues and needs in regard to border security, immigration and international trade. The variances in time zones precludes telecoms that include all members. The BTI Institute will continue to maintain contact with each of the territories individually and host an annual meeting of the territorial representatives at the National Homeland Security Conference.

D. WORKING GROUPS

D.1. BTI Fellows

The BTI Institute enlists the support of highly experienced and eminently qualified subject matter experts, over a wide spectrum of interests related to border security, trade, and immigration, in order to expand the Institute’s capabilities and capacity. Enacted in 2017, the BTI Fellows Program supports research, planning, and training initiatives – helping to ensure the BTI Institute’s ready access to an appropriate mix of interdisciplinary skill sets. Current BTI Fellows provide expertise in border security, transnational criminal organizations, violent gangs, homeland security investigations, cybersecurity, block chain technologies, intelligence analysis, red

teaming, US Coast Guard and aviation operations; and operational and strategic planning. BTI Fellows are not full-time staff. Based on their expertise, BTI Fellows may be engaged to work on BTI Institute projects as needed.

D.2. Border Security Unmanned Aerial Systems Working Group

In May 2017, the BTI Institute formed the Border Security Unmanned Aerial Systems (UAS) Working Group, consisting of representatives from: Customs and Border Protection, the U.S. Coast Guard, US Marshals Service, Federal Aviation Administration, the Texas Military Department, Texas Department of Public Safety (Aviation Division), and researchers from the following DHS Centers of Excellence: the BTI Institute, CREATE, National Consortium for the Study of Terrorism and Responses to Terrorism (START), Critical Infrastructure Resilience Institute (CIRI), and the Coastal Resilience Center. Also represented are the Combating Terrorism Center (United States Military Academy) and the Lone Star UAS Center of Excellence (Texas A&M).

The Border-Security UAS Working Group will meet on a bi-monthly basis.

Its purpose is to collectively address UAS policies and technology-related concerns for operations in border regions and develop strategies based on:

- Education of consumers and the law enforcement community
- Compliance with federal and state guidelines through improved information capabilities
- Evaluation of counter-drone technology to help minimize their use in illegal activities and their impact on security and safety of communities and facilities in the border and coastal regions

The Border Security UAS Working Group's initial objectives are to:

- Research new applications for UAS and adapt them for use in law enforcement and border security activities
- Promote the U.S.-Mexico border region as a test bed for UAS technology in border security and law enforcement operations
- Explore tactical and technological developments in counter-drone technology to prevent illegal use of UAS by Transnational Criminal Organizations (TCOs)
- Educate law enforcement partners on laws and regulations regarding safe and lawful operation of UAS, and
- Develop UAS tactics and applications for integration in future operational and strategic planning efforts.

Desired Outcomes. The Border Security UAS Working Group works to address federal state, and local law enforcement and border security issues surrounding the employment of Unmanned Aerial Systems

- Encourage development of UAS systems for homeland security, law enforcement, and emergency management missions for the U.S. border and coastal regions.
- Establish controls and procedures for the use of UAS systems by federal, state, tribal, territorial and local law enforcement in the border and coastal regions of the United States
- Develop counter-drone technology to help maximize homeland security, intelligence, and law enforcement capabilities against their use by cartels and criminal organizations

To date, as a result of the UAS Working Group, the BTI Institute has developed problem statements and concept papers for related research and the development of:

- **UAS App.** This smart phone app is designed to assist in the reporting of UAS in border and coastal regions with additional application to unlawful drone intrusion to critical infrastructure. To facilitate the timeliness of the report, the app can be pre-programmed to provide the name, agency, and contact information of the reporting individual. Similarly, the app will be pre-programmed to send information to specified fusion centers, agency headquarters, regional Joint Operations and Intelligence Centers, and other agencies. The operator can use a smart phone to photograph and/or videotape the drone, rapidly answer questions posed by the app which are designed to assist in providing an accurate and detailed Suspicious Activity Report prior to “send”. Through the camera’s GPS positioning system and camera aspect, analysts will then be able to estimate distance from the observer and the geographical flight path of the aerial drone.
- **UAS Data Base.** Based on the Department of Defense’s experience in Iraq and Afghanistan, the BTI Institute forecasts a need for a national data base that identifies commercial-off-the-shelf (COTS) drone technology. This data base would allow border security and law enforcement personnel ready access to a data base that identifies and provides photos of commercial UAS systems, their capabilities, reported use and noted adaptations.
- **UAS Surveillance Program for a Defined Geographic Area.** Develop a software program that employs multiple drones and geo-fencing to provide day and night surveillance and monitoring of a defined geographic area. When illegal activity is discerned, use the drones’ camera capabilities to maintain visual contact while guiding Border Patrol agents to the subjects.

Note: Each of the three aforementioned projects, while requested, has not yet been approved for funding. Upon confirmation of funding, the BTI Institute’s designated PI will finalize project tasks, milestones, and deliverables.

D.3. Tunnel Detection Working Group

In June 2017, the BTI Institute began formation of a Tunnel Detection Working Group consisting of representatives from Customs and Border Protection, the South West Border Sheriffs’ Coalition and the Department of Defense. Also invited to participate are researchers from CREATE, START, and the Combatting Terrorism Center (United States Military Academy). Following its inaugural meeting slated for July 2017, the Tunnel Detection Working Group will meet every two months.

Purpose. The Tunnel Detection Working Group serves to: *“Promote, through research, the development of technology to detect tunnels currently in existence and the construction of new tunnels so as to prevent their use by terrorist elements and criminal organizations seeking to gain illegal access to our nation.”*

The BTI Institute’s Tunnel Detection Working Group will identify tunnel detection issues raised by CBP and DEA, propose research strategies, explore existing related technologies and promote the application of emerging technology to develop reliable tunnel detection solutions.

The Tunnel Detection Working Group’s objectives are to:

- Identify research needs and opportunities for tunnel detection for border security and public safety activities
- Explore technical developments technology in mining and gas/oil exploration for adaptation/ use in tunnel detection operations

- Develop tactics and applications on the use of robotics in exploration of tunnels once detected
- Promote the U.S.-Mexico border region as a test bed for tunnel detection technology in border security and law enforcement operations
- Explore tunnel detection technology and tactics used by other nations

Desired Outcomes. The Tunnel Detection Working Group will refine its goals, objectives, and future performance metrics to aid in the effort to:

1. Promote the development of reliable tunnel detection technology and systems for homeland security and law enforcement missions in U.S. border regions
2. Advance research in robotics to create technical solutions to exploration of illegal tunnels that enhance the safety of homeland security and law enforcement officers
3. Enhance the ability to prevent the use of tunneling by terrorists and transnational criminal organizations.

E. EXTERNAL ADVISORY BOARD

The External Advisory Board serves to assist BTI Institute leaders in planning, research, technology and market development. As such its members work to: provide strategic advice to the Director, actively assist the BTI Institute in achieving its goals, provide links between the BTI Institute and its strategic and operational environment, act as a sounding board to BTI Institute leadership regarding development of the Institute, and enhance the visibility of the Institute nationwide. The BTI Institute is in the process of finalizing the charter for the EAB, and has secured the agreement of the Honorable Alan Bersin to serve as EAB Chair.

Alan Bersin served as Assistant Secretary for Policy & International Affairs and Chief Diplomatic Officer in the U.S. Department of Homeland Security (DHS). In those capacities, Bersin led and oversaw DHS's international engagement, served as the principal advisor to the Secretary in all matters pertaining to international affairs, and was responsible for leading the Department's strategic planning and policy formulation functions. Between 2012 and 2015, Bersin served as Vice President of INTERPOL for the Americas Region and as a member of the INTERPOL Executive Committee. He served through 2016 as Chair of the Advisory Committee for the International Policing Division Steering Committee of the International Association of Chiefs of Police (IACP).

The following distinguished individuals have agreed to serve as members of the EAB:

- David Aguilar, Former Commissioner of US Customs and Border Patrol
- Maria Luisa Boyce Director, Global Public Affairs
- Dane Egli Captain, US Coast Guard, (retired), Los Alamos Laboratory
- Joe Frank Martinez, Sheriff of Val Verde County Texas and Chair of the Southern Border Sheriffs' Coalition
- Gustavo Mohar Betancourt, Former Under Secretary of Secretaria de Gobernacion (Now in private consulting practice)
- Luc Portelance, Former President of the Canada Border Services Agency (CBSA) (Now in private consulting practice)
- Jonathan S. Spaner, McKinsey & Company, Public Sector Practice, Washington, DC

The External Advisory Board conducted its first plenary session and organizational meeting on June 27-28 in Houston.

Schedule of EAB meetings for Y3 is as follows:

September 13, 2017	Teleconference	4:30 PM ED/ST
November 13-14, 2017	Meeting	BTI Institute
January 25, 2018	Teleconference	4:30 PM ED/ST
April 18-19, 2018	Meeting	BTI Institute
July 26, 2018	Teleconference	4:30 PM ED/ST
October 24-25, 2018	Meeting	BTI Institute

F. INSTITUTE MANAGEMENT ACTIVITIES

The BTI Institute will administer tasks relating to the planning, execution, and reporting of BTI Institute activities. These activities include the Biennial Center Review by the COE Board of Directors (BoD) and the partnering with organizations selected via the RFP process. To safeguard the integrity of the RFP selection process, the BTI Institute will collaborate with other COEs to handle the review of proposals that present institutional conflicts of interest with the University of Houston.

F.1. Tasks

ID	Description	Responsibility	Effort Period
T.1	Work plan refinement for the project selected by DHS from RFP-17-01 submissions	Research Committee & Transition Team	07/17
T.2	Annual Report	Lead: Director Assist: Program Manager	07/17 - 08/17
T.3	Arrange External Scientific Review	Associate Director, Program Management	07/17 - 08/17
T.4	Biennial Review Preparation and Follow-up	Lead: Director; Assist: Executive Director, Strategic Partnerships; All	07/17 - 09/17
T.5	Conduct follow up on projects that are discontinued and/or revised.	Lead: Director, Assist: Associate Director, Program Management	11/17 – 12/17
T.5	Annual PI meeting	Lead: Associate Director, Program Management Assist: Program Manager & Communications Manager	07/17 - 10/17
T.6	Contract for project selected by DHS from RFP-17-01	Lead: UH Assist: Program Director of Business Operations and Administration	10/17

T.7	Work plan refinement for projects selected by DHS from RFP-17-02 submissions	Research Committee & Transition Team	10/17 - 11/17
T.8	Contracts for projects selected by DHS from RFP-17-02 submissions	Lead: UH Assist: Program Director of Business Operations and Administration	01/18
T.9	Annual OUP data call	Assoc. Director, Program Management	10/17 - 01/18
T.10	Work Plan Review and Recommendations for Y4	Research Committee & Transition Team	01/18 - 03/18
T.10	Annual Work Plan	Lead: Director Assist: Associate Director, Program Management	01/18 - 03/18
T.11	Prepare Feedback on BoD recommendations	Director	01/18
T.12	Preparations for issuing RFP-18-01	Lead: Associate Director, Program Management Assist: Program Manager & Communications Manager	04/18 - 05/18
T.13	Modifications to Annual Work Plan (based on BoD recommendations)	Lead: Director Assist: Associate Director, Program Management	01/18 - 03/18
T.14	BTI Director to embed in CBP Biometrics team during Year 3.	Director	9/18

F.2. Milestones

ID	Description	Achieved by
M.1	Submitted Annual Report	08/17
M.2	Submitted material for BoD biennial review of BTI	08/17
M.3	Annual PI meeting held	10/17
M.4	Submitted work plans for projects selected by DHS from RFP-17-01 & RFP-17-02 submissions	11/17
M.5	Responded to Annual OUP data call	01/18
M.6	Evaluate BTI Communications Strategy, Plan, and Activities	01/18
M.7	Annual Work Plan submitted	03/18
M.8	Modified Annual Work Plan submitted (based on BoD recommendations)	03/18
M.9	Feedback on BoD recommendations	04/18
M.10	RFP-18-01 issued	05/18

F.3. Outputs

ID	Description	Responsibility	Approval by
D.1	BTI Annual Report	Director	08/17
D.2	Annual Work Plan	Assoc. Director, PM	06/18
D.3	RFP-18-01 (announced by)	Associate Director, Program Management	06/18
D.4	Revised Annual Work Plan (based on Biennial Review outcomes)	Director	1/18
D.5	Develop three project proposals in biometrics to address challenges that complement existing efforts.	Director	6/18

F.4. Performance Metrics

ID	Description	COE Biennial Review Process	Quantitative Performance Target	Achieved by
P.1	BTI Institute engages with Federal, State, Territorial, Tribal, Local and private stakeholders	p. 8., q. 1	<ul style="list-style-type: none"> ▪ Federal stakeholders are offered opportunity to review and comment on Annual Work Plans <ul style="list-style-type: none"> - Annual Reports - Progress Reports - Transition Strategy & Project Transition Plans 	Ongoing
P.2	BTI Institute establishes strong, effective dialogue with PM, OUP and BoD		<ul style="list-style-type: none"> ▪ Director conducts weekly calls with the PM ▪ Yearly Work Plan is submitted on time, in proper format, and provides cogent information ▪ Annual Report is submitted on time, in proper format and provides required information 	Ongoing

			<ul style="list-style-type: none"> ▪ BTI Institute provides monthly report of activities 	
P.3	BTI Institute ensures the appropriate mix of disciplinary skill sets and partners needed to achieve research objectives	p. 8, q. 2	<ul style="list-style-type: none"> ▪ BTI Fellows are identified to address gaps in expertise and capabilities ▪ Work Plans are assessed to determine skill sets needed early in the project ▪ Partnerships established with institutions that expand BTI Institute expertise and capabilities 	Ongoing
P.4	BTI Institute has established meaningful partnerships with Minority Serving Institutions (MSI) to provide collaborative research opportunities for MSI faculty and students	p. 9, q. 5	<p>University of Houston; UNC-Charlotte; Rutgers Business School, Newark and New Brunswick; University of TX - El Paso are MSI</p> <ul style="list-style-type: none"> ▪ BTI Institute hosts DHS Summer Research Team from Norfolk State University (MSI) 	Ongoing
P.5	BTI Institute has established a transition strategy to ensure successful use of its research projects	p. 8, q. 3 p.10, q. 4	<ul style="list-style-type: none"> ▪ Transition Strategy is written and approved by OUP Project Manager ▪ Transition Strategy is coordinated with BTI Institute customers ▪ Comprehensive Transition Plans are developed for each project ▪ BTI Institute involves partners in implementation 	7/17 and Ongoing

			<ul style="list-style-type: none"> of its transition strategy ▪ # of Project Transition Plans that have transition agreements with end-users 	
P.6	BTI Institute regularly and actively collaborates on initiatives and research with other DHS Centers of Excellence and Federal Research Laboratories	p. 11, q. 4	<ul style="list-style-type: none"> ▪ # of projects and/or initiatives in which BTI Institute collaborates with other COE and Federal Research laboratories 	ongoing
P.7	BTI Institute has established a process for reallocation of funds from unproductive or less relevant projects	p.11, q. 5; p.12, q.7	<ul style="list-style-type: none"> ▪ Process is established and approved by OUP Project Manager ▪ Percentage of times funds were reallocated in accordance with process timelines 	7/17 and ongoing
P.8	The BTI Institute, in coordination with the OUP Program Manager and Board of Directors has established a prioritized list of unfunded research projects in the event funding becomes available	p.11, q. 5; p.12, q. 7	<ul style="list-style-type: none"> ▪ BTI Institute has on-hand a list of unfunded research projects, prioritized by the BTI Director in coordination with the OUP PM and BoD ▪ List is updated twice annually 	After approval of annual RFP and six months later
P.9	BTI Institute has an established methodology to identify and compete new projects of interest	p. 12, q. 8	<ul style="list-style-type: none"> ▪ Methodology is written and approved by OUP Project Manager 	7/17
P.10	BTI Institute has expanded its funding revenues through non-DHS grants		<ul style="list-style-type: none"> ▪ # of non-OUP grants/contracts received ▪ # of non-OUP projects funded through grants/contracts ▪ Amount of funds received annually 	6/18

			through non-OUP grants	
P.11	BTI Institute has expanded its funding revenues through non-OUP funding requests		<ul style="list-style-type: none"> ▪ # of funded projects through non-RFP funding requests ▪ Amount of funds received annually through non-OUP grants/contracts 	6/18
P.12	BTI Institute has expanded its funding revenues through non-DHS funded projects (state, territorial, tribal, local and private)		<ul style="list-style-type: none"> ▪ # of funded projects through non-OUP sources ▪ Amount of funds received annually through non-OUP sources 	6/18

G. PROJECT MANAGEMENT ACTIVITIES

A member of the Research Committee will be assigned overview of each BTI Institute project. The PPIs will provide to BTI Institute quarterly progress reports with updates documenting items such as progress in the tasks, milestone completion, transition planning, challenges encountered, and requests for assistance. The report should also include items such as the names of authorized project personnel and output (such as publications or degrees awarded).

The BTI Institute’s Research Committee will convene as a body to discuss the reports, evaluate the progress, and provide feedback and corrective action, if needed. Each report will be assigned a primary reader to lead the committee’s discussion during the meeting. The committee will meet with the PPI by teleconference three times a year, and provide written feedback. The BTI Institute’s Research Committee will also evaluate the effectiveness of stakeholder engagement strategy and transition planning so as to assist PPIs in developing a pathway to transition. Additionally, it will provide guidance and recommendations on how to improve performance metrics for project activities and manage personnel activities. The biennial management review criteria will be included in the evaluation rubric that the Research Committee will use.

In that capacity, Research Committee members will provide advice and guidance to the PPI in leveraging the capabilities of the University of Houston and the BTI Institute’s partner institutions in PPI tech transfer and commercialization efforts. The Research Committee will seek to engage relevant UH units (such as the Office of Intellectual Property Management, Center for Industrial Partnerships, Cyvia and Melvyn Wolff Center for Entrepreneurship) to assist the PPI and help ensure the success of the project.

Satisfactory progress is required in order to authorize payments. If the BTI Institute leadership deems that a PPI does not make substantial progress towards meeting the objectives set forth, the Director will notify the DHS Program Manager.

G.1. Tasks

ID	Description	Effort Period
T.1	Conduct teleconference with each PPI for Committee Review of project progress.	12/17;2/18;5/18

T.2	Conduct Committee Review of written project progress reports and provide feedback.	12/17;2/18;5/18
T.3	Provide recommendation on Concept Papers received by the BTI Institute	Ongoing, monthly

G.2. Milestones

ID	Description	Achieved by
M.1	Completion of Kick-Off Meetings for RFP 16-01 Projects approved by DHS	09/17
M.2	Revision of Project Management activities based on Biennial Review recommendations	12/17

G.3. Outputs

ID	Description	Completed by
D.1	Progress reports from project PPIs.	12/17;2/18;5/18
D.2	Written review reports to PPIs	12/17;2/18;5/18

G.4. Performance Metrics

ID	Description	COE Biennial Review Process	Quantitative Performance Target	Achieved by
P.1	Project description clearly addresses a knowledge gap identified as a Homeland Security Enterprise problem or need	p.7, q.2	% of BTI projects that clearly identify and document the knowledge gap identified as an HSE problem or need	6/18 and ongoing
P.2	Project Champion is identified and engaged		% of BTI projects with Program Champion identified	6/18 and ongoing
P.3	Project Champion signs off/approves the notional transition plan		% of BTI projects with Program Champion approval of notional transition plans	6/18 and ongoing
P.4	Concluded Project has an identified, committed customer	p.7 q1	Customer agrees to accept background papers, studies or analyses	6/18 and ongoing
P.5	Project has established meaningful performance metrics	p.7, q.1	Customer agrees with performance metrics	6/18 and ongoing
P.6	The Research Committee and designated research committee members are fully		Conduct of three (3) progress reviews BTI Institute policy of open communication	6/18 and ongoing

	and continuously engaged with the PPIs		# conference calls	
P.7	Research Committee assists PPIs in establishing project teams with optimal mix of interdisciplinary skill sets and partners		% of projects assessed for interdisciplinary skill sets and partners by the Research Committee	6/18 and ongoing
P.8	Transition Plan agreements in place for each concluding project		% of concluded BTI projects with Transition Plan agreements with customers	6/18 and ongoing

H. Training and Workforce Development

H.1. Training and Workforce Development Initiatives

The BTI Education and Workforce Development (EWD) Initiatives program director will develop and carry out the BTI Institute’s EWD work plan. The BTI Institute’s strategic EWD plan is designed with the primary goals (i) training, seminars and workshops critical to HSE, and (ii) establish a pathway for post-secondary students to pursue a career path with HSE. The BTI Institute is able to meet workforce training needs and support skill development with high quality, timely workforce development offerings to address critical needs of current HSE employees. The BTI Institute can build connections through educational course offerings, trainings, and internships to facilitate interest in HSE careers with post-secondary students. This activity will be led by the Program Director of Education and Workforce Development Initiatives.

The specific BTI Institute **objectives** will be to facilitate course development, course offerings, and internship programs. Engaging with HSE to provide opportunities that will directly benefit HSE, including the BTI Institute’s research and education activities, capabilities, and outputs that are tailored to their needs. Key strategies involve face-to-face workforce development courses that can be transitioned to online offerings. The purpose will be to strengthen the HSE relationship, support HSE employees, and develop a long-term relationship between HSE departments and agencies, and BTI Institute.

A major component aim will be to recruit and train current and future workforce participants in areas related to the BTI Institute’s mission. Through EWD, the BTI Institute will use a mixture of workforce development, and internship programs to educate audiences, especially those from diverse backgrounds, to engage in content areas and professional development related to HSE. Through these programs, the BTI Institute seeks to expand knowledge in the areas of HSE culture and operations, knowledge of borders, trade and immigration as well as joint border management related content, and leadership. This outreach is designed to motivate participants to pursue education, research, and career opportunities in HSE fields.

Another component of the EWD initiative is to expand the value that the BTI Institute brings to HSE through engagement of a post-secondary audience. The specific objective will be to increase awareness of issues across a variety of disciplines. The general strategies for this audience will be to develop academic courses related to borders, trade, and immigration as well as joint border management for degree seeking students. This will be accomplished through academic course development and offerings.

H.1.a. Tasks

ID	Description	Effort Period
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T.1	Develop Education and Workforce Goals (including success/failure criteria and metrics) for each quarter	07/17; 09/17; 12/17; 3/18; 6/18
T.2	Attend monthly education working group calls	Monthly
T.3	Summer Research Team Program	11/17 – 6/18
T.4	Student Summer Research Fellow	07/17; 08/17
T.5	Submit proposals in response to relevant RFP	As applicable
T.6	C-Level Training: Global Maritime Supply Chain Leadership	Multiple offerings
T.7	Develop and offer small Business training in Cyber Security and related topics	Ongoing
T.8	BS Course: Transnational Flows course development	Ongoing
T.9	Stackable certificates: concept paper	09/17
T.10	Certificate in Trade (concept draft)	09/17
T.11	Evaluation of training	Ongoing; 06/18

H.1.b. Tasks Contingent on Funding

ID	Description	Effort Period
T.12	Planning and Management training program (<i>contingent on funding</i>)	As applicable: 10/17; 11/17; 2/18
T.13	BTI Institute Facilitated Summer Internship Program (<i>contingent on funding</i>)	As applicable; 06/18
T.14	BTI Institute's Innovation Corps (<i>contingent on funding</i>)	As applicable; 04/18
T.15	COE Change Makers (<i>contingent on funding</i>)	As applicable
T.16	Sub-contract with CEEZAD for training course addressing Cross-Border Biological Threat Detection	As applicable

H.1.c. Milestones

ID	Description	Achieved by
M.1	Conduct of C-Level training course	11/17

H.1.d. Outputs

ID	Description	Completed by
D.1	C-Level course offering	11/17
D.2	Submit proposals in alignment with EWD	08/17; 06/18
D.3	Offer three security courses focused on SME	Development 08/17; offering: 11/17; 01/17; 03/18
D.4	Course development plan (stackable, trade)	03/18

H.1.e. Performance Metrics

ID	Description	Quantitative Performance Target	Achieved by
P.1	C-Level training	15 enrolled; 80% highly satisfied on logistic rating metrics	11/18
P.2	SME course offerings	10 enrolled per offering; three offerings	11/17; 01/17; 03/18
P.3	Proposal submission	Submit proposals in alignment with EWD initiatives	Ongoing
P.4	Develop course offering plans	Course development plan (stackable, trade, BS transnational)	07/17

H.2. Continuity of Operations (COOP) Train-the-Trainer Courses

In 2018, the BTI Institute will partner with FEMA Region 6 to deliver instruction in Continuity of Operations Training to requesting border and coastal regions. The BTI Institute received requests for this training from the South East Texas Regional Planning Commission, the Rio Grande Council of Governments, and the South Texas Development Council. This activity will be led by the Executive Director of Strategic Partnerships.

The requested COOP training will serve to establish a nucleus of FEMA-certified COOP trainers in each region from which Councils of Government can schedule additional training as required.

The BTI Institute will provide a two-person team of FEMA Master Continuity Practitioners (MCPs) to conduct the two-day FEMA E/L-548 *Continuity of Operations Training Program Manager Train-the-Trainer Course* and the three-day E/L-550 *Continuity of Operations Planner Train-the-Trainer Course*.

The schedule of COOP training is:

- Beaumont, Texas November 2017
- El Paso, Texas July 24-28, 2017
- Zapata, Texas September 25-29, 2017

Note: Training for the Southeast Regional Planning Commission in Beaumont, Texas began in June 2017 with the conduct of the *E/L-548 Continuity of Operations Training Program Manager Train-the-Trainer Course*. Due to Tropical Storm Cindy, the follow-on *E/L-550 Continuity of Operations Planner Train-the-Trainer Course* was postponed until November.

The COOP training is funded by the University of Houston.

H.2.a. Tasks

ID	Description	Responsibility	Effort Period
T.1	Present FEMA E/L-548 Course in El Paso, TX	Executive Director, Strategic Partnerships; BTI Fellow	7/24-25/17
T.2	Test E/L-548 Course Students in El Paso, TX	Executive Director, Strategic Partnerships; BTI Fellow	7/25/17
T.3	Present FEMA E/L-550 Course in El Paso, TX	Executive Director, Strategic Partnerships; BTI Fellow	7/26-28/17
T.4	Test E/L-548 Course Students in El Paso, TX	Executive Director, Strategic Partnerships; BTI Fellow	7/28/17
T.5	Submit Course Completion Report to FEMA Region 6	Executive Director, Strategic Partnerships; BTI Fellow	8/3/17
T.6	Present FEMA E/L-548 Course in Zapata, TX	Executive Director, Strategic Partnerships; BTI Fellow	9/25-26/17
T.7	Test E/L-548 Course Students in Zapata, TX	Executive Director, Strategic Partnerships; BTI Fellow	9/26/17
T.8	Present FEMA E/L-550 Course in Zapata, TX	Executive Director, Strategic Partnerships; BTI Fellow	9/27-29/17

T.9	Test E/L-548 Course Students in Zapata, TX	Executive Director, Strategic Partnerships; BTI Fellow	9/29/17
T.10	Submit Course Completion Report to FEMA Region 6	Executive Director, Strategic Partnerships; BTI Fellow	10/03/17

H.2.b. Milestones

ID	Description	Achieved by
M.1	Presented E/L 548 Train-the-Trainer Course (El Paso)	8/1/17
M.2	Presented E/L 550 Train-the-Trainer Course (El Paso)	8/1/17
M.3	Presented E/L 548 Train-the-Trainer Course (Zapata, TX)	10/1/17
M.4	Presented E/L 550 Train-the-Trainer Course (Zapata, TX)	10/1/17

H.2.c. Outputs

ID	Description	Responsibility	Completed by
D.1	Presented E/L 548 Train-the-Trainer Course (El Paso)	Executive Director, Strategic Partnerships; BTI Fellow	7/25/17
D.2	Presented E/L 550 Train-the-Trainer Course (El Paso)	Executive Director, Strategic Partnerships; BTI Fellow	7/28/17
D.3	Presented E/L 548 Train-the-Trainer Course (Zapata, TX)	Executive Director, Strategic Partnerships; BTI Fellow	9/26/17
D.4	Presented E/L 550 Train-the-Trainer Course (Zapata, TX)	Executive Director, Strategic Partnerships; BTI Fellow	9/19/17

H.2.d. Performance Metrics

ID	Description	Quantitative Performance Target	Achieved by
P. 1	Number of students who successfully complete the course of instruction	90 % of attendees successfully complete E.L-548 Train-the Trainer Course in El Paso	8/1/17
P. 2	Number of students who successfully complete the course of instruction	90 % of attendees successfully complete E.L-550 Train-the Trainer Course in El Paso	8/1/17
P. 3	Number of students who successfully complete the course of instruction	90 % of attendees successfully	10/1/17

		complete E.L-548 Train-the Trainer Course in Zapata	
P. 4	Number of students who successfully complete the course of instruction	90 % of attendees successfully complete E.L-550 Train-the Trainer Course in Zapata	10/1/17
P. 5	Course reports submitted to FEMA within 7 calendar days of course completion	100% of course reports are submitted properly within 7 calendar days of course completion	8/5/17 & 10/5/17

I. Transition Strategy

As per OUP, “Transition is defined as the process and eventual transfer of ownership and operation/maintenance of a product or system: Transfer of responsibility for a product or system from a research and development organization to a receiving activity, with subsequent integration of the product or system into the receiving activity’s operations. For purposes of this definition, the term "operations" can include any phase of an acquisition program, capability development, or equivalent.”

The transition strategy is a three-sided process driven by the Project Principal Investigator and assisted by the BTI Institute team, leveraging the resources of the University of Houston, and directly engaging with end-users in the DHS community to deliver pragmatic solutions for the near-term, the mid-term, and the long-term needs of the DHS. In general, there are five phases to transition:

- **Phase 1 – Pre-Award:** The transition team assists the PPI to develop a notional transition plan – an integral part of the project work plan.
- **Phase 2 – Performance Period:** Customer is identified and included in the briefings related to the project.
- **Phase 3 – Post Award:** Evaluation of the deliverables is performed to decide if transition is desired by the Customer.
- **Phase 4 - Transition Plan Development/Approval:** A viable transition plan for the Customer(s) is developed and approved, in consultation with the DHS Project Champion within the first year.
- **Phase 5 - Implementation:** Transition is undertaken by an entity decided by the customer.

I.1. Transition Team

Reflecting the three-sided structure of the transition strategy to ensure the continued advancement, timely adoption, and effective migration from research to use by the DHS community, each project will include representatives from the Project’s Principal Investigator (PPI) Organization, BTI Institute, and DHS as follows:

- PPI’s Organization
 - The principal investigator
 - Representative from the Technology Transfer Office of the PPI’s organization
 - Representative from the Communications Office of the PPI’s organization

- BTI Institute
 - BTI Institute’s Transition POC (Prof. Shishir Shah)
 - The BTI Institute’s Executive Director for Strategic Partnerships
 - Member of the BTI Institute’s Research Committee assigned oversight of the project
 - The BTI Institute’s Emerging Technologies Architect (TBN)
- Representative from UH’s Technology Transfer Office
 - Project Champion
 - Project Advocates
 - Customer’s Transition POC (beginning in Phase 4)

Note: The Transition Team is not limited to the agencies, organizations, and positions listed above. The BTI Institute may add partners and personnel to the Transition Team as necessary to ensure a successful transition of research to its customers.

I.2 Phase 1 – Pre-Award

During this phase, the BTI Institute forms a Transition Team to assist the PPI in an analysis of deliverables and the development of the work plan, of which the notional transition plan is an integral part.

Phase-1 Process:

Use-cases/needs: The transition team will assist the PPI in identification of specific use cases/needs. This includes the identified use-cases/needs as well as those masked, hidden, or compensated for by policy, doctrine, or practices. To facilitate the identification of the use-cases/needs, provide accurate metric-verifiable codification, and share across the transition team, the codified details of the use-cases/needs are seminal to the generation of the transition plan. In addition, using existing use-cases (through CGAP or acquisition documents like a CONOPS, or planning CONOPS) will be explored.

It should be recognized that, in this phase of transition plan development, the initial use-case/need may be eclipsed or integrated into an identified/discovered broader scope and scale of applicability. In turn, that may drive or shape the near-term, mid-term, and long-term transition plans and actual project development. The dogmatic pursuit of a single use-case/need solution, within the context of a greater potential application, should only be advocated as a near-term foundational/proof of concept prolegomena to a broader application of the solution.

Deliverables Analysis: The types of deliverables (tools, technology, software, knowledge product) are:

Deliverable type	Description
A: Algorithm	A computational science algorithm to perform a specified task

B: Brief	A report about an issue including detailed analysis and recommendations
Co: CONOPS	A document outlining a Concept of Operations
C: Course	The materials associated with an education or training offering
D: Dataset	A dataset to be used for the development, validation, and testing of an algorithm
H: Hardware Prototype	A hardware prototype designed to perform a specified action.
P: Publication (Conference or Journal)	A peer-reviewed publication in a scientific journal
Pr: Protocol	A protocol of operations
R: Report	A report about an issue including detailed
So: Software	Executable and source code
Su: Survey	A validated instrument to conduct a survey for a set of questions
V: Video	A video explaining to a lay person the problem being addressed, the solution and the impact of the solution.

During the pre-award work plan development process and during the continuation of work plan development processes, the PPI includes the answers to the following questions in the work plan:

- What is the nature of the deliverables?
- To what degree is the technology of the deliverables end-user / customer specific?
- Is the academic, industrial, or commercial environment of the technical context of the solution so volatile that a solution may be eclipsed or overtaken by evolutions in the specific or a parallel arena of development?
- What are the functional/operational requirements for the proposed deliverables as identified?
 - Are the functional/operational requirements unique to a specific end-user/customer or a spectrum of users?
 - Are there capability gaps, critical vulnerabilities that the end user may have articulated, but not yet refined into requirements
 - How does the work relate to initial requirements (these are pre-refined Operational Requirements that are basic agent statements with an initial level of analysis at a planning workshop; not yet to be considered as Operational Requirements)?
- Are there any technical, procedural, policy, or doctrinal dependencies that exist and would need to be modified, or would be required for the end-user to adopt/acquire to use the developed solution?
- Are there alternative technologies/ processes/methods/protocols/knowledge products that could address the requirements for solving the problem?
 - What methodology was employed to survey alternatives?
 - If they exist, what are their limitations/advantages?

- What is the comparative rate of development in the alternative technology, and is there potential for the proposed solution to be eclipsed or overtaken by the alternative technology?
- What are the means and methods used by the PPI to engage with PPI's organization's technology transfer office and communications office to leverage the capabilities and assets they represent, including:
 - Frequency and level of communication
 - Leveraging of existing contacts from the identified/discovered potential end-user(s)/customer(s) within the DHS community and allied communities
 - Partner COE, academic, industrial, and commercial contacts

Phase-1 Outcomes: PPI updates the work plan with detailed descriptions answering the questions from the deliverables analysis and the notional transition plan. It should be emphasized that the notional transition plan is a dynamic document subject to modification as dictated by changes in physical, geographic, and regulatory environments of the end-user(s)/customer(s) and new manifestations of use-cases/needs. The Project Principal Investigator, assisted by the BTI Transition Team, may amend/update the written notional transition plan over time. The work plan is approved by the Project Champion and OUP and contract is signed.

I.3. Phase 2 – Performance Period

During this phase, the transition team assists the PI to identify a customer for the project.

Phase-2 Process: All team members offer leads to the PPI and facilitate introductions. The DHS components function/operate across a broad spectrum of physical, geographic, and regulatory environments. Use-cases/needs identified for a specific user have a high probability of being applicable to components in the original form or with minimal modification. To ensure the greatest return on investment from DHS funds, resources, staffing, and time, the broadest possible user community must be identified, and should be included. *Customer Discovery:* Toward a comprehensive and accurate understanding of the potential customers for a project and the proposed deliverable, the user community including the DHS S&T program advocates, DHS agency advocates, DHS agency contact(s) for project acquisition, allied agency/community advocates/subject matter experts (external to the DHS, University of Houston, or BTI community), project champion(s), and potential end-user(s)/customer(s) should be surveyed with, at a minimum, the following questions:

- Who is/are the potential and most likely end-user(s)/customer(s) of proposed deliverables?
 - How, potentially, will the end-user(s)/customer(s) change in scale and scope across the near-term, mid-term, and long-term research, development, testing, and deployment of the project?
 - Are the deliverables scalable?
- What are the functional/operational requirements for the proposed deliverables as identified?
 - Are the functional/operational requirements specific to a specific end-user/customer or a spectrum of users?

- If there are significant conflicts between the optimal deliverable across a spectrum of potential end-users/customers, how will it be resolved?
- How is the optimal solution as prescribed by cost/time/resources defined?
- Are there any technical, procedural, policy, or doctrinal dependencies that exist and would need to be modified, or would be required for the end-user to adopt/acquire to use the developed solution?
- Are there alternative technologies/ processes/methods/protocols/knowledge products that could address the requirements for solving the problem?
 - What methodology was employed to survey alternatives?
 - If they exist, what are their limitations/advantages?
 - What is the comparative rate of development in the alternative technology, and is there a potential for the proposed solution to be eclipsed or overtaken by the alternative technology?

Phase-2 Outcomes: The PPI writes a memorandum of record for each potential customer documenting the interaction and its outcomes and identifies one or multiple customers for the specific project. Each potential customer offers a written commitment to participate in the development of an evaluation plan for the deliverables.

I.4. Phase 3 – Post Award

During this phase, the BTI Institute develops and implements an evaluation plan for the deliverables based on the customer use cases. The DHS Champion helps identify the: 1) Requirements Manager; 2) Program Manager; 3) Operational Sponsor.

Phase-3 Process: The BTI Institute team interviews the customer(s) to write the requirements for the specific need. BTI Institute invites the Champion to designate a Customer Transition POC. The BTI Institute performs an evaluation of the deliverables against the requirements and provides a report to the customer. Focus is placed on ensuring gaps, requirements and use cases are used to ensure and explain how the product can be evaluated against the initial problem.

Phase-3 Outcomes: The BTI Institute provides a written evaluation of deliverables to the Customer. The Customer(s) designates a Transition POC(s) to assist in the development of the specific Transition Plan. The Customer's Transition POC will have the responsibility/authority to approve the specific Transition Plan.

I.5. Phase 4 - Transition Plan Development/Approval

During this phase, the PPI develops a specific Transition Plan.

Phase-4 Process: The transition plan will include:

- A clear and concise explanation for the concrete real-world use of the research and subsequent deliverables
- The deliverables as defined by the analysis, including: the specific granularity of the deliverables as developed for a committed end-user(s)/customer(s) within the DHS community, the applicability across a larger scale and scope, and any limitations or technical, procedural, policy, or doctrinal dependencies.

- A clear and concise explanation for the transitional pathway to deploy the deliverables to end-user(s)/customer(s) within the DHS community, including the issues of:
 - The rights of intellectual property
 - Manufacturing considerations
 - As appropriate, identified sources for software, hardware, fabrication, and/or manufacturing
 - The operational and maintenance considerations, including: cost, end-user(s)/customer(s) required knowledge base
 - Test, training, and evaluation (with metrics for testing) for end-user(s)/customer(s)
 - The means and methods of engagement with and deployment to end-user(s)/customer(s)
 - Documentation of best practices and methods, and provisions of accessibility to end-user(s)/customer(s)
 - The specific initial end-user(s)/customer(s) recipients (by agency, role, and name where possible) of the deliverables and the protocol for sharing by the initial recipients to other users within the DHS and allied communities
 - The means of deployment for deliverables to specific initial end-user(s)/customer(s) recipients
 - Potential plans for publication of metrics, narratives, source code, presentations, web sites, workshops, teleconferences, emails, and face-to-face meetings and “how-to” instructions to the DHS.

Phase-4 Outcomes: Specific Transition Plan has been developed and approved by the Customer POC.

I.6. Phase 5 - Implementation

During this phase, the Phase-5 assigned entity performs the transition.

I.7. Assessment of the Transition Process

Beyond the satisfactory meeting and/or delivery of the stated task, milestones, deliverables, and performance metrics, the assessment of the transition process will be a measure of:

- The effective deployment of the deliverables to end-user(s)/customer(s)
- The level of engagement by end-user(s)/customer(s) in the use of the deliverables
- The closing of a knowledge, and/or operational capability gap/deficiency of significant importance to the Homeland Security Enterprise, and/or a change in the technology, software, database, CONOPS, visualizations, process, method, or protocol of end-user(s)/customer(s) with no major outstanding/remaining business issues
- The establishment of a “transition agreement” and protocol with the end-user(s)/customer(s) for the sustainment and maintenance of the deliverable deployment
- As appropriate, the effective and wide-spread circulation of metrics, narratives, source code, presentations, web sites, workshops, teleconferences, emails, and face-to-face meetings and “how-to” instructions to the DHS stakeholders

J. Research Development

J.1 RFP

Preparation of the RFP Themes: Questions for the BTI Institute's RFPs will be sourced from the original NOFA. The OUP PM will inform the BTI Institute Director of any questions that should be excluded and include additional ones if desired by DHS.

PRP Submission forms: The BTI Institute will review and update the materials used for issuing the call (including the text of the call itself and additional guidance documents).

Submission System: The BTI Institute will employ the services of an independent, auditable submission system that is separate from all the University of Houston's systems to handle its RFP submissions. The BTI Institute Associate Director, Program Management is the only BTI Institute team member with access to that system.

RFP Announcement: The RFP call will be posted on the BTI Institute's website and announced via the BTI Institute's email lists and social media platforms (e.g., Facebook, Twitter, LinkedIn). An announcement will also be included in the news and events section of the BTI Institute's website, and the BTI Institute's newsletter. In addition, the RFP announcement will be communicated to major academic funding databases (e.g., ProQuest Community of Science/Pivot, SPIN Funding Opportunities Database, SciVal Funding, GrantScoop, and GrantForward). The BTI Institute will coordinate with DHS S&T to promote the announcement via its wider distribution channels.

SME Review: The BTI Institute will employ the services of an independent researcher database to identify SMEs for all submissions not presenting a conflict of interest, by using automated search algorithms. At least two reviewers will be assigned to each proposal.

Conflicts of Interest: All proposals presenting institutional conflicts of interest with the University of Houston will be routed to a different COE (subject to the approval of the DHS PM). The external COE will handle the organization of the Subject Matter Expert (SME) External Review using the same guidelines incorporated by the BTI Institute for all other submissions. In particular, all personnel and reviewers who handle proposals will complete the same/common review forms, scoring forms, and Conflict of Interests and Non-Disclosure Agreements. The BTI Institute will not receive any info about the experts employed by the external COE.

BTI Institute Recommendations: At the Request of the OUP Program Manager, the BTI Institute will be prepared to offer its recommendations regarding the scientific aspects to the proposals submitted.

Transmission of Proposals to OUP: Following the conclusion of the SME External Review, all materials will be forwarded to the OUP PM to conduct the relevancy review. The BTI Institute will not receive any information about the reviewers employed by OUP.

OUP Selections: OUP will inform the BTI Institute of the outcomes of the review and provide a slate of proposals selected for Work Plan development. The BTI Institute will inform all applicants of the outcome of their proposals (including all comments), and invite selected applicants to refine their work plan by addressing the comments received. The PM will designate a DHS Project Champion for every proposal selected for work plan development.

Work Plan Development – Pre-Award: The Research Committee and the assigned Project Champion will meet with the applicant to provide feedback on how to improve the work plan to be

more responsive to the DHS needs. Revised work plans will be submitted by the BTI Institute to the OUP PM for final approval.

OUP Decisions: OUP will inform the BTI Institute of the work plans selected for funding. The BTI Institute will inform all work plan developers of the outcome.

J.2 Process to Identify and Compete New Projects of Interest

The BTI Institute periodically issues Requests for Proposals (RFPs) to address topics of interest within its mission space. The RFP questions are drawn from the list found at <http://www.uh.edu/bti/partnerships/RFPs/RFP-17-02/>.

The BTI Institute uses two methods to identify problems relevant to its mission that are not included in this list of questions. These problems are identified through: 1) the BTI Institute's Stakeholder Engagement Process, and 2) unsolicited concept papers from potential Project Principal Investigators. These problems (knowledge and capability unknowns and associated homeland security challenges) must lend themselves to government support, provide a public good, and to being addressed by research, education and/or workforce development initiatives that are not currently being sufficiently supported to meet the challenge.

J.2.a BTI Institute Stakeholder Engagement

1. **Identify the Problem.** Regardless of whether the issue is raised by a member of a client agency/jurisdiction or another interested party, the BTI Institute will solicit and/or work with the client agency/jurisdiction to develop a clear, concise statement of the problem to be addressed and research requested. Ultimately, this problem statement will be approved by the representative of the client agency/jurisdiction.
2. **Determine How the Project Supports Client Agency Mission and Priorities.** The BTI Institute will seek to ensure it attains a full understanding of the client agency/jurisdiction's mission, its strategic and operational priorities, and how the project requested will support them. This mission and relevant priorities will be included in concept papers and proposals as the initiative moves forward.

As a consideration, not as a requirement, the BTI Institute's Director or designated official may seek the insight and guidance of the BTI Institute's External Advisory Board members on the initiative.

3. **Confirm the Project's Nexus to the BTI Institute Mission.** The BTI Institute representatives will ensure that the project/initiative has a nexus to the Institute's mission.
 - i. Should a nexus to the BTI Institute mission be established, the project will move forward to the next step.
 - ii. Should it be determined that the project/initiative is not within the BTI Institute's purview, and is more appropriately addressed by another Center of Excellence, the Executive Director, Strategic Partnerships will: contact that Center directly; provide them the problem statement; brief them on the initiative; provide them background on client agency mission and priorities; and provide introductions to client agency/jurisdiction representatives to ensure a smooth project transition.
4. **Appointment with the Agency Headquarters representative.** As a prequel to any further commitment of time and resources, the BTI Institute will receive a commitment by agency/jurisdiction representatives for a meeting with the appropriate executive of that agency/jurisdiction.

5. **Concept Paper.** After receiving confirmation of the aforementioned meeting, the BTI Institute will conduct a meeting with appropriate researchers, faculty, and staff to develop a concept paper (one page, front and back) that incorporates: the problem statement, supported agency mission and priorities, proposed course(s) of action, anticipated costs, and any outstanding or related issues.
6. **Meeting with Agency Representative.** As previously agreed, a BTI Institute representative(s) will meet with the Agency Sector Chief or appropriate executive official before further commitment of resources. The objectives of this meeting will be to:
 - Confirm the problem statement
 - Confirm strategic and operational priorities
 - Receive the agency/jurisdiction's commitment to the project
 - Discuss proposed course of action moving forward
 - Determine funding.
7. **Next Steps.** The Agency Representative will determine the next steps that could be one of the following: 1) decide to fund through own funds using the Basic Ordering Agreement; 2) recommend to headquarters to consider for funding using the Basic Ordering Agreement; 3) request (via the BTI Institute's Director) to the OUP PM that this problem statement is included in the next BTI Institute RFP.

J.2.b White Papers

A good White Paper (Appendix 4) discusses problems to be addressed rather than a specific technical solution to solve the problem. They should not focus on technical solutions, although some brief examples of project ideas to illustrate the kind of projects suitable to address the problem may be included. A White Paper must not contain proprietary information.

The White Paper will be evaluated by the BTI Institute's Research Committee. If it passes the review, it will be submitted to the OUP PM. The possible responses from OUP PM are: 1) invite the White Paper author to submit a proposal; 2) include the challenge identified in the White Paper in a future RFP; and 3) decline to take action.

J.2.c Project Funding

Projects can be resourced via one of two methods.

- a. Selected by DHS OUP (or other federal agency with grant issuing authority) for funding using the Cooperative Agreement, after a proposal has been submitted to a BTI Institute's RFP.
- b. Basic Ordering Agreement. Should a DHS Component wish to allocate their own funds to a project, the BTI Institute representative will refer them to OUP for use of the Basic Ordering Agreement (BOA).

J.3 Process to Reallocate Project Funding

Project Review. Each BTI Institute research project each year undergoes: 1) three progress reviews (by the BTI Institute Research Committee); 2) a work plan development/review (for the following performance year) (by the BTI Institute Research Committee); 3) a work plan review and approval (by OUP and the Project Champion).

Additionally, BTI Institute research projects are reviewed by the Board of Directors and Office of University Programs during scheduled biennial reviews. Research Projects are reviewed based upon criteria established in “*COE Biennial Review Process, DHS S&T Office of University Programs – Standard Operating Procedures*,” (undated).

Termination. Research projects funded under the Cooperative Agreement may be terminated for a variety of reasons to include: loss of Principal Investigator (due to illness, death, loss of job, etc.); lack of sufficient progress; or if its research is deemed no longer relevant by Project Champions and/or prospective customers and end-users.

Should the BTI Institute Project Team determine that the funded research project has made insufficient progress or that the research is no longer relevant, the BTI Institute may submit a recommendation through the Director to the Office of University Programs Program Manager for project termination.

As a professional courtesy, prior to submitting the recommendation for termination, the Director will inform the Project Principal Investigator and the leadership of its partner university of the pending action.

Research projects may also be terminated by the decision of the Office of University Programs PM and Board of Directors. **Final decision on termination of DHS-funded research projects rests with the Office of University Programs.**

Project Closure. Upon notice to the Project Principal Investigator of the OUP decision to terminate, research ends. The Project Principal Investigator, in coordination with their university’s Finance Office, will follow the project termination procedures specified in their subcontract.

Alternate Project List. The BTI Institute will request and maintain a list of unfunded research projects as submitted through prior Request for Proposals (RFPs). The BTI Institute Director will request a list of previously proposed, but unfunded research projects, ranked by the Board of Directors and PM based on need. This list will also include projected cost and time required to accomplish the research.

New Project Nomination. Within seven days of a project termination, the BTI Institute’s Director will review the Alternate Project List and provide nominations to the Office of University Programs PM of the top three projects most suitable for reallocation of remaining funds. The Director will offer to discuss the nominations with the PM and Board of Directors.

As a consideration, not as a requirement, the BTI Institute’s Director or designated official may seek the insight and guidance of the BTI Institute’s Executive Advisory Board members on the nominations and rankings, prior to submission to OUP.

New Project Approval. The Office of University Programs will decide which research project will be funded and the amount of that funding. Typically, the PM will notify the Director, BTI Institute in writing of OUP’s decision (email is sufficient).

New Project Notification of Award. Within three working days following project confirmation and written approval by the PM the BTI Institute will notify the new Project Principal Investigator and partner university that their project will be funded, outline required next steps, identify members of the BTI Institute Project Team in support of that research, and schedule an introductory meeting/orientation.

J.4. DHS Grant to Prepare Communities for a Complex Coordinated Terrorist Attacks (CCTA)

In January 2017, the South East Texas Regional Planning Commission (SETRPC) requested the BTI Institute’s assistance in submitting a DHS grant to Prepare Communities for Complex

Coordinated Terrorist Attacks. The SETRPC was awarded the grant, from which the BTI Institute is projected to receive \$867,607 over the course of three years with work projected to begin in September 2017.

Upon receipt of this grant, the BTI Institute will hire a full-time planner and an emerging technology architect.

The purpose of the grant is to develop and implement effective, sustainable, and regional approaches for enhancing preparedness for complex coordinated terrorist attacks, which include the following components: identifying capability gaps, developing and/or updating plans, training to implement plans and procedures, and conducting exercises to validate capabilities. The project will focus on advancing whole community and regional partnerships by collaborating across jurisdictional boundaries and multi-disciplinary entities.

The BTI Institute's role will focus on developing research-based planning templates and technological solutions to assist communities in furthering their preparedness and the effectiveness of a Unified Regional Response to a Coordinated Complex Terrorist Attack. In its grant submission, the BTI Institute stated its intent to develop replicable planning and response templates and products that would assist the smaller cities in border and coastal regions (with application nationwide) in preparing and responding to a Coordinated Complex Terrorist Attack.

L. MEDIA AND COMMUNICATIONS

The Manager, Communications-Operations, working in concert with the Communications Advisor, Website Support Specialist and the Executive Director of Strategic Partnerships, will develop and enact the BTI Institute Communications Plan for this performance Period. The BTI Institute Communications Plan for Performance Period 3 will be designed to target three major audiences with different objectives, strategies, tactics, and evaluation methods: engaging with key stakeholders; marketing the BTI Institute's research and education activities, capabilities, and outputs to stakeholders and the public; and recruiting students to the BTI Institute's Research and Professional and Workforce Development program.

Strategic stakeholders directly involved with the BTI Institute can be grouped under several categories, internal (academic partners, industry partners, transition partners, and community partners) and external (e.g., COE network, HSE stakeholders). They will typically influence or be influenced by the research and activities of the BTI Institute, and thus will be more active in communication. The specific BTI Institute **objectives** will be to engage and to form relationships. Engaging with key stakeholders ensures that they can benefit from the BTI Institute's research and education activities, capabilities, and outputs that are tailored to their needs. Key strategies involve face-to-face interaction and two-way communication with these stakeholders via various communication platforms. The purpose will be to not only keep the stakeholders informed, but also actively engaged and committed to a long-term relationship with the Institute.

Another major component aim will be to recruit and train current and future workforce participants in areas related to the BTI Institute's mission. The BTI Institute will use a mixture of interpersonal and mediated communication to educate these audiences, especially those from diverse backgrounds, about research and professional and workforce development programs in the Institute, and motivate them to pursue education, research, and career opportunities in HSE fields.

The last component aim will be to provide awareness among the general population about the

value that the BTI Institute brings to HSE. Because this audience is broad and may not necessarily see a need for this, the specific objective will be to increase awareness. The general strategies for this audience will be to inform utilizing mediated communication and to develop media relations.

L.1. Tasks

ID	Description	Responsibility	Effort Period
T.1	Develop Period 3 Communications Plan (including success/failure criteria and metrics)	Lead: Manager, Communications/ Operations; Assist: Communications Advisor; Exec Director Strategic Partnerships	07/17
T.2	Create and distribute short Weekly Updates on BTI Institute activities to BTI Institute Team, PIs, selected External Advisory Board members, and University of Houston leadership	Manager, Communications/ Operations	Weekly
T.3	Create and distribute Monthly Updates on BTI Institute activities to BTI Institute Team, PIs, External Advisory Board members, and list serve	Manager, Communications/ Operations	Monthly
T.4	Provide immediate information/synopsis on notable events, significant accomplishments of note to the Program Manager, OUP outside of normal reports and updates	Director and Manager, Communications/ Operations	Within 24 hours
T.5	Attend monthly COE Communication Working Group calls	Communications Advisor	Monthly
T.6	Create and distribute the BTI Institute Quarterly Newsletter	Lead: Manager, Communications/ Operations; Assist: Exec Director Strategic Partnerships; Communications Advisor	08/17; 11/17; 02/18; 05/18
T.7	Evaluation of four issues of newsletter; publicity materials for projects;	Manager, Communications/ Operations; Communications Advisor; Exec	07/17; 10/17; 01/18; 04/18

		Director Strategic Partnerships	
T.8	Distribute and promote RFP. Provide leader notice for RFP on web site and social media immediately upon notification from DHS. Post RFP on the BTI Institute's web site. Distribute RFP using ProQuest Community of Science/Pivot, SPIN Funding Opportunities Database, SciVal Funding, GrantScoop, GrantForward, Research Gate, and Academia.edu list serves, social media sites including LinkedIn and Facebook (both BTI Institute and DHS S&T). Distribute through professional organizations such as IEEE, SAME, et al)	Lead: Manager, Communications/ Operations; Assist: Communications Advisor; Associate Director, PM	05/18
T.9	Conduct analysis of BTI communications strategy, plan, and activities	Lead: Executive Director Strategic Partnerships Assist: Director, Manager, Communications/ Operations; Communications Advisor; Website Support Specialist	01/18
T.10	Create and update publicity materials (media releases, talking points, point papers, information papers, photos, etc.) for projects	Lead: Manager, Communications/ Operations; Assist: Communications Advisor; Exec Director Strategic Partnerships	Ongoing; 06/18
T.11	Maintain stakeholder database/ mailing lists	Manager, Communications/ Operations; Website Support Specialist	Ongoing; 06/18
T.12	Maintain the website: update with new events, research activities,	Lead: Web Specialist, Assist: Manager, Communications/ Operations; Communications Advisor	Ongoing; 06/18

T.13	Update BTI Institute fact sheet	Manager, Communications/ Operations	Ongoing; 06/18
T.14	Update HSUP website (BTI Institute section)	Lead: Manager, Communications/ Operations; Assist: Website Support Specialist	Ongoing; 06/18
T.15	Update the Project Reporting System	Lead: Executive Director; Assist: Website Support Specialist	As applicable; Quarterly review and update
T.16	Maintain current social media accounts (Facebook, LinkedIn) and expand social media outreach	Communications Advisor; Manager, Communications / Operations	Ongoing; 06/18
T.17	Produce and pitch news media as newsworthy events occur and update repository	Manager Communications; Communications Offices of partner Universities	As applicable; 06/18
T.18	Create Resource database with publications, conference proceedings, white papers, photo gallery, videos, etc.	Lead: Manager, Communications/ Operations; Assist: Communications Advisor; and Website Support Specialist	As applicable; 06/18
T.19	Promote Homeland Security Symposium series via newsletter, website, and social media	Manager, Communications/ Operations	As applicable; 06/18
T.20	Evaluation of events: conduct Hotwash for smaller events (demonstrations by project PIs, visits, conferences, etc.) and formal After Action Reviews for major events (discussion-based and operations-based exercises, conferences hosted by BTI Institute, etc.)	Lead: Exec Director Strategic Partnerships; Assist: Manager, Communications/ Operations; Communications Advisor; and Website Support Specialist	As applicable; throughout the year List of BTI Institute Activities for Y3 at Appendix 5

L.2. Milestones

ID	Description	Achieved by
M.1	Twelve Issues of Monthly Report disseminated	6/18
M.2	Four issues of Institute newsletter published	08/17; 11/17; 02/18; 05/18
M.3	Call for Proposals issued	05/18
M.4	Twelve articles posted on LinkedIn	6/18

M.5	Eight Media Advisories of Speakers Program events	6/18
M.6	Conduct analysis of BTI communications strategy, plan, and activities	01/18
M. 7	Update of Project Reporting System	Quarterly

L.3. Outputs

ID	Description	Responsibility	Completed by
D.1	50 issues of BTI Institute Weekly Report	Manager, Communications/ Operations	Weekly with the exceptions of weeks of New Year, 4th of July, Labor Day and Thanksgiving holidays
D.2	12 issue of BTI Institute Monthly Updates	Manager, Communications/ Operations	Published and disseminated within 3 days of the end of the month
D.3	24 articles posted in social media (LinkedIn)	Manager, Communications/ Operations; Communications Advisor	Not less than two per month
D.4	Four issues of BTI Institute newsletter	Manager, Communications/ Operations; Communications Advisor; Executive Director, Strategic Partnerships	09/17; 12/17; 03/18; 06/18
D.5	Publication and solicitation of projects to RFP-18-01	Lead: Manager, Communications / Operations	Upon notice by DHS
D.6	Analysis of BTI communications strategy, plan, and activities	Jointly: Manager, Communications/ Operations; Communications Advisor; Executive Director, Strategic Partnerships	01/18

L.4. Performance Metrics

ID	Description	Quantitative Performance Target	Achieved by
P.1	Four issues of Institute newsletter	Newsletter reach as reflected in click rate and open rate, both to be above industry average (20% and 6%, respectively)	07/17; 11/17; 03/18; 07/18
P.2	Ongoing task: Website	Assessing website traffic to the projects through number of unique visits and average number of page visits: 100 unique visitors, accessing more than two pages per visit	06/18
P.3	Ongoing task: Social media	Number of social media members engaged with the Institute (such as number of followers, retweets, likes) to reach an equivalent to that of recently-established peer COEs	06/18
P.4	Respond to Requests for Information	Provide a telephonic or email acknowledgement to callers within 24 hours of receipt	Ongoing

M. BTI Institute Speakers Program

In 2017, the BTI Institute will begin its Speakers Program, held as a monthly event during the academic year, to promote a balanced discussion of significant issues in the homeland security, border security, international trade, and immigration policy/system arenas. This program will invite experts on subjects of interest related to border security, trade, immigration and the safety and resilience of communities in the border regions, to share their expertise with the Houston community.

Program Objectives. Through the Speakers Program, the BTI Institute seeks to:

- Engage in discussions that address real world challenges
- Present pre-eminent speakers on current topics concerning the transnational flows of people, goods, data and financial capital
- Educate students and citizens on topics related to securing our nation's borders, facilitating legitimate trade and travel, and ensuring the integrity of our immigration policies.
- Host presentations during evening hours at selected venues on the University of Houston's main campus

Desired Outcomes.

- Offer transdisciplinary education through presentations by multi-disciplinary national and international experts
- Educate students and citizens on economic, social and cultural challenges affecting the city of Houston, the state of Texas, the United States of America, and the world
- Offer speakers the opportunity to interact with students and researchers at the University of Houston

Projected Schedule. The BTI Institute's Speakers Program's notional schedule, drafted for the 2017-2018 academic year, hosts speakers and panels for the following topics:

September 21	<i>The Art of Cyber Conflict</i>	Henry Sienkiewicz
October 26	<i>The Scourge of Human Trafficking</i>	Panel Discussion

November	<i>Changing NAFTA?</i>	Panel Discussion
February	<i>Sanctuary Cities: Yes or No?</i>	Panel Discussion
March	<i>The State of the Border</i>	TBN
April	<i>Ports of the Future</i>	Panel Discussion

N. BTI INSTITUTE PROJECTS

Theme 1. Enhance the U.S. Border Management Operations

- Central America’s Immigrant and Refugee Crisis: Limiting Unauthorized Migration through the Alliance for Prosperity and Reintegration Efforts
- Uncovering Human Smuggling Patterns from Guatemala to the U.S.
- Security Technologies Kitchen (STK)
- Homeland Security Symposium Series

Theme 2. Enhance the Ability to Secure and Facilitate Transnational Flows of People

- Image and Video Person Identification in an Operational Environment
- A Systematic Process for Vulnerability Assessment of Biometric Systems at Borders
- Modeling Methodology and Simulation of Port-of-Entry Systems
- Modeling International Migrant Flows: Theory, Evidence and Forecasts
- Missed Detections: From Data to Actionable Estimates

Theme 3. Enhance the Ability to Secure and Facilitate Transnational Flows of Goods

- Participatory Operational Assessment (POA): Evaluating and predicting the operational effectiveness of Cargo Security Processes at Ports of Entry
- Secure and transparent cargo supply chain: enabling chain-of-custody with economical and privacy respecting biometrics, and blockchain technology
- Modeling Methodology and Simulation of Port-of-Entry Systems

Theme 4. Enhance the Ability to Promote the Integrity of the Immigration System Within the U.S. Border

- The Impact of Central American Child and Family Migration on U.S. Communities

Central America's Immigrant and Refugee Crisis: Limiting Unauthorized Migration through the Alliance for Prosperity and Reintegration Efforts

Project PI: Randy Capps, Director of Research for U.S. Programs, Migration Policy Institute (MPI)

1. Introduction

Border Patrol apprehensions of unaccompanied alien children (UACs) during fiscal year (FY) 2016 (60,000) approached their level during the peak year FY 2014 (69,000), while apprehensions of family units—parents and children traveling together—were higher in FY 2016 (78,000) than in FY 2014 (68,000) [1]. But UAC and family unit apprehensions during the past two months—February and March 2017—fell precipitously to below levels for comparable months over the past several years [2]. These trends suggest that migration of UACs and families—primarily from the “Northern Triangle” Central American countries of El Salvador, Guatemala and Honduras—may be an enduring phenomenon and will likely continue to challenge DHS and other federal agencies. Because they are composed so heavily of women and children, many with potentially legitimate asylum claims, the new Central American flows are presenting new challenges for DHS and its component agencies CBP and ICE in terms of the core immigration functions of apprehensions, migrant processing, long-term detention, providing alternatives to detention, and safe and orderly repatriation. Understanding emigration pressures in the Northern Triangle, adopting long-term strategies to reduce unauthorized migration, and developing reintegration strategies to ensure safe repatriation and deter return migration are thus of critical policy significance to DHS.

While large-scale migration of UACs and families is new, the underlying push factors in the Northern Triangle are not. For 5 years, the Migration Policy Institute's (MPI) Regional Migration Study Group (RMSG) has been addressing the intersection between migration and the violence, insecurity, political instability, and economic underdevelopment that have afflicted *the region* [3]. Through the RMSG, MPI staff have worked intensively in Mexico and the Northern Triangle countries to investigate migration push factors and promising practices for reintegration of return migrants from the U.S. We have also created deep relationships with the governments and civil society of the region, including officials in charge of the countries' migration portfolios. The work has produced a number of foundational, widely cited publications on Central American flows and, notably, reintegration. Project PI Randy Capps is on the Community Reference Committee of the U.S. Immigration and Customs Enforcement's Family Case Management Program; that program is piloting reintegration planning services to Central American families during the removal process. Based on our involvement with the RMSG, prior analyses, experience in the region, and extensive ties to governments and non-governmental stakeholders there, MPI is uniquely positioned to conduct policy-related research and propose concrete recommendations regarding migration push factors, strategies to discourage unauthorized migration, and reintegration programs.

MPI's work will explore two broad policy strategies to reduce unauthorized migration: (1) initial implementation of the Alliance for Prosperity (AFP) by the Northern Triangle countries to combat crime, violence and poverty and thereby address central push factors [4] and (2) reintegration programs for children and families in Mexico and the Northern Triangle that offer promise to ensure safe and orderly repatriation and deter future migration. Neither of these strategies has been reviewed in academic or policy research.

MPI will leverage our ongoing activities in Central America and Mexico, substantial research in the field, and broad networks of governmental and nongovernmental experts across the region and in Washington to produce two high-quality research briefs on (1) the promise of AFP and

other initiatives in the Northern Triangle to reduce migration, and (2) the challenges faced in reintegrating repatriated migrants along with promising practices to overcome these challenges and thereby reduce migration pressures. MPI will present findings from these briefs to an expert roundtable composed of DHS officials, U.S. experts on Central American migration, and other U.S. and regional stakeholders. We will also publish the research briefs, along with commentaries or op-ed pieces that summarize results in a user-friendly format for a broad public audience, on MPI's high-volume website and through media outlets. MPI's research team includes PI Randy Capps, who led two prior DHS S&T funded studies of U.S.-Mexico border enforcement metrics, and Senior Advisor Doris Meissner, who was INS Commissioner during the 1990s; is well known across the Northern Triangle region; and has extensive contacts with government and the civil society leaders there. Former MPI staff member Victoria Rietig, who has conducted extensive research in Mexico and Central America, will be a consultant to the project.

2. Research Question(s) being addressed

This proposal addresses the following three questions in the RFP through exploratory research:

8. Central American Immigrants & Refugees Crisis: Is There a Paradigm Shift?

8.a.iii. What strategies are being used to discourage Central Americans from initiating an illegal trip to the United States, and what is the return on investment of those strategies—that is, which strategies are working, and which need to be revisited? Which new strategies need to be implemented? How can “on the ground efforts” be best monitored (e.g., media messaging campaigns or new programs that aim to deter people from leaving for the U.S. in an unauthorized fashion) to assess their impact and effect? Who are the deterrence partners in each country (e.g., at the government level, civil society, non-governmental organizations, universities, schools) and how can those partnerships be effectively leveraged?

8.a.iv. How can the U.S. help improve conditions—and which conditions—in the countries of origin to deter the unauthorized movement of large masses of people to the U.S.?

8.a.v. How are re-integration efforts for people sent back working or not working? Do U.S. and Mexican immigration agencies providing reintegration planning before deportation, and how useful is that planning to returning migrants? What data sources are available on re-integration programs, and what can be learned about them? What approaches can be developed to discourage individuals from attempting to return to the U.S. multiple times?

3. Goal and Objectives

The principal goal of the project is to develop policy-related research findings and recommendations for DHS and other stakeholders that address the three research questions described above. The research will help DHS to better understand the degree to which well-documented emigration pressures in Central America are amenable to U.S. policy interventions. Through our RMSG work, MPI has a broad and grounded understanding of the region generally and more specifically, how the regions' weak labor markets—particularly for youth—drive outmigration [5]. Weak labor markets push youth to emigrate for economic reasons just as they make reintegration of deportees and other return migrants difficult. At the same time, all three Northern Triangle countries are engulfed in a wave of gang-related violence that has led to well-documented trauma among many children and families fleeing the region [6].

The AFP, as conceptualized by the Northern Triangle governments and supported by the U.S. government, addresses both of these problems head on. It includes funding to improve governance, enhance security, and reduce crime, but it is also intended to support job creation through investment in infrastructure, new business development, education, and training [7]. Mexico has committed to be a regional strategic partner of the AFP with the potential to provide

support for and examples of development practices in education, health, and infrastructure [8]. It remains in Mexico's interest to stem migration from the Northern Triangle countries and to cooperate with them on reintegration efforts—given migration pressures and the high and rising number of deportations from Mexico. This regional cooperation is likely to continue despite any changes in foreign relations between Mexico and the United States.

If the AFP is successful in improving security and labor-market conditions in the Northern Triangle, it should also reduce emigration pressures. Monitoring the early implementation of the AFP will be important for assessing the program's potential to reduce migration pressures, identifying implementation challenges (both expected and unexpected), and generating feedback loops so that the program can adapt to changing circumstances on the ground. Early AFP implementation will also provide lessons to the U.S. and governments in the region about the long-term prospects of cooperative strategies to address crime, instability and poverty.

Reintegration services for return migrants may also be successful in reducing migration pressures and deterring recidivism, if they can provide long-term safety and economic stability for participants. While AFP plans to fund some reintegration services, a wide range of initiatives already underway can be studied. Return migration to the Northern Triangle is significant: Mexico and the U.S. deported 800,000 individuals including 40,000 children to the region from 2010-14 [9]. With the majority of migrant returns coming from Mexico, reintegration efforts have increasingly focused on fostering better regional collaboration between Mexican and Central American authorities during the deportation process and improving oversight of migrant rights and treatment in detention. Thus, reintegration of Central American child and family migrants deported from Mexico will also be a focus of the study.

Returnees are a heterogeneous group that includes deported violent criminals who often contribute to already widespread security deficits, but also children who have suffered from trauma and interrupted formal education, many of whom have difficulty accessing schools and services upon their return. At the same time, returning migrants can represent important opportunities. Some returnees bring English language skills and U.S. work experience that are in high demand but short supply. Others build deportee networks or link diaspora organizations to other new returnees. Indeed, successful return migrants may be one of the most underutilized resources for preventing outmigration. MPI's research finds that their actions and words tend to have greater credibility and impact than awareness campaigns, yet they are often excluded from return projects and investments [10].

El Salvador, Guatemala, Honduras, and Mexico operate short-term reception services for returnees. But long-term comprehensive reintegration programs that offer job training and placement services for adults, and health and mental health services or help with school enrollment for children, are extremely limited. They reach only a fraction of deportees: a few dozen or hundreds, compared to the hundreds of thousands of deportees who need them [11]. Building better reintegration programs based on regional collaboration could maximize the benefits of return migration and slow a revolving door of migration, deportation, and remigration. But to date, little is known about programs' actual impacts, making return migration and reintegration severely under-studied phenomena.

Given these overarching research goals and MPI's research experience and strong ties to stakeholders in the region, the proposed study would:

- Examine the critical early implementation phase of the AFP when policy trajectories are being set and can be adjusted to account for changing realities on the ground.

- Investigate reintegration services for unaccompanied children repatriated to Central America and Mexico (and those repatriated to Central America *from* Mexico); identify reintegration challenges; and share promising practices among providers in Mexico and Central America.
- Describe reintegration planning services provided prior to repatriation by Mexican and U.S. immigration authorities, for instance the planning services provided to Central American families via ICE's Family Case Management Program during the removal process.
- Analyze the potential of reintegration services to stem repeat migration to the U.S.
- Develop recommendations for the U.S. government to shape strategies that reduce Central American migration to the U.S. and ensure safe and orderly repatriation.
- Promote communication and collaboration between DHS and other stakeholders, including governments in the region, civil society organizations, reintegration programs, researchers, and other migration experts.

4. Research Methodology

The MPI research team will address the project's objectives through the following four principal activities.

(1) Conduct field research and a policy scan. MPI will gather information and monitor policies by drawing on our extensive network of U.S. and Central American stakeholders and visiting the region. MPI's project team will continue to participate in relevant convenings that can inform the research, such as the working group convened by the Technical Secretariat of the Alliance for Prosperity at the InterAmerican Development Bank (IDB), ICE's Family Case Management Program (FCMP) Community Reference Committee (CRC), and relevant DHS meetings on return migration. The team will draw on the work of academic researchers, governmental and nongovernmental agencies, advocates for migrants and other stakeholders in the region.

The scan will be focused on two policy strategies. The first includes responses to conditions forcing regional outmigration, with a specific focus on crime, violence, and labor markets. MPI's research team will monitor trends in these migration push factors, assess AFP's early efforts and long-term potential to address them, and develop actionable policy recommendations for the U.S. government, governments in the region, and civil society.

Team members will visit the Northern Triangle and Mexico to meet with senior officials and nongovernmental stakeholders, including those at the grassroots/community level, about AFP implementation over a course of two weeks during summer 2017. By meeting with senior officials, MPI researchers will assess progress and challenges in implementing the AFP, and identify specific migrant-sending communities that may be affected by AFP implementation.

The second strategy involves reintegration efforts in Mexico and Central America. Through more than a year of research and intensive exchange with governments, academics and service providers in the region, MPI has gathered an exhaustive list of reintegration programs in Central America, and is currently working on expanding it to Mexico [12]. We will draw from this work to identify programs that appear most promising for deterring repeat migration, assess their strength in providing short- and longer-term services to migrants, explore how successful programs could be adapted in different settings (e.g., Mexico versus Central America, for services to children versus parents), and develop

recommendations for implementing successful repatriation programs and scaling them to meet demand. We will also assess reintegration planning efforts by U.S. Immigration and Customs Enforcement—for instance through the Family Case Management Program—and by counterpart agencies in Mexico.

The study team will travel to migrant-sending communities to meet directly with nongovernmental stakeholders, for example the reintegration networks INSAMI and La Red Kat (described below). These meetings at the grassroots level will allow MPI researchers to gain valuable insights from community informants about the tangible results and limitations of AFP and reintegration programs. Nongovernmental stakeholders may also organize focus groups to obtain community input on AFP initiatives and reintegration programs. Because there is so little research on AFP and reintegration programs, our work will be exploratory and the exact composition of our key informants and the content of our meetings with them will be determined by our policy scan, conversations with higher-level informants, and our network of nongovernmental organizations active in the region.

Within one month after the international trip, MPI will submit an interim report listing the organizations and stakeholders included in the policy scan and fieldwork, and summarizing discussions with stakeholders and any focus groups organized by them. The trip report will also provide initial insights and impressions about AFP and reintegration programs, including their implementation progress, successes and challenges.

(2) Write policy briefs. MPI researchers will synthesize findings and develop policy recommendations in the form of two policy briefs—one assessing the AFP’s efforts to address migration push factors, and the second analyzing reintegration programs and their potential to decrease repeat migration and anchor deportees in their home countries. The audiences for these policy briefs will be key stakeholders in DHS, other agencies, governments in the region, and nongovernmental stakeholders in the region as well as the broader public.

(3) Convene a policy roundtable. The MPI team will present findings of the two research briefs to a roundtable including key policymakers at DHS and other federal agencies, representatives of governments from the region, international agencies like UNHCR and IOM, migrant service providers, academic experts, advocates, and other stakeholders. Our project’s champions will be the career leadership in ICE and CBP. While the political leadership of these agencies is changing, career leaders will likely remain in place. MPI has strong informal but institutional relationships with two career ICE leaders (Daniel Ragsdale and Thomas Homan), and we believe the new administration will continue to have a strong interest in supporting successful reintegration of deportees to the Northern Triangle.

The roundtable will follow the format of successful meetings MPI held for prior DHS S&T grants (with CBP officials, academic experts, border region advocates, and other stakeholders) to discuss Southwest border metrics. The meeting will be closed-door and all comments will be off-the-record to facilitate a neutral but robust conversation between governmental and nongovernmental stakeholders. Meeting participants will vet MPI’s draft reports, the research findings, and policy recommendations.

(4) Disseminate policy briefs and summaries of findings. The two policy briefs and related commentaries will be published on MPI’s website and will be disseminated to relevant MPI and external audiences via its mailing lists, social media, and outreach to journalists in the United States and in the region, and possibly with an op-ed through an external media

source. MPI’s website received more than 4.5 million unique visits during 2015, and is routinely rated as one of the top migration websites in the United States and internationally by Alexa, a leading website traffic monitoring service. The project team will also pursue and conduct briefings with DHS and ICE staff, meetings with governments and stakeholders in the region, and public speaking engagements to disseminate the work. Since 2014, MPI has held more than 40 public and private meetings in the region on migration-related topics.

PI Randy Capps, who has led MPI studies for two prior DHS S&T funded studies of U.S.-Mexico border enforcement metrics, will direct the study and serve as the principal contact with DHS and external stakeholders to ensure that research findings and policy recommendations meet stakeholders’ needs. Dr. Capps has a Ph.D. in Sociology from the University of Texas and more than 20 years of immigration-related research experience, including extensive contract work for different federal agencies. He currently serves on the Community Reference Committee for ICE’s Family Case Management Program. Former INS Commissioner Doris Meissner, who has worked for years in the region with governments and civil society, will advise development of the study’s methodology, review report findings, and assemble the expert roundtable. Consultant Victoria Rietig, who has a M.P.P. from Harvard University, will advise the project and provide contacts in the field, based on her substantial experience in the Northern Triangle region. Before joining MPI, Ms. Rietig worked for the United Nations Institute for Training and Research (UNITAR), a Berlin-based international NGO, and the joint DHS, DOJ and DOS Human Smuggling and Trafficking Center (HSTC). She has consulted with the Foreign Ministry of Mexico and Guatemala’s Congress on forced migration and unaccompanied minors, and has conducted one year of in-depth research including field research on return migration. Ms. Rietig is the author of two recent reports on Central American migration trends and reintegration in the Northern Triangle. Ms. Rietig is currently participating in the discussion and working group at the Alliance for Prosperity’s Technical Secretariat, while Dr. Capps is participating in ICE’s FCMP CRC to ensure compliance with immigration court dates and removal orders, and develop reintegration planning prior to removal, for newly arriving Central American family units.

5. Tasks

ID	Description	Completed by (# of months past start date)
T.1	Teleconferences with project champion(s), DHS/ICE stakeholders	1, 4, 7, and 10 months
T.2	Refine study methodology	2 months
T.3	Conduct policy scan and field research	8 months
T.4	Write interim report on findings from policy scan and international field research	9 months
T.5	Draft two policy briefs	10 months
T.6	Convene stakeholders to discuss project findings, recommendations	10 months
T.7	Produce final project policy briefs and commentaries	12 months

6. Milestones

ID	Description	Completed by (# of months past start date)
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M.1	Study plan/methodology completed	2 months
M.2	Policy scan and fieldwork completed	8 months
M.3	Interim report on policy scan and international fieldwork submitted	9 months
M.4	AFP research brief drafted	10 months
M.5	Reintegration research brief drafted	10 months
M.6	Stakeholders convened	10 months
M.7	Final briefs, fact sheets posted	12 months

7. Deliverables (Outputs)

ID	Description	Completed by (# of months past start date)
D.1	Interim report on policy scan and international fieldwork	9 months
D.2	Stakeholder convening	10 months
D.3	Final research brief on AFP	12 months
D.4	Final research brief on reintegration	12 months
D.5	Commentary/op-ed on AFP	12 months
D.6	Commentary/op-ed on reintegration	12 months
D.7	Project briefings/presentations	12 months and later

8. Performance Metrics

ID	Description	Quantitative Performance Target	Achieved by (months past start date)
P.1	High-quality research briefs produced, published on MPI's website	2	12 months
P.2	Commentaries/op-eds produced and published	2	12 months
P.3	Meetings with DHS/ICE officials	4	Over course of project
P.4	U.S. and international governmental and nongovernmental stakeholders contacted/visited	50	Over course of project
P.5	DHS and external stakeholders participating in policy roundtable	25	10 months
P.6	Dissemination of results to broad audiences	4 briefings/presentations	12 months and after the life-course of the project

ID	Baseline Performance	How is baseline established?
P.1	MPI has a track record of producing high-quality research reports for broad policy audiences.	MPI has published more than 125 reports and 100 policy briefs since the start of 2014.
P.2	MPI policy briefs and commentaries are accessible to broad audiences, have large readership, and result in media coverage; our	MPI's website receives more than 4.5 million unique visits annually, and its publications have been

	website is one of the most common sources of information about immigration to the U.S.	downloaded more than 5.8 million times since the start of 2014.
P.3	MPI staff have conducted numerous policy meetings with DHS, CBP and ICE leaders for prior DHS S&T-funded projects, and on other homeland security topics. Senior MPI staff have also testified before Congress on these topics.	MPI staff met with and briefed DHS, CBP and ICE leadership more than 12 times since 2010. MPI staff testified before Congress 5 times during 2014-2015.
P.4	MPI staff have close working relationships with Northern Triangle governments, international organizations, civil society, academics, and other stakeholders throughout the region.	More than two dozen organizations and government agencies have been involved in the RMSG.
P.5	MPI has recently convened closed-door roundtables with DHS, other governmental and nongovernmental stakeholders on Central American migration, border metrics, asylum reform, and refugee integration.	MPI has convened 28 private roundtables with federal, state, and/or local policymakers during 2014-16, including 2 roundtables for prior DHS S & T grants.
P.6	MPI researchers present findings to policy, practitioner, funder and general audiences;	MPI held 40 events, and MPI researchers conducted more than 200 additional external briefings and presentations during 2015,

ID	How will final performance be assessed?
P.1	Policy utility of reports to DHS/ICE and external stakeholders
P.2	Accessibility of policy briefs and commentaries/op-eds to broad audiences
P.3	Utility of meetings to DHS/ICE officials and to MPI project staff for information gathering
P.4	Utility of meetings/contacts to external stakeholders and to MPI project staff for information gathering
P.5	Quality of roundtable discussion, participants' review of quality of research findings, participants' feedback on roundtable, and quality of policy recommendations developed
P.6	Hits on MPI websites, invitations to present/brief results

9. Stakeholder Engagement

The MPI team will seek to work closely with staff in the DHS Office of Policy and ICE's policy staff engaged in Central American repatriation efforts throughout the life of the project. Individual DHS or ICE stakeholders have yet to be contacted. DHS/ICE project champions will be included on quarterly conference calls; help identify other internal and external stakeholders to inform the study; review the study methodology, draft policy briefs, and final briefs; attend the policy roundtable; and suggest additional project briefings and presentations.

MPI will also partner with a broad range of governmental actors, nongovernmental local-level experts, advocates, service providers, and other on-the-ground stakeholders in the U.S., Mexico, and Central America. These stakeholders include the following:

- Embassies of El Salvador, Guatemala, Honduras, and Mexico (United States)
- Inter-American Development Bank, Technical Secretariat of Alliance for Prosperity (United States)

- Washington Office on Latin America, WOLA (United States)
- The Woodrow Wilson International Center for Scholars (United States)
- The United Nations High Commissioner for Refugees, UNHCR (United States)
- The Inter-American Dialogue (United States)
- Central America and Mexico Migration Alliance, CAMMINA (Mexico)
- Instituto para las Mujeres en la Migración, IMUMI (Mexico) – a non-profit organization dedicated to promoting the rights of women migrants in Mexico and the United States, regardless of their country of origin.
- Centro de Investigación y Docencia Económicas, CIDE (Mexico)
- International Committee of the Red Cross, ICRC (Mexico)
- Citizen Council of the Instituto Nacional de Migración, INM (Mexico)
- Fundación Nacional para el Desarrollo, FUNDE (El Salvador)
- Fundación Salvadoreña para el Desarrollo Económico and Social, FUSADES (El Salvador)
- Instituto Salvadoreño del Migrante, INSAMI (El Salvador) – a non-profit organization dedicated to promoting the migrant rights, focusing on the reintegration of migrants repatriated from the United States.
- Kids in Need of Defense, KIND (Guatemala/United States)
- Asociación de Investigación y Estudios Sociales, ASIES (Guatemala)
- Asociación de Retornados Guatemaltecos, ARG (Guatemala) – an association of repatriated Guatemalan migrants which promotes public dialogue on issues of reintegration and promotes reintegration services.
- La Red KAT (Guatemala) – a social entrepreneurship venture promoting the reintegration of repatriated migrants through job training programs in culinary arts as a way to provide a meaningful alternative to emigration.
- Casa Alianza (Honduras) – a non-profit organization which provides housing and shelter for children and youth, and monitors migrant repatriations from the United States and Mexico.
- UNDP Tegucigalpa Office (Honduras)
- Asociación de Municipalidades de Honduras, AMHON (Honduras)

MPI will also rely on its well-established network of contacts among key government officials in charge of migration portfolios, including interior and foreign ministries.

This broad set of governmental and nongovernmental stakeholders in the region will provide input into our policy scan and field research design. We will contact these stakeholders during the life of the project to help us develop our policy analysis, serve as and recommend key informants, assemble focus groups of migrant-sending community members, draw out concrete research findings, and write policy recommendations. Several individuals, selected in consultation with DHS/ICE stakeholders, will be invited to our policy roundtable. These experts will also help us review elements of our final policy briefs for accuracy and completeness, and they will be involved in dissemination efforts at the end of the project.

10. Transition Approach

Unlike more technical projects, this research study will not result in technology that can be transitioned to DHS component agencies. However, it is anticipated that the findings about repatriation programs will be of particular value to ICE policy staff engaged with repatriation and reintegration of children and families to Central America. The project team will identify ICE champion(s) early on in the project, and work with ICE stakeholders to develop actionable recommendations (such as specific reintegration program designs) for transition of this information. More generally, the project team will work with the DHS policy office to translate the findings and recommendations about components of the AFP that appear promising to address migration push factors in the region.

11. Impact/Benefit (Outcomes)

- **DHS:** Rapidly evolving migration patterns from Central America are difficult to predict, and better information on future flows is needed for DHS' strategic planning efforts. Flows of Central American children and families are particularly challenging because of statutory and regulatory requirements for the treatment of these groups *while in CBP and ICE custody* [13]. Securing and managing U.S. borders are central DHS functions, and the 2014 Quadrennial Homeland Security Review has recognized agility in response to new trends in illegal Central American migration *as an institutional goal* [14]. The proposed study will provide strategies to mitigate the migration crisis via components of the AFP and reintegration programs that show promise to limit recidivism and reduce long-term emigration pressure from the region.
- **Stakeholders/HSE/Others:** A large array of governmental and nongovernmental stakeholders across the region have become engaged in the issue of child and family migration from Central American to the U.S. Regional governments, the IDB, UNHCR, IOM, and other international organizations are focused on the AFP as an instrument for developing the region and deterring future migration. A variety of advocates, humanitarian organizations, and policy experts have become concerned about the well-being of children and families including those who migrate, those who integrate in the United States, and those who are repatriated. Reintegration service providers operating at the grassroots level can learn from each other about the challenges they face and promising practices for service provision. All these stakeholders stand to gain from our proposed participatory process of information gathering (i.e., via networks of these same stakeholders); the policy analysis and recommendations developed in our policy briefs and commentaries/op-eds; the stakeholder convening and other potential project briefings and meetings; and broad dissemination of information about migration push factors, the AFP, and reintegration programs that can support informed policymaking.

12. Programmatic Risks and Mitigation Plans

The project faces a number of research challenges and programmatic risks. One is the exploratory nature and short (one-year) timeline of the project: this timeline may make it challenging to study the impact of the AFP on sending countries in the region, and to assess reintegration programs that may just be starting. To address this challenge, the study team's field research will engage stakeholders in conversations about the initial implementation challenges of AFP and reintegration programs, and the potential of these programs going forward. This study will also provide a baseline for future research and policy development in these areas.

A second challenge is inherent in MPI's mission as a think tank providing sound, evidence-based, and nonpartisan ideas that can help spark change. The challenge is that MPI's work is typically ahead of the center of gravity in present-day debates. Thus, the notion of regional solutions to migration matters is not broadly accepted or meaningful to most policy actors at present. Instead, current debates continue to dwell on control of U.S. borders as a unilateral matter and answer to migration problems. To mitigate this limitation, MPI will carefully select and work with the right allies and partners who recognize the importance of broader strategies and longer-term efforts that can carry forward the findings and knowledge provided by MPI's research for concrete policy changes during and after the termination of the project.

Other risks that in the past have complicated MPI's work in Mexico and Central America include political upheaval, corruption scandals, economic recessions, public health emergencies like the recent Zika virus, and a general lack of trust of populations and civil society organizations in the ability and willingness of their governments to address migration and other political challenges. Attempting to stay ahead of the curve, MPI regularly monitors the political and economic

environment in the Northern Triangle and Mexico, and we will work closely with governments and trusted nongovernmental organizations in the region to adapt the project to changing circumstances and ensure its successful completion.

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Uncovering Human Smuggling Patterns from Guatemala to the U.S.

Project PI: Gary J. Hale, Voir Dire International, LLC

1. Introduction

This project will address the gap of knowledge (“the unknowns”) in specific Human Smuggling routes, patterns, and the numbers of human migrants moving north from Central America through Mexico. Project Findings (number of migrants in the flow, or “unknowns”) will be compared with DHS detention data (the number of arrests of “the knowns”) to assess the number of successful entrants (“The Successful”) into the U.S. This knowledge will provide DHS a better ability to manage resources at the U.S. southern border.

The project will utilize Geographic Information Systems (GIS) to plot, map and analyze critical nodes in the transportation or Human Smuggling “supply chain” and to develop estimated numbers of migrants in the stream. The GIS database will establish a framework that allows for visualization of the data and more efficient decision making.

This project envisions the utilization of “Time and Space” as an effective mitigation strategy to allow DHS enforcement personnel to more effectively secure and manage our borders and thereby more effectively enforce and administer U.S. immigration laws and streamline the entry of people into the U.S. This Human Smuggling project will build upon existing detection and monitoring activities of DHS/CBP by providing a more comprehensive, multi-dimensional and strategic view of the areas of interest and linking that knowledge to a proposed regional detection and monitoring approach that will include the proposed interaction of several Central American nations, Mexico and the U.S.

2. Research Questions Being Addressed

This project is attempting to answer question 1.c.14 of the FOA: What innovative methodologies may be used to best identify travel patterns and behavioral characteristics of individual terrorists, illegitimate actors, and transnational criminal organizations? This research will support the DHS international strategy of combating terrorism and Trans Criminal Organizations (TCO’s), strengthening the security and resilience of the Global Supply Chain and Travel System, expediting lawful flows of people and goods and promoting lawful immigration. This research is especially timely given the changing policies being enacted by the Trump Administration and their priority focus on reducing the presence and impact of TCO’s on the U.S. border and building a border wall to reduce immigration.

3. Goals/Objectives

To develop a framework of assets related to Human Smuggling migration patterns and generate an associated geospatial model to provide an environment for analysis and visualization of those patterns, ultimately enhancing border security decision-making strategies. This framework will evolve as new data is received so that changes in migration patterns can be discerned.

4. Research Methodology

The target of this project is to allow DHS stakeholders to make better decisions or determinations about border enforcement strategies. These decisions or determinations will be supported by analysis of geographic and non-geographic data that have been located, plotted and mapped. They will also be supported by survey data about smuggling contracts and other journey dynamics that will be analyzed and provided in narrative form with tables and charts.

This project will acquire open-source and commercially-available aerial imagery which will assist in the visual identification of support-infrastructure related to Human Smuggling movement and allow for cover-change detection.

These include the discovery of new pathways leading to river crossings, visible alteration of surface features that reveal human activity, and other discernable changes to the landscape.

Once identified, the positions of real-world features and captured biometric data will populate the developing geo-database using a GIS platform. These include existing and conspicuous multi-modal transportation means and conveyances.

5. Project Tasks (7/1/2017 – 6/30/2018)

ID	Description	Completion Date
T.1	Complete Data Collection	12/17
T.2	Develop/Conduct Migrant (“Smugglers Contract”) Surveys	12/17
T.3	Travel to D.C./DHS HQs for Update Meeting with Stakeholders/Champions	11/17
T.4	Perform Analysis/Validate Proof of Concept	06/18
T.5	Period III Review and Publish Findings	04/18
T.6	Travel to D.C./DHS to Delivery of Project Findings & Final Report	06/18

(T.1) Complete Data Collection

(T.2) Develop and conduct surveys based on DHS Requirement for knowledge of “migrant-smuggler’s contracts.

(T.3) Travel to D.C./DHS HQs for update meetings with Champions.

(T.4) Perform Analysis/Validate Proof of Concept

- Construct a base map (framework)
- Conduct theoretical analysis for data usage by operators
- Conduct practical exercise with DHS stakeholders
- Quarterly meeting with Champions.

(T.5) Conduct Period III Project Review and publish Project

(T.6) Travel to D.C./DHS HQs for final meeting and delivery of Project Findings & Final Report with/to Champions.

6. Project Milestones (7/1/2017-6/30/2018)

ID	Description	Completion Date
M.1	Populate the Mapping Tool	12/17
M.2	Perform the Analyses	04/18
M.3	Proof of Concept/Make decisions based on analyses	06/18

M.1 - Populate the mapping tool

- A geodatabase will be designed to reflect the nature of the project’s goals;
- The geodatabase will be designed provide the environment for the storage and retrieval of collected tabular and spatial data;
- The geodatabase will enable users to identify the locations of immigrant activities, support structures and/or movement along any transit routes;
- Interview information acquired through surveys will be organized, collated and converted into tables for integration with GIS datasets for further analysis.

M.2 - Perform the analysis

- Communicate with stakeholders to identify real-world data requirements;
- Based on data requirements received, provide a model environment within the mapping tool that reflects real-world features relating to immigrants and the spaces through which they move
- Based on data requirements received begin to answer questions by spatially manipulate those features within the mapping tool
- The analysis will exploit the geometries of these features to be used as input for to answer general questions like *What is where?* With regards to this project, examples of questions which can be answered with such analyses may be *Through which Mexican administrative units do immigrant routes pass? Which immigrant support structures are within walking distance to railroads? or How many known border crossing points does the Tucson Border Patrol District contain?*
- To further enhance analyses and provide answers to “why” the migrants have chosen to depart their home countries for the U.S., policy-related answers derived from surveys will complement the mapping data.

M.3 – Proof of Concept/Make decisions based on analysis

- The results of spatial analyses through generation of resulting map layers, can be visualized within desktop or web-based mapping environments for researchers and government users
- The results of spatial analyses through generation of information products such as tables, charts and graphs can be visualized within desktop or web-based mapping environments for researchers and government users
- From these derivatives, decisions can be made which can help optimize resource allocation.

7. Project Deliverables (Outputs) (7/1/2017 – 6/30/2018)

ID	Description	Delivery Date
D.1	Project Findings & Final Report	06/18
D.2	Delivery of Map Service/Database	06/18

- D.1 – A meeting will be convened at the end of the period and a Project Findings & Final Report will be published that will deliver the results of the data analysis performed.
The narrative document will provide baseline information about migration patterns, including maps showing routes and support structures. The narrative document will also describe the technology tools available for decision-making. It will also provide the findings of migrant surveys conducted during both performance periods.
- D.2 – A database (also known as the Map Service) containing the sum of all data collection, mapping, analysis and employment of GIS to solve questions of an “unknown” nature will be delivered. This database will complement the on-line map service (ArcGISonline.com Web Mapping Service) to be deployed which will allow DHS users in Washington and the field access to the data collected and analyzed.

8. Performance Metrics

ID	Description	Qualitative Performance Target	Achieved by (MMYY)
P.1	Score on the Mapping Tool Rubric.	Above 80%	06/18
P.2	Score on the Rubric for Project Findings & Final Report	Above 80%	06/18

ID	Baseline Performance on 06/16	How is baseline established?
P.1	Define and apply “unknowns” to a baseline model	Identify stakeholder needs and requirements
P.2	Identify and use existing analysis models	Site visit and collaboration with stakeholders

ID	How will final performance be assessed?
P.1	Mapping tool functions as expected and as assessed by Project Champion using Rubric

8.a. Mapping Tool Rubric

Criterion 1: Clear identification and attribution of unique real-world features that describe the geography of a framework for Human Smuggling previously not located and mapped. In evaluating this criterion, the following questions will be considered:					
	Strongly Disagree (0)	Disagree (1)	Neutral (2)	Agree (3)	Strongly Agree (4)
Does the mapping tool enable the user to locate components of the previously-unknown framework for Human Smuggling?					
Are the components of the geographic human smuggling framework identified by attributes describing types of support activities, place names and geographic coordinates?					
Are smuggling routes identified and separated by conveyance method?					

Criterion 2: The specific software used to develop the Mapping Tool is suitable for meeting the Project’s Goals and Objectives. In evaluating this criterion, the following questions will be considered:					
	Strongly Disagree (0)	Disagree (1)	Neutral (2)	Agree (3)	Strongly Agree (4)
Is the Mapping Tool “user-friendly” and/or easy to use?					
Is the Mapping tool data easily migrated or integrated with DHS databases of Human Smuggling routes, patterns and support structures?					

Does the Mapping tool provide “added value” to DHS data bases regarding Human Smuggling activities?					
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Criterion 3: The locational data represented within the Mapping Tool is sourced to its origin to ensure reliability and validity. In evaluating this criterion, the following questions will be considered:					
	Strongly Disagree (0)	Disagree (1)	Neutral (2)	Agree (3)	Strongly Agree (4)
Are the individual data points identified by origin or source?					
Are the individual data points validated by a validity and/or reliability structure?					

9. Stakeholder Engagement

DHS Office of Policy; Department of Homeland Security.

10. Notional Transition Plan

10.a Categories of Deliverables:

- Database + Visualization
- Brief; Report; Policy document

10.b End Users:

- a. Office of Immigration Statistics, DHS Washington, D.C.
 - Use Case: Policy Brief. The brief will contain a narrative of the hypothesis, work conducted, data collected, data analyzed, the resulting findings and policy recommendations.
- b. Deputy Chief, U.S. Border Patrol Headquarters, Washington, D.C.;
- c. Operations Officer, Strategic Planning & Analysis Directorate, U.S. Border Patrol Headquarters, Washington, D.C.
- d. Sector Chiefs, Nine Sectors
- e. Patrol Agents in Charge – Sector Intelligence Units, Nine Sectors
 - Use Case 1: Policy Brief. The brief will contain a narrative of the hypothesis, work conducted, data collected, data analyzed and the resulting findings.
 - Use Case 2: Database and Mapping Tool (Visualization.) The mapping tool developed by this project will allow USBP HQs and field personnel to access granular geographic data and manipulate geographic data collected during this project, in support of their mission. The mapping tool will be developed on ArcGIS, a commercially available, off-the-shelf, mapping utility that can be easily integrated by USBP GIS Analysts. The mapping tool will be easily and further developed by USBP GIS Analysts familiar with the ArcGIS software.

- There are no requirements, at this time, for further development of the proposed mapping tool.
- There are no improvements necessary, at this time, for using or adopting the proposed mapping tool.
- The USBP already has access to an ArcGIS software license and utilizes the software as part of their mission.
- There are no known alternate technologies or products that could address the requirements for mapping migrant support structures in Mexico.

10.c Transition Approach and Delivery (End of Year 3: 6/30/2018)

- The project will deliver physical Geo-database on a hard drive (also known as the Map Service). The Map Service will contain the sum of all data collection, mapping, analysis and employment of GIS to solve questions of an “unknown” nature.
- This database will complement the on-line map service (ArcGISonline.com Web Mapping Service) to be deployed which will allow DHS users in Washington and the field access to the data collected and analyzed.
- The project will publish the contents of the database on an internal DHS web-map for policy and field users.
- The project will convene a meeting to deliver the mapping tool, project findings and final report (hereafter Policy Brief) publication to DHS Champions and USBP Stakeholders.
- The Policy Brief will contain the results of the data analysis performed including baseline information about migration patterns and will include maps to show routes and support structures used on the migrants routes.
- The Policy Brief will also describe the technology tools available for decision-making.
- The Policy Brief will also provide the results of migrant surveys conducted during both performance periods including any data collected regarding migrant motivations, smuggler contracts, decision points and consequence factors identified during the research.

11. Project Outcomes

Better representation of known and unknown data utilizing GIS analysis tools will enhance DHS ability to better understand the information

Data will be converted to geographic context which will allow DHS the ability to conduct spatial (locational) queries with respect to other related data sets.

This view of the data allows field operators to become more efficient and thereby more adequately focus on, or prioritize, the allocation of resources.

12. Programmatic Risks and Mitigation Plans

There are some potential risks of data verification regarding immigrants/smugglers:

There is a potential for being unable to validate data of subjects within the smuggling patterns.

Mitigation: Most of the data collected will be about places and locations of immigrant supply structures. In those cases where individual immigrants reveal their Personally Identifying Information (PII) during survey collection, the project personnel will react according to the Sensitive Information Protection Plan.

Some subjects may be a part of an ongoing investigation of suspects, such as recruiters, transporters and other exploiters of vulnerable individuals.

Mitigation: The Principal Investigator and (yet-to-be-identified) Survey Collector are former law enforcement officials with security clearances. The Principal Investigator has a current SECRET security clearance. The Survey Collector will be a retired Border Patrol Agent with an active national level security clearance. Both participants are knowledgeable of Sensitive material designations. Any PII of suspects, recruiters, transporters or others involved in Human Smuggling will be handled according to the Sensitive Information Protection Plan.

Security Technologies Kitchen (STK)

Project PI: Shishir K. Shah, Univ. of Houston

Project co-PI: Ioannis A. Kakadiaris, Univ. of Houston

Introduction

The Security Technologies Kitchen (STK) is an educational initiative that directly aligns with the DHS's mission of producing a new generation of HS experts by informing current STEM students of the critical mission of the DHS and engaging them in real-world problems that have a direct and obvious impact on our nation's security. Specifically, this project will provide resources and educate students in security technologies relevant to biometrics, situational awareness, and technologies for first responders.

Gap/Challenge Question(s) being addressed

Background & Motivation: DHS has a growing need for a next generation of homeland security professionals who can address current and emerging challenges related to security technologies and their applications as they relate to DHS's strategic initiatives. Specifically, CBP has a need to develop a pipeline of STEM educated professionals who are aware of, and knowledgeable in, the challenges and technologies relevant to land border security, maritime border security, POE security, and first responder technologies. Improved awareness of the challenges facing CBP and other HSE, coupled with training and exposure to technologies that can be used to facilitate solutions, will help encourage STEM students to consider career options that can serve the mission of CBP and other HSE. This project will serve as an educational initiative that directly aligns to meet this need. Specifically, this project will provide resources and educate students in security technologies relevant to biometrics, facilitating legalized trade, cargo screening, situational awareness, and technologies for first responders.

Challenges: Producing a new generation of HS experts who have an enhanced understanding of the critical mission of DHS and the HSE, are educated and trained in STEM fields, and have received hands-on training through project-driven problem solving that uses security technologies that are relevant in solving real-world problems that have a direct and obvious impact on our nation's security.

3. Goal and Objectives

The overall objectives of STK are:

- to educate students about the critical mission of DHS and the HSE, and to increase an understanding on how their STEM knowledge and skills can be used in the context of HS;
- to develop and offer relevant coursework to support education of students in fundamentals of engineering design, problem solving, and design and testing of security solutions;
- to provide hands-on training in addressing real-world problems motivated by current and emerging challenges relevant to border security, and legal trade and immigration; and
- to provide space and support for those students to develop and test ideas related to technologies and solutions relevant to HS challenges.

4. Methodology

In the first year of this project, a new course and educational material has been developed to support education of students in the fundamentals of engineering design, human centered approach to problem solving, and design and development of security solutions leveraging visual sensing. We will build on this effort and will leverage the capstone and/or senior project

requirement of STEM curricula. We will continue to form meaningful connections between university faculty who can mentor research and development of technology projects that relate to HS and students from diverse STEM fields. The developed coursework will be expanded to accommodate students from Engineering, Technology, and Computational fields. This will facilitate the development of a pipeline of diverse individuals to be recruited and trained. Students who are within two years of their graduation will be recruited. We will target US citizens for this effort.

Developed educational material will be expanded to continue the core objective of educating and training students in multiple areas including DHS mission, challenges, career options, project-based training, and development of technology solutions using incremental and agile development cycles and team-oriented execution. Faculty mentors will be identified from diverse STEM disciplines and will develop project ideas that would be relevant to HS mission and challenges by working closely with Office of Training and Development (OTD). Recruited students will be able to choose from a pool of projects to work on and will develop an initial project plan that will include relevant literature review, a summary of existing methodologies and solutions for the identified problem, and a proposed solution to the problem. In guidance from the faculty mentors, students will implement/develop the proposed solution and its findings will be summarized at the end of the course.

STK will continue to provide the necessary equipment to quickly prototype project solutions, including meeting/conference space, data acquisition and analysis tools. We will purchase additional small equipment and sensors needed for the execution of student projects.

We will advise and engage faculty across STEM disciplines; leverage existing student recruitment focused NSF programs and NSA programs of relevance to HS; partner with community, industry, and HSE representatives to provide students with understanding of relevant real-world challenges and use of relevant technologies, technical support, and professional mentorship.

We will work closely with the Office of Training and Development (OTD). We will consult with OTD in developing appropriate projects that will relate to problems/challenges that are relevant for CBP. We will also work with OTD in identifying other stakeholders who could inform and serve as guides and mentors of student projects. OTD will also provide guidance and feedback based on our assessment reports and student project reports. We anticipate making 2 trips each year to Washington DC to meet with OTD and other CBP stakeholders to inform them about project progress and seek input in student project topics.

5. Tasks

ID	Description	Duration (Start and end as # of months past start date)
T.1	Meeting with project champion	07/17
T.2	Develop and update material to educate students about the mission of DHS and HSE	09/17
T.3	Outline possible project topics and define their objectives	10/17
T.4	Meeting with project champion to discuss and finalize project topics	11/17
T.5	Identify faculty mentors, develop educational material and resources necessary for finalized STK projects, and recruit students	01/18

T.6	Perform surveys and evaluations	02/18
T.7	Meeting with project champion	03/18
T.8	Conduct training, assess project progress, and facilitate project execution	05/18
T.9	Perform surveys and evaluations	05/18
T.10	Perform analysis and write annual report	06/18
T.11	Develop presentation material such as a poster and/or short video that showcases the project and developed solution	05/18
T.12	Meeting with project champion	06/18

6. Milestones

ID	Description	Completed by
M.1	Students recruited and assigned a project	01/18
M.2	Projects completed and student training assessed	05/18
M.3	Presentation material such as a poster and/or video developed to showcase the project and developed solution	06/18

7. Deliverables (Outputs)

ID	Description	Completed by
D.1	Course description, developed project topics, and education material to support hands-on training and mentoring for project topics relevant to HS	06/18
D.2	Project reports describing team projects and implemented solutions	06/18
D.3	Annual report	06/18
D.4	Poster and/or video developed to showcase project and developed solution	06/18

8. Performance Metrics

Evaluation of the project will include both formative and summative activities. Formative evaluation will be conducted each year of the grant period. The purpose of the formative evaluation will be to receive feedback from project participants in order to modify and improve the program.

Surveys and interviews will be conducted with both students and faculty to obtain feedback in the following areas:

- (1) Student level of knowledge pertaining to HS issues;
- (2) Student interest towards HS technology solution needs;
- (3) Feedback on adequacy of STK facility and project-based course implementation; and
- (4) Faculty assessment of projects.

Students completing the course and project will be surveyed about their post-graduation intentions. It is hypothesized that these students will be more likely to pursue HS-related fields after graduation than students who did not participate in the course.

The summative survey will measure the following:

- (a) # of students who intend to obtain employment in an HS-related area;
- (b) # of students who intend to pursue graduate research or career in an HS-related area.

The formative and summative assessments will be developed based on a Likert scale and the responses analyzed will be included in the annual reports.

ID	Description	Quantitative Target	Performance Achieved by
P. 1	# of students that intend to obtain employment in an HS-related area	>20% of students who will complete STK projects	06/18
P. 2	# of students that intend to pursue graduate research in an HS-related area	>20% of students who will complete STK projects	06/18

ID	Baseline Performance	How is baseline established?
P.1	Unknown	We will conduct a survey of students interested in participating in STK. The survey will include questions related to their awareness of DHS mission and challenges along with questions about their intent to obtain employment in HS-related areas. The survey will be based on a Likert scale and the responses analyzed to form aggregate measures. The baseline measure will also be compared to responses obtained from students participating in STK in the first year of the project.
P.2	Unknown	We will conduct a survey of students interested in participating in STK. The survey will include questions related to their awareness of DHS mission and challenges along with questions about their intent to pursue further studies in HS-related areas. The survey will be based on a Likert scale and the responses analyzed to form aggregate measures. The baseline measure will also be compared to responses obtained from students participating in STK in the first year of the project.

ID	How will final performance be assessed?
P.1	We will conduct a survey of students who complete STK projects. The survey will include questions about their intent to obtain employment in HS-related areas. The survey will be based on a Likert scale and the responses analyzed to form aggregate measures.
P.2	We will conduct a survey of students who complete STK projects. The survey will include questions about their intent to pursue further studies or seek employment in HS-related areas. The survey will be based on a Likert scale and the responses analyzed to form aggregate measures.

9. Stakeholder Engagement

MCBP OTD will be our primary contact. In addition, we will engage with TSA, ICE and other HSE to create a cohort of partners to gain an understanding of HS-related real-world challenges. These will be used to generate student projects that will utilize fundamental

technologies. Engaged stakeholders and the broader HS community will be invited for project demos and presentations, and to provide formative feedback.

10. Notional Transition Plan

The deliverable for this project is the curriculum and developed course material. The material will be provided to the U.S. Customs and Border Protection, Office of Training and Development. The material will include a syllabus with learning objective along with notes and learning resources for each topic of the syllabus. In addition, homework and project descriptions taken up by student teams will also be provided along with video presentations of each project made by the student teams. Additional learning resources for sensors and technological platform used for student projects will also be provided. The beneficiaries of this material will be US CBP officers and personnel involved in training new agents, analysts, and law enforcement personnel. Use and further dissemination of the material will be decided by the Office of Training and Development at US CBP.

The developed material is expected to educate the next generation of individuals interested in careers with Homeland Security Enterprise, specifically in the applicability of advances in technology to further serve the mission of DHS. To ensure adoption, the curriculum has to provide foundational knowledge in developing security related technological solutions and incorporate the ability to balance the use of technology with domain constraints.

11. Student Involvement

We will aim to recruit 20 students to work on projects to be developed within STK.

12. Impact/Benefit (Outcomes)

- **DHS:** This project contributes to improvements in HS by motivating a new cohort of students to engage in HS activities and potentially pursue careers in a HS-related field. Students from STEM fields who are within two years of their graduation will be recruited. Specifically, this initiative will support the strategic direction of engineering a pipeline for the next generation of Homeland Security professionals.
- **Stakeholders/HSE:** We will directly interact with CBP OTD. CBP has a growing need for next generation of homeland security professionals who can address current and emerging challenges related to security technologies and their applications as they relate to strategic initiatives of land border security, maritime border security, POE security, and first responder technologies. Improved awareness of the challenges facing CBP and other HSE coupled with training and exposure to technologies that can be used to facilitate solutions will help encourage STEM students to consider career options that can serve the mission of CBP and other HSE including ICE, NPPD, and USCG.

13. Programmatic Risks and Mitigation Plans

The critical programmatic risks involve successful recruitment of students and defining of appropriate and relevant STK projects. We will seek to recruit US citizens for this program. This risk will be mitigated through our multi-pronged recruitment efforts. We will engage closely with OTD to help gain understanding of HS challenges and shape relevant project definition and scope.

Homeland Security Symposium Series

Project PI: Victor M. Manjarrez, Jr.

1. Introduction

The homeland Security Symposium Series addresses educational and supplemental training needs identified by DHS and other homeland security enterprise stakeholders. The University of Texas at El Paso (UTEP) has developed a symposium series on topical issues related to border security and legitimate trade and travel. The nature of the project allows that other topical themes may emerge during the performance period, as stakeholders dictate. The symposium series utilizes subject matter experts contracted by UTEP, including the possibility of DHS Centers of Excellence, DHS Officials, UTEP and partner university faculty. Symposia will be half day events with the possibility of one event becoming a full day event. The aim of this program is to assist in maturing and strengthening the homeland security enterprise. The symposium series is at not no cost to attendees and no funds are used for the travel of attendees to any symposium event. The previous point is consistently made clear in symposium advertising.

2. Gap/Challenge Question(s) being addressed

Background and Motivation: The Department of Homeland Security has identified 'maturing' and 'strengthening' the homeland security enterprise as outlines in its strategic plan and in the 2014 Quadrennial Homeland Security Review (QHSR) as a key component to its workforce development. Not only does the Homeland Security Symposium Series (HSSS) leverage existing research symposiums, the PI understands that BTI Institute research projects will eventually have potential training and educational relevance. The HSSS is a good platform to further distribute the results of the applicable BTI Institute research projects, if the BTI Institute Director deems appropriate.

Workforce Challenges: Workforce development is often challenged by budgetary constraints that not only impact the department but a large array of state and local homeland security practitioners. The DHS National Training and Education Division has historically done a poor job within the homeland security enterprise in promoting current course offerings to state and local entities. In addition, the division normally requires a minimum number of personnel in attendance that surpasses what federal, state, and local entities can afford to provide alone. Although the DHS course offerings will be leverage for this program, it will not be the only avenue for course material as discussed in other portions of this plan.

3. Goal and Objectives

The goals for this program include: (1) disseminating research findings, data, and results from relevant research through face-to-face and online modalities, as deemed appropriate by the PI; (2) providing training and education to meet the needs of DHS component agencies, local law enforcement, and other homeland security stakeholders.

4. Methodology

The symposium series topics and content are driven by the needs of stakeholders within the homeland security enterprise. Although UTEP is aware of the thematic areas of interest, the PI will continue to solicit stakeholder input. Existing DHS approved courses meeting a need identified by the BTI Institute constituency may be offered through the symposium series as well the results of applicable research findings conducted by DHS COE network affiliates, other

institutions of higher education to include UTEP. The exit surveys for symposia will play a vital role in the development of future symposia events by seeking the participant's interest in both expanding the content of the symposia they attended or providing the opportunity to suggest other topical interests. In addition, applicable BTI Institute or other DHS COE research projects have potential relevance in the HSSS. The PI will coordinate with the BTI Institute Director or appointee to maximize those opportunities to further distribute the research findings. The PI will suggest future topics, which may include based on continuous stakeholder engagement and exit surveys but are not limited to, the following areas of interest. The topical issues will be contingent on stakeholder approval.

1. Homeland Security Enterprise
 - Understanding domestic and foreign threats
 - Cyber social network analysis
 - Human Trafficking Identification
 - Transnational Criminal Organization Network Analysis
 - Money laundering
 - Impact and the driving force of the flow of unaccompanied minors
 - DNA law enforcement topics
 - Forensics (Cyber, pollen, evidence, etc.)
 - Violence on the border
 - Gangs (U.S. & Transnational)
 - Learning the responses by other countries to domestic terrorism
 - Use of Force issues
 - Policing related issues
 - Interviewing and interrogation
 - Cultural awareness
 - Terrorism (specific aspects to be developed)

2. Trade and Travel
 - Commercial fraud
 - Impact of economic policies on enforcement
 - Game Theory as it relates to ports of entries
 - Bulk cash smuggling
 - Emerging technologies for trade

The themes above represent broad notions and are subject to modification based on stakeholder input and approval. The PI will deliver five (5) symposiums during the performance period.

5. Tasks

ID	Description	Duration (Start and end as # of months past start date)
T.1	Meeting with project champion (telephonic)	07/17: Zero month
T.2	Select first two topics of the symposia series	08/17: Two months
T.3	Seek course providers/materials to meet interests identified	08/17: Two months
T.4	Announce and schedule first two symposium events	09/17: Three months

T.5	Symposium 1	10/17: Four months
T.6	Meeting with project champion (telephonic)	10/17: Four months
T.7	Announce and schedule third and fourth symposium event	12/17: Six months
T.8	Symposium 2	12/17: Six months
T.9	Symposium 3	02/18: Eight months
T.10	Meeting with project champion (telephonic)	01/18: Seven months
T.11	Announce and schedule fifth symposium event	03/18: Nine months
T.12	Symposium 4	04/18: Ten months
T.13	Symposium 5	06/18: Twelve months
T.14	Meeting with project champion (telephonic)	06/18: Twelve months

6. Milestones

ID	Description	Completed by
M.1	Deliver five (5) symposium events	06/18
M.2	Conduct and distribute to the BTI Institute Director a symposium After Action Report for symposium 1.	December 2017
M.3	Conduct and distribute to the BTI Institute Director a symposium After Action Report for symposium 2.	February 2018
M.4	Conduct and distribute to the BTI Institute Director a symposium After Action Report for symposium 3.	April 2018
M.5	Conduct and distribute to the BTI Institute Director a symposium After Action Report for symposium 4.	May 2018
M.6	Conduct and distribute to the BTI Institute Director a symposium After Action Report for symposium 5.	July 2018

7. Deliverables (Outputs)

ID	Description	Completed by
D.1	Symposia #1: Results of the Pre/Post Symposia Tests, Exit Satisfaction Surveys, Research in Brief, After Action Report, and Symposia recordings	12/17
D.2	Symposia #2: Results of the Pre/Post Symposia Tests, Exit Satisfaction Surveys, Research in Brief, After Action Report, and Symposia recordings	2/18

D.3	Symposia #3: Results of the Pre/Post Symposia Tests, Exit Satisfaction Surveys, Research in Brief, After Action Report, and Symposia recordings	4/18
D.4	Symposia #4: Results of the Pre/Post Symposia Tests, Exit Satisfaction Surveys, Research in Brief, After Action Report, and Symposia recordings	5/18
D.5	Symposia #5: Results of the Pre/Post Symposia Tests, Exit Satisfaction Surveys, Research in Brief, After Action Report, and Symposia recordings	7/18

8. Performance Metrics

ID	Description	Quantitative Performance Target	Achieved by
P.1	Satisfaction with symposia content, quality, and relevance as reported by participant exit surveys	Above 70%	Each symposia event.
P.2	Conduct a single pre-test and post-test for each symposium to measure learning as result of the event experience	The average Post-Test score will be 10 points higher than the average Pre-Test Score (The scale will be 0 – 100)	Before and after each symposia event.
P.3	Conduct a single pre-test and post-test for each symposium to measure learning as result of the event experience	Average participant post-score of 70% or better	Before and after each symposia event.

ID	Baseline Performance	How is baseline established?
P.1	Not Applicable	Not Applicable
P.2	Not Applicable	Not Applicable
P.3	Not Applicable	Not Applicable

ID	How will final performance be assessed?
P.1	Survey of all participants
P.2	Pre-test and post-test evaluation
P.3	Pre-test and post-test evaluation

9. Stakeholder Engagement

Unless otherwise noted by either the BTI Institute Director or the DHS S&T OUP Program Manager the DHS stakeholder will continue to be the CBP Office of Training and Development (OTD). The PI will schedule a quarterly call with CBP OTD personnel.

The PI will coordinate closely with local stakeholders to assess desired attributes of the proposed symposium series, student learning outcomes, and course coverage areas. The PI for this project typically engages homeland security enterprise stakeholders on a weekly basis (telephonically, email, and face-to-face), but for the purpose of this project the PI has developed a local Homeland Security Symposia Series Advisory Board (HSSSAB). The HSSSAB will quarterly and will consist of the following agencies for the purpose of capturing the topics of interest for federal, state, and local homeland security enterprise first responders:

- ICE HSI and ERO
- CBP (US Border Patrol and Office of Field Operations)
- Transportation Security Administration
- US Secret Service
- US Army Research Lab
- El Paso Sheriff's Office
- El Paso Police Department

10. Notional Transition Plan

The symposium series topics and content are driven by the needs of stakeholders within the homeland security enterprise. Although UTEP is aware of the thematic areas of interest, UTEP will continue to solicit stakeholder input. Completed and applicable research by the BTI and within the network of other DHS Centers of Excellence will be analyzed by the PI and the BTI Thrust Lead for possible inclusion in the symposium series. The PI understands the usefulness of the symposium topics are critical to maintain relevancy to practitioners of the homeland security enterprise. In order to ensure relevancy of the symposium the PI has and will continue the following two practices:

1. *Exit Survey*: Conducting exit surveys will allow UTEP to review both positive and negative feedback about the homeland security symposium series content, instructors, facilities and equipment, etc. This information allows UTEP to evaluate itself and implement changes to improve the overall quality of the homeland security symposium series.
2. *After Action Reports*: The survey will seek information from participants in areas such as achievement of participant's expectations, the symposium increased the participant's knowledge in the subject matter, the content was relevant and useful to the participant's current employment, effectiveness of instruction, etc. The PI will compile exit survey statistics based on the results of its most recent homeland security symposium series event to determine the if the rates are congruent with the program's goals and objectives. The PI will summarize the feedback received from the exit surveys and present those findings in the quarterly Homeland Security Symposium Series Advisory Board (please stakeholder engagement for further information on the Board) in the form of an After Action Report to review the feedback received from the surveys. Based on the summarized feedback, recommendations for improvement are discussed and agreed upon, if applicable. Improvements are implemented and results are monitored and documented through the exit surveys and after action reports. Subsequent boards meetings are utilized to determine if whether the new procedures should continue or

further changes are needed. Solicitation of feedback, assessment of feedback, implementation and monitoring of improvements is an ongoing cycle. In addition, the PI will conduct the same type of cycle on an annual basis with DHS CBP OTD.

Recordings/Material: Recordings, After Action Reports, and Research in Brief materials will be delivered to the BTI Institute Director within 60 days of the conclusion of the symposium event in electronic in addition to being placed on either the BTI or Center for Law and Human Behavior websites for further dissemination. The materials will be maintained on either a UTEP or BTI website and available to the general public, to include members of the homeland security enterprise, for no less than three (3) years after the date of the symposium.

Although not all DHS entities see the value in live webcasts of the symposiums, there is a general agreement the recorded, edited, and archived materials serve as an additional resource to their respective work-force. The symposium materials to include agendas, PowerPoints, Research in Briefs, and videos will continue to be available.

11. Student Involvement

Undergraduate Students:

Total Number: 2

Two undergraduate students will both work on the flowing tasks: T3-5, T7-9, and T11-13.

Both students are being exposed to research and the Department of Homeland Security for the very first time. Not only will they gain exposure to the department they will develop workforce skills that will benefit them in the future (meeting timelines, preparing reports, scheduling, interacting with homeland security practitioners, etc.)

Both students will be involved with milestones M1-M6 and deliverables D1-5. The students will benefit from this work as they will be exposed to the various components of the homeland security enterprise and in particular the Department of Homeland Security. The students will gain an understanding that the Department of Homeland Security is career option that does not necessarily require law enforcement skills. The students will interact with high levels pf practitioners exposing them to terrific role models. In addition, they will further develop critical thinking and problem solving skills.

12. Impact/Benefit (Outcomes)

- **DHS**
- **Stakeholders/HSE/Others**

The intent of the project outcomes is to advance or impact the homeland security enterprise workforce capabilities by enhancing the knowledge, skills and abilities of practitioners. The curriculum will be driven by and consistent with DHS workforce development, training, and education “unity of effort” initiatives that are consistent and directly support the objective of maturing and strengthening the homeland security enterprise as outline in the 2014-2018 DHS Strategic Plan and the 2014 Quadrennial Homeland Security Review (QHSR). In particular, the goal of enhancing the DHS workforce is supported by this program. The program seeks to do the following:

- Deliver 5 symposia during the performance period

- 70% satisfaction with symposia content, quality, and relevance as reported by participants in exit surveys.
- Attract a diverse audience of federal, state, local, and tribal homeland security enterprise stakeholders as reported in symposia After Action Reports.
- Symposia series events will be accessible and available to a larger audience than in actual physical attendance by placing recorded event information on the Center for Law & Human Behavior (CLHB) website, YouTube, or other social media platforms as identified by the PI.
- Widely distribute the “Research in Brief” briefing papers through the CLHB website and/or other mediums deemed appropriate by the PI.

13. Programmatic Risks and Mitigation Plans

Course availability in regards to offerings and time periods appear to be the biggest programmatic risks. Secondary in nature is the non-participation of homeland security enterprise practitioners in symposia events due to exigent circumstances.

The PI will present his findings, approaches, results, as well as, any potential obstacles to success. The PI also will report to the BTI Institute Director the progress he has made on the project as well as critical metrics including the number of stakeholder-endorsed symposiums that are developed. The results and input received from stakeholder focus groups will also periodically reported to the BTI Institute Director. Regarding focus groups, the PI will provide status updates in his engagements with stakeholders and continue to solicit input to further refine the symposium content to ensure it meets their training and/or educational needs. If problems require a mitigation plan, the PI will provide one for the Director’s assessment.

Image and Video Person Identification in an Operational Environment

Project PI: Ioannis A. Kakadiaris, University of Houston

Project co-PI: Shishir K. Shah, University of Houston

1. Introduction

Effectively screening and identifying individuals against both known and unknown perpetrators is encumbered by the unconstrained pose, arbitrary illumination conditions, and resolution mismatches present in the image and video data compared. This problem is compounded when the image or video of an individual is acquired at a distance using trail cameras, which is often the case at US borders. To address these challenges, our approach is to develop new methods and integrate existing solutions as needed to improve overall operational and performance capabilities. Our goal is to develop accurate, robust and efficient face recognition algorithms from image and/or video for identification in adverse outdoor conditions.

In achieving this goal, in our efforts so far, we have:

1. evaluated publicly available facial datasets for 2D-2D, 3D-3D, and 3D-aided 2D facial image matching under varying pose, inter-pupillary distance (IPD), and indoor uniform illumination;
2. curated a dataset for addressing the challenges encountered in images acquired by trail cameras (UHDB31.B);
3. developed software framework (URxD) capable of integration and evaluation of different modules to design and evaluate the face recognition problem on 2D still images;
4. developed and evaluated algorithms for landmark detection and pose estimation on the curated datasets; and
5. developed and evaluated the facial matching system for off-frontal facial probes against a frontal gallery.

To further our overall goal, the specific objectives for the next six months are to:

1. extensively benchmark our developed system for matching non-frontal images of varying resolutions to a frontal image;
2. extensively test the prototype software in collaboration with our Champion and improve upon their feedback.

2. Gap/Challenge Question(s) being addressed

Biometric technologies have gained popularity in enabling a variety of applications that require identity management. In 2000, the USS Cole was attacked by suicide bombers sailing on a small boat full of explosives during a routine refueling at Port Aden. The USS Cole's officers on duty were unaware that the seemingly innocent crew of the approaching vessel would engage in a terrorist act. But what if cameras on board the USS Cole had been able to acquire pictures of those on board the smaller vessel and use face recognition to identify any terrorist suspects among them before the smaller vessel could get dangerously close to the Cole? The Cole's crew would have had some warning. On a daily basis, numerous small vessels are boarded by Border protection or Coast Guard officers who inspect them for contraband or narcotics. Similar is the challenge for CBPO at our national borders that are faced in identifying potential perpetrators trying to cross our borders.

Challenges: The above is indicative of how face recognition can be useful in operational environments, but it also underscores the computational challenges that need to be addressed: non-uniform illumination, partial occlusions and pose variations, both under low resolution, are some of the main factors determining the difficulty of the problem.

3. Goal and Objectives

Our goal is to comprehensively understand the above challenges and develop effective facial matching solutions under availability of 2D images (from trail cameras). We believe that by using a generic 3D model of the face and by addressing variations in pose and resolution, it is possible to improve face matching and rigorously test the improved technology for operational environments of interest to CBP and ICE.

4. Methodology

The framework developed in our project so far allows for face recognition and assigns a similarity score for one-to-one comparisons between 2D images (3D-aided 2D). In the next six months, we will: (i) extensively benchmark our developed system for matching non-frontal images of varying resolutions to a frontal image; (ii) extensively test the prototype software in collaboration with our Champion and improve upon their feedback.

We will continue expanding on the 2D domain approach we have taken by constructing an appearance-based facial signature through model-based registration and alignment of two image data. The main principle of the proposed system is the registration of 2D image data using a 3D shape model. The 3D model is chosen based on a fitness criterion that accounts for the input 2D image. Building on our previous personalized model-selection scheme, a selected 3D shape model will be used to map image values to 3D surface points and vice-versa. The generic 3D shape models will be developed based on data that will encompass pose variations under varying resolutions. Using an implicit coordinate-system alignment, imposed by the surface representation of the 3D model (avoiding the explicit need for face alignment), and an explicit 3D-2D projection, we will achieve two types of data registration: local feature alignment, and pose normalization. In addition, any given image will be associated with a gallery-independent, 3D-aided signature, thus facilitating pairwise similarity values for a 1-1, accept/reject-type, verification decision or $1 - N$ identification ranking.

The fitting process will be based on the 3D deformable Annotated Face Model (AFM) that we have developed for 3D-3D face recognition. In effect, the AFM is fitted to input 3D data. Geometry images (i.e., regularly-sampled, three-channel, 2D images) are generated using the model surface parameterization, encoding the shape components (3D coordinates) of each vertex $\mathbf{v} = [X, Y, Z]^T \in \mathbb{R}^3$. These can be further enhanced to include additional channels, such as shape, texture, visibility, discriminability, annotation etc. For facial signature extraction in this work, only appearance (texture) and visibility channels will be employed. In addition, an indicator function of 3D points that are non-visible to the 2D sensor, a visibility map, is computed. In this project, all model fitting is part of the pre-processing step, of pool model construction from external, reference training data. Both gallery (enrollment) and probe (recognition) processing follow the same steps for signature extraction.

In the verification or identification stage, the input to the recognition system is a 2D image. Nine fiducial landmarks (four inner and outer eye corners, nose tip and nose inner corners, mouth corners), corresponding to the nine 3D landmarks stored for each gallery dataset, will be localized on the resulting image using the method developed in the first year. Using the 3D-2D landmark correspondences between image and 3D shape model, estimates of the facial pose and camera parameters will be acquired using a full perspective projection model, once again leveraging the

method already developed. The projection parameters will be used to define the mapping between point model and image points and assign texture values to the geometry image from the closest image texels. Specifically, after generic 3D model selection, the probe image texture will be mapped onto the retrieved or learned model, along with a visibility map (accounting for partial views and pose variations), under the estimated projection transformation. Finally, a global correlation-based similarity metric will be extracted from local gradient orientations of the pose-normalized textures.

5. Tasks

Specific Tasks

ID	Description	Duration (Start and end as # of months past start date)
T.1	Meeting with project champion	07/17
T.2	Benchmark method for matching non-frontal face images in varying resolutions	07/17 – 11/17
T.3	Test our prototype software in collaboration with our Champion	07/17 – 11/17
T.4	Refine method based on the results of testing	07/17 - 12/17
T.5	Meeting with project champion and write annual report	12/17

6. Milestones

ID	Description	Completed by
M.1	Benchmarking of our method in varying resolutions.	11/17
M.2	Feedback received during the testing of the prototype software integrated to our face matching software system	12/17

7. Deliverables (Outputs)

ID	Description	Completed by
D.1	Prototype code for facial matching (identification) for multiple probe images with pose $\pm 30^\circ$ and IPD of 250-300 pixels	12/17
D.2	Annual Report detailing the developed methods and results of performance evaluation and testing	12/17

8. Performance Metrics

ID	Description	Quantitative Performance Target	Achieved by
P.1	Rank-1 Identification rate for multiple probes with pose variations within $\pm 30^\circ$ and resolution equivalent to	At least 5% improvement over baseline	12/17

	inter-pupillary distance of 250-300 pixels		
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ID	Baseline Performance	How is baseline established?
P.1	Unknown	We will establish baseline performance by using the commercial 2D face recognition ROC SDK. Baseline will be established using images from acquired dataset for which faces are detected using a standard face detector such as Viola-Jones, and pose and image resolution is established within expected performance range ($\pm 30^\circ$ and inter-pupillary distance of 250-300 pixels).

ID	How will final performance be assessed?
P.1	We will perform face identification experiments using developed face matching algorithms on cohorts from acquired and curated dataset. CMC curves will be generated and rank-1 recognition rate will be compared against that established as baseline to measure improvement.

9. Stakeholder Engagement

Throughout the project, in collaboration with Chief Trindade and other identified partners, we will work towards identifying user groups that can benefit from the proposed system. We will make the alpha and beta versions of the system available to interested user groups and collaborating agencies for testing. Generated reports will be disseminated to collect feedback and gain more insights into operational challenges.

The development of a system for accurate, robust, and efficient face recognition algorithms from image and/or video in adverse conditions will support the mission of multiple agencies including U.S. Customs and Border Protection (CBP), Transportation Security Agency (TSA), and Immigration and Customs Enforcement (ICE). Associate Chief Trindade (Enforcement Systems, CBP) will be our direct contact and will provide guidance and feedback as we work towards each of the specified objectives.

10. Notional Transition Plan

The deliverable of this project is a software prototype for matching a facial image to a gallery of facial images with variety of poses and illuminations. This prototype software will be installed on the Intelligent Computer-Assistant Detection (IDENT) system of US Border Patrol. The output of the software is a matching score for each image in the database selected as gallery. The score provides a mechanism to rank the gallery images and assist in ascertaining a match to the input image. The beneficiaries of this information will be US BP agents, analysts, dispatchers, and

Law Enforcement Communication Assistants. Transition of the software will be decided by the Enforcement Systems Division of the US Border Patrol.

The functional requirements for the prototype software include:

- ability to ingest a set of images to create a gallery
- computing the biometric signatures (derived by the UH software) for each image in the gallery and associating the signature to the respective image in the gallery
- ability to ingest a probe image to be matched against the gallery
- computing a biometrics signature (derived by the UH software) for the image to be matched against the gallery images.
- matching computed biometric signature from a probe image to a gallery of signatures and computing a matching score.

This software is expected to improve the Division's ability to better classify threats and alerts. Integration of the software will be governed by US BP documents that describe interface standards for the software. To ensure adoption, the matching software has to improve at least two of three factors when compared with the solution US BP is currently using (or solutions that are currently available commercially): (i) statistically significant improved accuracy for rank 1 matching; (ii) lower cost of system acquisition and maintenance; and (iii) faster processing to obtain matching scores. The proposed software should not require buying licenses to additional products.

11. Student Involvement

The methods developed constitute part of the PhD thesis of the students contributing to this project. The students obtain a first-hand experience of a system working under real world conditions.

12. Impact/Benefit (Outcomes)

- **DHS/Stakeholders/HSE/Others:** The development of a system for accurate, robust, and efficient face recognition algorithms from image and/or video in adverse conditions will support the mission of multiple agencies including U.S. Customs and Border Protection (CBP), Transportation Security Agency (TSA), and Immigration and Customs Enforcement (ICE). Associate Chief Trindade (Enforcement Systems, CBP) will be our direct contact and will provide guidance and feedback as we work towards each of the specified objectives.

13. Programmatic Risks and Mitigation Plans

Developing a comprehensive understanding of the impact of pose and resolution variations is dependent on the extent of such variations exhibited in images/datasets used. This also translates to the reliability of developed algorithms intended to be robust to these variations. As a result, it is possible that datasets we have acquired/used are not sufficient to achieve the expected performance capabilities.

If this is the case, we have the capability and needed resources to collect additional data. The UH's Facial Data Acquisition System will be used to collect additional data. Students will be recruited as needed to augment the datasets.

A Systematic Process for Vulnerability Assessment of Biometric Systems at Borders

Project PI: Bojan Cukic, University of North Carolina at Charlotte

Senior Co-PIs:

- Mohamed Shehab, University of North Carolina at Charlotte
- Emanuela Marasco, University of North Carolina at Charlotte

1. Introduction

Biometric identification is a critically important technology in traveler, immigration and refugee management. The technology itself and the processes related to human identification and identity management are a prime target for identity theft, tampering, spoofing, and impersonation. In the past year, our team developed a systematic methodology for identification of biometric technology vulnerabilities and identity management process limitations. Using the methodology, we defined several attack vectors and tried to establish objective measures of risk exposure. Observed gaps are creating new research agenda for the next academic year. We propose to further develop our methodology to describe how to identify and deploy available countermeasures, technical as well as managerial, and to understand their strengths and limitations. In order to better estimate the risk of “undetected” attacks, we propose to monitor publicly available information sources that may reveal the extent of threats, availability and sophistication of attack tools and how-to recipes. Our results should lead towards a well-defined defense strategy.

2. Gap/Challenge Question(s) being addressed

This project is attempting to answer question 3.b.5 of the FOA: What future forms of biometric information have the most potential for accurate identification while being the least susceptible to defects, fraud, concealment, or manipulation? Research literature in the field of biometric security, including liveness detection and anti-spoofing is evolving. A good understanding of the risks stemming from zero-effort attacks obtained in recent years (biometric misidentification rates due to the probabilistic nature of the technology) is just the tip of the iceberg of identity misrepresentation risks in homeland security. Subverting biometric recognition with artificial materials (gummy fingers, intense face make-up or patterned lenses in eyes) is becoming known once the reports of successful attacks surface in public. In addition to technical limitations of biometric collection and matching, some of the broader identity verification processes (limitations of trust placed on foreign ID documents or exception handling due to unavailable biometric, for example) may inadvertently allow inaccurate identification or intentional acts of identity tampering. Yet, the accuracy of human identification for travelers, immigrants and refugees is the cornerstone of trustworthy immigration system and US borders, the subject of intense national scrutiny.

As the government clamps on illegal immigration and strengthens border control, the illegal and malicious activities to bypass or get through the identity checks and security vetting are likely to increase. The new generations of individuals that want to visit US as travelers, become immigrants or receive refugee status are avid technology users. For example, Syrian refugees have used social networks and smartphone apps to plan different legs of their journey to Europe, and to locate resources, aid and in some cases smugglers [1]. In addition, some refugees may have been using online social media sites to communicate and share their experiences and offer services [2]. Individuals trying to hide their identity will very likely use technology to their

advantage. These activities will inevitably be extended in the dark web space, the anonymous TOR based web, where the identity of users is secret and where the sale and distribution of illicit activities and resources can be acquired anonymously too. TOR based web forums and market places are likely to provide an Amazon-like experience that allows users to surf and purchase tools and how-to kits about avoiding identification. For example, recently, dark web vendors have advertised selling blank British passports and entry to passport database for just £2,000 [3].

In our current research, we developed a systematic approach for identification of technical and process-based vulnerabilities that could be exploited by malicious travelers, immigrants and refugees. To achieve this, we combined the understanding of biometric device vulnerabilities, biometric collection and identification workflows, hypothesized attacker's motivation, required means / costs, and required technical competence. We used attack tree notation to describe identity attack vectors. This notation allows us to develop a practical methodology for risk assessment and software tools that assist with its automation. The rest of this section describes the challenges we would like to address next year.

2017/18 Challenges: Continuation of our work on reducing the identity misrepresentation risk and misuse opportunities for travelers, immigrants and refugees requires us to address the following open problems:

1. Understand resources and techniques for identity concealment that could be acquired from open and black markets, and open and dark websites. This information would allow us to tune-up the risk model with collected metrics, costs and possible experiences related to attack vectors.
2. Assuming that the types of attack techniques made available "for sale" in open and black markets are the likely attack vectors to be attempted in practice, we can concentrate on developing Attack Countermeasure Trees. In other words, we will incorporate defense mechanisms and their effectiveness in the identity attack trees we developed and will continue to develop in our project.

3. Goals and Objectives

Our goals and objectives for 2017/18 closely follow the challenges described above. We list them here:

1. Investigate open and dark websites and compare the availability of tools, hardware and software required for faking identity and biometric presentation attacks as they may relate to immigration services. Enhance and tune-up the evaluation of the risk introduced to the immigration process based on the resources available on the dark web.
2. Investigate availability, costs, ease of acquisition, effectiveness of application and other metrics related to biometric acquisition manipulation (presentation attacks) and process tampering as it may relate to travelers, immigrants and refugees.
3. Further highlight vulnerable processes, devices, operations and activities in the visa processing, border control and vetting processes.
4. Analyze the effectiveness of known countermeasures and discuss their availability in homeland security operations.
5. Update attack trees and develop Attack Response / Countermeasure Trees that will be useful for prioritization, cost and effectiveness analysis of defensive measures, allowing

the selection of minimal and optimal measures and a preliminary Return on Investment (ROI) calculations.

4. Methodology

Proposed risk-based identity misrepresentation attack assessment methodology targets the probability of occurrence, consequences and defensive measures of non-zero-effort attacks, concealment attempts and manipulation processes. Our primary attention so far has been on feasible biometric presentation attacks to DHS biometric infrastructure and weaknesses in administrative processes and procedures that may enable them. We have developed a set attack trees based on the information available about the human factors motivating travelers, immigrants and refugee status seekers to attempt identity fraud, our understanding of adversary's resources and methods. Our hypotheses has been developed using common knowledge and published literature to avoid any possibility of sensitive information release. Adequacy and completeness of preliminary findings are being discussed with project champions and stakeholders. Nevertheless, we believe our attack trees and ensuing risk analysis can be made more accurate and useful if we expand the number and type of sources of information to include places where the information about adversary's resources and methods is commonly shared. Subsequently, we will expand our attack tree notation to reflect collected information and available defense mechanisms.

To achieve these goals, we will investigate use of crawlers for dark web spaces. These crawlers will require the use of tools that are able to operate over the TOR network such as the Ahmia Tor search engine (<http://ahmia.fi>) and the TOR browser crawlers (<https://github.com/webfp/tor-browser-crawler>).

Using the collected data, we propose updating and redeveloping the identity security cards collection (raw information about adversary's motivations, resources, methods and human impact of ensuing attacks). Subsequently, we will update and redevelop attack trees based on the information from open and black market respectively. As the attack trees are the basis for the calculation of identity attack risk, we plan to recalculate the risk by taking into account attack tree updates. Since it is logical to expect that the perpetrators of identity misrepresentation attacks will use (i.e., abuse) of information from anonymous dark web markets, new risk estimates are expected to be more accurate. More importantly, the process used to update and extend the set of attack trees will be clearly defined so it can be reused at any future point in time.

We note that current attack tree notation cannot easily integrate metrics and costs based on the newly collected data. To this end, we will extend the notation of attack trees along the lines of attack response graphs [5] and attack countermeasure trees [6]. We proposed to develop attack countermeasure trees (ACT) for identity misrepresentation attack that may be perpetrated by travelers, immigrants and refugee applicants. ACT will enable us to place defense mechanisms at any node of the tree, not just at the leaf nodes as in defense trees [7]. We will consider ACT to perform probabilistic analysis (e.g. probability of attack at the goal node, attack investment cost, impact of an attack, return on attack (ROA) and return on investment (ROI) in the defensive measures) in an integrated manner. We develop a methodology to use ACT to select an optimal countermeasure set with respect to currently identified attacks from the pool of defense mechanisms. Given that the set of biometric attack countermeasures, including liveness detection algorithms, is rapidly expanding and their impact is evaluated only within early-stage research studies, the impact of the proposed methodology may offer less expensive, yet

comprehensive defensive considerations. Adequacy and completeness of our findings will be discussed with project champions and stakeholders...

Compliance Assurances: *ITAR/Export Controls*

We have consulted UNCC ITAR/Export Control office related to the content of this proposal. Members of our research team have conducted studies that included data collection from dark web. In principle, risk modeling is not subject to export restrictions. The descriptions of biometric presentation and system attacks, which we will analyze in this project, are most likely available in academic and open literature. Dark web represents the market for their distribution. Careful consideration of available tools and techniques, their cost and ensuing risk classification represent the added value of the project, but they are not subject to ITAR/Export Control regulation since they enhance the effectiveness of defensive activities.

5. Project Tasks

ID	Description	Duration
T.1	Meeting with project champion (phone).	August 15, 2017; November 15, 2017; February 15, 2018; May 15, 2018.
T.2	Create new data management plan to include dark web data, receive approval from UNC Charlotte and BTI.	September 1, 2017
T.3	Selection of dark web browser, search engine and crawler.	October 1, 2017
T.4	Analysis of availability, costs, ease of acquisition of biometric impersonation tools	January 1, 2018
T.5	Analysis of countermeasures and definition of Attack Countermeasure Trees	April 1, 2018
T.6	Update of the Risk model	June 30, 2018

6. Project Milestones

ID	Description	Completion Date (MMYY)
M.1	Updated data management plan approved	September 15, 2017
M.2	Completed analysis of dark web	January 1, 2018
M.3	Definition of Attack Countermeasure Trees for travelers, immigration and refugee management.	April 1, 2018
M.4	Completed risk modeling for attack vectors in day-to-day operations of traveler, immigration and refugee identity management systems.	June 30, 2018

7. Project Deliverables (Outputs)

ID	Description	Delivery Date (MMYY)
D.1	Technical report: A inventory of dark web marketplace for identity misrepresentation	January 1, 2018
D2	Technical Report: Attack Countermeasure Trees for travelers, immigration and refugee management.	April 1, 2018
D.4	Conference Paper submission: Cost and ease of acquisition of biometric impersonation tools.	April 1, 2018

D.3	Final Report: Attack risk management in traveler, immigration and refugee identity management.	June 30, 2018
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8. Performance Metrics

ID	Description	Quantitative Performance Target	Achieved by (MMYY)
P.1	Identify biometric identity fraud tools for presumed perpetrator's for each of the following three DHS operational domains: a. traveler operations b. immigration services c. refugee management	At least one biometric identity fraud scenario (attack vector) for each of the three DHS operational domains.	January 1, 2017
P.2	Identify countermeasures (if any) for each attack vector identified in the previous task.	Identify at least one countermeasure in each of the three DHS operational domains: a. traveler operations b. immigration services c. refugee management	April 1, 2018
P.3	Establish risk mitigation for each attack vector identified in the previous task.	Identify at least one attack vector with High or Medium probability of occurrence in each of the three DHS operational domains.	June 30, 2018

ID	Baseline Performance	How is baseline established?
P.1	Availability and cost in illicit markets of identity subversion tools is not known.	Discussion with project champions, discussion with industry and academic colleagues.
P.2	Biometric presentation attack vectors have not been formalized and classified.	Discussion with project champions, discussion with industry and academic colleagues, peer review of papers.
P.3	Comprehensive countermeasures for biometric attack vectors in DHS domain have not been established.	Discussion with project champions, discussion with industry and academic colleagues.

ID	How final performance will be assessed?
P.1	Crawling of dark web identifies at least one biometric identity subversion tool that could be utilized in three DHS operational domains will be identified and assessed by project monitors as realistic.
P.2	The project identifies countermeasures for identity subversion tools in the three DHS operational domains.

9. Stakeholder Engagement

Proposed project and its value for the sponsor critically depend on active collaboration with stakeholders and project champion. We plan to maintain active exchange of information with the project champion (Apex Air Entry Exit Re-engineering) and other stakeholder representatives in the Resilient Systems Division (RSD) who have agreed to participate as independent evaluator of project results. Through close collaboration with project champion, the project will recruit the experts for interviews / discussions about tools that may influence identity obfuscation in DHS operations. Project will maintain monthly conference calls with project champion throughout the period of performance. The Principal Investigator and his team will brief the champion on the content of all project deliverables.

10. Notional Transition Plan

In 2017/18, our project will be in Year 2. The project is developing methodologies for monitoring threats for impersonation or identity obfuscation threats in homeland security operations that include human identification, most commonly in form of biometrics. Some of the steps in developed methodologies will be accompanied with prototype software tools. At this time, we do not anticipate that any of the products (methods or tools) will be subject to intellectual property protection.

The project is expected to create the following types of deliverables suitable for transitioning and / or infusion within the existing workflow of the sponsoring agency:

- a. Research reports with lessons learned:
 - i. A methodology for threat explanation and categorization and research findings
 - ii. A methodology for identity obfuscation threat identification (CONOPS) and research findings
- b. Selected software tools, including:
 - i. A tool for creation and maintenance of identity attack trees (2016/17)
 - ii. A toolset for crawling dark Web for threat discovery (2017/18)

In the second year of the project, we will actively seek guidance from project champions not only on the possible customers, but also how could the proposed concepts of continual identity threat monitoring be integrated within the existing agency operations. This will be discussed with the project Champion and with the director of Futures Identity office at OBIM.

Eventual tools and products that could be interesting for technology transition include dark web crawlers and software tools for modeling risks of attack vectors. The tools will be supported by the back-end probabilistic risk modeling engine and a database of risk artifacts.

11. Student Involvement

The project will include one PhD student. We plan to create research opportunities for undergraduate students during Summer 2018. The students will be funded for 6 weeks of research through a Research Experience for Undergraduates award from the National Science Foundation.

12. Impact/Benefit

- **DHS:** Proposed work will have direct benefits to DHS operational capabilities though better understanding of the level of resilience of biometric systems to attempts of identity manipulation, obfuscation, concealment and fraud. More specifically, the work will address the following theme areas of BTI:
 - Theme Area 1 Border Security, 1.a Policies, Question ID 1.a.1 - What influence would a policy requiring biometric technology have on immigration fraud?
 - Theme Area 2 Legitimate Trade and travel, 2.b Technologies, Question ID 2.b.2 - Do biometrics and mobile technologies offer opportunities to streamline processing of legitimate trade and travel?
 - Theme Area 3 Immigration, 3.b Concept of Operation, Question ID 3.b.5 - What motivates individuals to commit immigration benefit fraud and how can adjudicators identify these motivations and induce applicants to admit to fraud?
- **Stakeholders/HSE/Others** Project stakeholders will include DHS agencies that collect and verify human biometric information, including but not limited to DHS OBIM, DHS CBP, DHS S&T Human Factors. More specifically, the project is anticipated to directly influence maintenance and operations of existing biometric deployments and programs such as APEX Air Entry / Exit Re-engineering (AEER), Apex Border Enforcement Analytics, APEX Screening at Speed and possibly others. If successfully completed, the project is also expected to provide the basis for impact analysis for policy changes. For example, if a decision is to be made to mandate the use of biometrics at border crossings, the project is expected to inform decision makers about estimated cost, efforts and capabilities needed to defeat biometric verification by organized crimes groups.

13. Programmatic Risks and Mitigation Plans

Project success and its value to the sponsor depend on the level of collaboration created with the project stakeholders and agency champions. Due to possible sensitivity of project findings, principal investigators agreed that no information about misuses or exploitation of biometric vulnerabilities from the DHS operations is going to be solicited for the work described in this proposal. This situation creates the risk that the project may not identify biometric attack vectors or countermeasures that are of utmost importance (gravest impact) for operation of systems in traveler, immigration and refugee management at DHS.

We will mitigate the risk by collecting information about biometric attacks from the dark web. These attack vectors will be shared with project stakeholders. We will strive to continually demonstrate applied practical nature of the project, making sure the results are applicable to systems deployed in the operational environment.

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Modeling Methodology and Simulation of Port-of-Entry Systems

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Introduction

Fast and secure flows across U.S. Ports-of-Entry (POEs) are essential to the U.S. economy and its supply chains, whereas slow flows and disruptions can cause severe economic damage, or even pose a strategic threat to the national economic wellbeing. In particular, excessive delays at POEs are detrimental to the national economy, as they translate into a variety of economical burdens and environmental costs, including personal inconvenience to travelers in terms of time and missed connections, increased supply chain lead times and their attendant cascading disruptive effects, and an elevated transportation carbon footprint resulting in environmental and public health consequences. The U.S. Customs and Border Protection (CBP) agency is the nation's largest law enforcement agency, responsible for securing U.S. borders while facilitating lawful travel and trade across its POEs. As such, CBP plays a key role in supporting the nation's physical and economic security. However, like any government agency, CBP operates to fulfill its mission under resource constraints. Consequently, CBP needs to find efficient and cost effective solutions to the problem of managing traffic across POEs and overseeing their evolution commensurate with fluctuating traffic levels. This proposal supports this objective by providing a suite of detailed simulation models of selected POEs, allowing CBP planners to experiment with POE design configurations and operational procedures that balance the reduction of POE waiting times and the attendant costs.

Gap/Challenge Question(s) being addressed

This project is attempting to answer question 2.b.3 of the FOA: How can we measure, assess, and predict the impact of technology on the facilitation of legitimate trade and travel? Currently, CBP Office of Field Operations (which houses our project champion) uses simulation to solve primarily tactical short-term problems related to POEs. CBP further needs detailed and flexible simulation models of POEs that permit flexible experimentation and provide answers to what-if questions, primarily for planning purposes. Specifically, CBP stakeholder users need detailed simulation models of POEs to be studied and manipulated in an in-vitro laboratory environment. Typical applications include longer-term planning of POE facilities e.g., adding lanes, stacking booths by adding an additional tandem one officer in a booth, experimenting with new trusted traveler programs, as well as studying “what-if” questions on POE performance in the wake of adverse traffic surges due to hypothetical adverse events that disrupt traffic flows, such as a major accident, natural disaster, terrorist incident, etc., which require managing temporary surges of flows across POEs. Such emergency management issues should also be of interest to FEMA. Additionally, creating modeling a geographic cluster of POEs will facilitate experimenting with traffic leveling schemes across such clusters.

Goal and Objectives

The proposed project is designed to fill the gap described in the previous section by providing a suite of detailed POE simulation models, dubbed POESS (POE Simulation System). In this project, the POEs to be modeled are selected by our champion and his group at CBP, to be used as an in-vitro laboratory for experimentation and answering “what-if” questions related to effective and cost efficient traffic management across POEs. The simulation models will provide decision support, primarily for strategic longer-term planning such as capacity planning, that is, expansion

of existing POEs or creation of new ones before traffic growth overwhelms current POEs. They will also be used to study traffic management following a hypothetical adverse disruptive event that seriously impedes traffic flow.

From CBP's vantage point, the goal of this project is to support future planning of POE evolution (typically expansion) and assessing the resultant performance metrics for decision making and optimization (e.g., selecting a best configuration among a set of candidates). Detailed simulation models can be readily further modified and customized to support other DHS planning activities pertaining to hypothetical adverse scenarios, including (a) evacuation of a local population due to a natural or man-made disaster, such as inclement weather (e.g., impending hurricane or flooding), chemical accident, etc.; (b) loss of POE infrastructure (e.g., terrorist event resulting in POE closure); and (c) traffic-disruptive event (e.g., accident resulting in lane closures at a POE). Moreover, simulations of POE clusters can be used to study and understand methods of traffic balancing by directing excess traffic to a nearby alternative POE. Thus, each proposed simulation model will serve as decision support systems (DSS), namely, an application that analyzes data and presents it so that users can make business decisions more easily. In our case, the models will support analysts and decision makers in a variety of activities that guide POE evolution: analysis and evaluation of POE performance metrics, POE long-term planning, and study of hypothetical POE "what-if" scenarios.

From a user vantage point, the goal is to develop detailed simulation models of POEs that are readily understood by observers, be they experts or laypersons. This will be achieved by laying POE facilities over a realistic and familiar geographic map that shows the roads and inspection facilities layout as well as animated traffic across a POE and dynamic evolution of key statistics (e.g., histograms, means, variances, and coefficients of variation of crossing-time, etc.) and metrics (e.g., the monetized cost of waiting times to drivers, the environmental impact of waiting in terms of vehicle emissions, etc.). In a similar vein, simulation objects (facilities, vehicles, etc.) will be rendered in two or three dimensions with the ability to switch among views. Emphasis will be placed on ease of use and flexible parametrization of models (via dropdown menus, forms, tables, etc.), and selected dynamic parameterization (changing parameters, say, by sliders while the simulation is running). Furthermore, the user will be able to zoom in and out of the model to inspect a variety of hierarchical views at various structural granularities, such as a single POE station, a POE facility or a cluster of POEs. The project requirements will be guided by interaction with and input from CBP-OFO and other CBP stakeholders to ensure that the simulation tool conforms to their needs.

For this (Year-3) continuation proposal, we will complete the development of a detailed simulation model of the Bridge of the Americas POE at El Paso, Texas, which has been work-in-progress during Year 2, but model validation and transitioning is expected to complete in late summer, 2017. For the balance of Year 3, at the request of our primary champion and his group at CBP, we propose to create a detailed simulation model of the Peace Arch POE in Blaine, WA, near the U.S. – Canada border.

4. Methodology

The POE simulation methodology and detailed model development will follow the well-established paradigms of modern modeling and simulation (Law and Kelton, 2015). We will use primarily the discrete-event simulation methodology, where model building is customized to each POE. Traffic generation and modeling will use the agent-based modeling methodology, while the modeling of operations (movement through POE stations) will use a process-based modeling methodology.

Developing such detailed models calls for a powerful but reasonably priced simulation development platform. Accordingly, we have been using the AnyLogic platform (Borshchev, 2013), which admits multi-method simulation paradigms (discrete event, continuous, and agent-based), visual and textual construction of models using built-in and user-created icons, integration with general programming capabilities (using the ubiquitous Java programming language), intuitive visualization, and full animation. All these modeling methodologies are supported by the AnyLogic simulation platform, which admits mixtures thereof in the same model. The end product will be transferred to the end user as a Java application program that can run without purchasing the AnyLogic platform. However, if end users wish to change model code, then the AnyLogic platform will have to be acquired.

5. Tasks

ID	Description	Duration (Start and end as # of months past start date)
T.1	Validate the simulation model of the Bridge of the Americas (BOTA) POE	7/17 – 7/17
T.2	Meet project champion (by phone/skype or in person)	8/17
T.3	Write user manual for BOTA and deliver the BOTA simulation to CBP	8/17 – 8/17
T.4	Perform usability assessment of POESS for BOTA	9/17 – 9/17
T.5	Develop a detailed prototype simulation model design, including structure, user interface and other features of the Peace Arch POE	9/17 – 12/17
T.6	Meet project champion (by phone/skype or in person)	1/18
T.7	Code the design and produce the prototype simulation model program of the Peace Arch POE	1/18 – 4/18
T.8	Meet project champion (by phone/skype or in person)	4/18
T.9	Verify the simulation model of the Peace Arch POE	5/18 – 6/18
T.10	Meet project champion (by phone/skype or in person)	6/18

6. Milestones

ID	Description	Completed by
M.1	Completion of simulation model validation and tests of the Bridge of the Americas (BOTA) POE	8/17
M.2	Completion of usability assessment of POESS for BOTA, thereby completing the BOTA project	9/17
M.3	Completion of model information gathering and data collected of the Peace Arch POE	12/17
M.4	Completion of data models identification and preliminary parameterization of the Peace Arch POE	1/18
M.5	Completion of prototype model design and coding of the Peace Arch POE	5/18
M.6	Completion of model verification and tests of the Peace Arch POE	6/18

7. Deliverables (Outputs)

ID	Description	Completed by
D.1	Delivery of the simulation program of the BOTA POE in the public archive FIGSHARE	8/17
D.2	User manual of the simulation model of the BOTA POE	9/17
D.3	Report on the usability assessment of the POESS BOTA model	
D.4	Technical report of model description of the Peace Arch POE	12/17
D.5	Technical report describing the parameterized models of traffic and service processes for the Peace Arch POE	5/18
D.6	Annual report, to be delivered to BTI, primary project champion, and archived in arXiv. Elements of this project will be targeted for publication in peer-reviewed journals and presentation in peer-reviewed conferences.	6/18

8. Performance Metrics

ID	Description	Quantitative Performance Target	Achieved by
P.1	Usability metric of the simulation program's user interface. We will recruit up to 15 but not less than 10 potential users who will run the software in one session. They will then fill out the usability questionnaire (on a Likert scale of 1-7) in (Lund, 2001).	Average satisfaction rate > 75% through a test-retest process.	6/18
P.2	POE crossing time response curve to a range of increasing traffic congestion for sets of fixed service resources	Monotonically increasing response curve	6/18
P.3	POE crossing time response curve to a range of increasing service resources for sets of fixed traffic congestions	Monotonically decreasing response curve	6/18

ID	Baseline Performance	How is baseline established?
P.1	There is no baseline at this time	N/A
P.2	There is no baseline at this time	N/A
P.3	There is no baseline at this time	N/A

ID	How will final performance be assessed?
P.1	We will report the results and tests in the final annual report on 6/18
P.2	We will report the results and tests in the final annual report on 6/18
P.3	We will report the results and tests in the final annual report on 6/18

9. Stakeholder Engagement

Stakeholders of the POE modeling methodology and detailed models include CBP-OFO personnel e.g., , as well as emergency management components such as FEMA. We will work closely with CBP champions in designing the simulation models and their features to fit their

needs. These interactions will be carried out via site visits accompanied by presentations and tool demos as well as frequent conference calls for information exchanges and discussions.

- **Stakeholders/HSE:** The **primary champion** for this project is within the Operational and Enterprise Analytics, U.S. Customs and Border Protection. Two additional stakeholders are:
 - 1) A Secondary champion with Program Management and Shared Services, Office of Field Operations, U.S. Customs and Border Protection
 - 2) A Stakeholder who indicated interest within Cargo Security, DHS/S&T

The DSSs above will be used by CBP-OFO as a longer-term planning tool, primarily for capacity planning, that is, expansion of existing POEs or creation of new ones before traffic growth overwhelms current POEs. They will also be used to study, plan and answer “what-if” questions related to traffic management following a hypothetical adverse disruptive event such as a major accident, natural disaster, terrorist incident, etc., which require managing temporary surges of flows across POEs. Such emergency management issues should also be of interest to FEMA.

10. Notional Transition Plan

The proposed transition plan of this project centers on the suite of detailed simulation models of ports of entry (POE), dubbed POESS (Port-of-Entry Simulation System). This deliverable falls within the category **Software; Compiled Program**.

The primary use case consists of analysts and modelers of POEs. The specific end-user group is located at **Customs and Borders Protection (CBP) – Office of Field Operations (OFO)**, where our primary champion is a member.

A transition involving project outputs will take place on each POE simulation model completion. Transition elements will include the following:

1. **Software.** A newly-completed POE simulation model, developed on the AnyLogic platform, will be added to the POESS model suite. This software deliverable will be in the form of a Java app, that is, a stand-alone executable (compiled code) which does not require the AnyLogic platform; its only dependency is a Java platform for running the POESS app. In future, CBP may optionally decide to develop additional POE simulation models and add them to the POESS suite, possibly reusing POESS code. In this case, an AnyLogic platform license would need to be purchased. The initial cost of the professional AnyLogic version is approximately \$20K, and the annual renewal fee is approximately 25% of the purchase price. However, CBP could conceivably negotiate better prices for larger purchases.
2. **Documentation.** A detailed POESS user manual will be provided with the software.
3. **Training.** A hands-on training of end users of the simulation models (mainly, CBP-OFO modelers) will be administered.

Maintenance. POESS models will be maintained by the project team over the lifetime of the project. This will include bug fixes, upgrades, and minor modifications of model features based on user feedback. Additionally, we will communicate with the Intellectual Property (IP) organization of Rutgers University and discuss searching for a company to take over software

maintenance and upgrades of POESS past the project period. Commercialization arrangements will also be explored.

11. Student Involvement

The project employs one graduate student. This student is a doctoral student fully funded by the project. The main task of the student is to code the simulation program and help the PI and co-PI in POE modeling and simulation design. Accordingly, the student benefits from his role in the project by learning how to model complex systems and how to design and code the model in a simulation platform (in our case, the multi-method, Java-based AnyLogic simulation platform).

12. Impact/Benefit (Outcomes)

The following benefits will accrue from this project:

- **DHS:** Outcomes attendant to the simulation methodology and detailed models are in support of the CBP mission of facilitating fast and secure traffic across U.S. POEs, without compromising security. This project will benefit DHS by providing a suite of DSSs that support planning and operational decisions at POEs. In this project, the DSSs will be detailed simulation models of individual POEs. These will serve primarily as strategic planning tools designed to support CBP's mission of overseeing fast and secure flows of vehicles and pedestrians across U.S. POEs. The DSSs to be created will serve as easy-to-use and flexible tools that facilitate more accurate longer-term planning, as well as studying "what-if" questions concerning POE performance in a changing environment in the wake of adverse traffic surges due to hypothetical adverse events.
- **Stakeholders/HSE/Others:** Since the simulation models to be created under this project also model traffic disruptions, they will support studying "what-if" questions concerning POE performance in the wake of adverse traffic surges due to hypothetical adverse events. Consequently, such models could be of interest to organizations that deal with preparedness and emergency response, such as FEMA.

Additional outcomes that can benefit all stakeholders in this project are the intangibles of modeler end-user satisfaction stemming from ease of use and speeded up POE modeling and evaluation. As simulation modeling is a highly technical area requiring users with a high degree of expertise and experience, the POE simulation models to be developed will serve the needs of a small group of simulation experts at CBP-OFO as users; however, the stakeholder group is much broader and includes port directors and other administrators, but these will be consumers of simulation results who are not expected to directly exercise the simulation models. Since the detailed simulation models and their usability will be developed in close collaboration with the target user group, user satisfaction will be automatically ensured via ongoing discussions with the users in the course of continual interactions with them.

13. Programmatic Risks and Mitigation Plans

The main risk is not achieving adequate fidelity when modeling incoming traffic. If that proves unsatisfactory (say, due to actual traffic burstiness), we will use time series generation techniques that inject autocorrelation into inter-arrival times to capture traffic burstiness effects. As is the case in all applied modeling endeavors, there is always the risk of using inaccurate modeling details and operational parameters, but close interaction with champions and stakeholders, as well as careful model verification and validation, should minimize this risk.

14. References

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Modeling International Migrant Flows: Theory, Evidence and Forecasts

Project PI: David Leblang, University of Virginia

1. Introduction

Across developed countries, policymakers have been surprised by recent episodes of migration, whether from Central America across the southern border of the United States or from the Middle East and North Africa into the European Union. In addition to the larger number of arrivals, receiving states have been unprepared for the new demographics of these migrant populations. Unaccompanied minors and women traveling with children make up an increasing proportion of Central American migrants to the United States, while entire families displaced by violence live in temporary arrangements inside the European Union. These instances of unforeseen increases in migration and changes in the composition of migrant flows place pressure on the receiving communities and stretch the capabilities of government officials to process arrivals and assist with resettlement or deportation.

We will conduct a two-year project to advance the current state of understanding regarding migrant flows and offer insights into predicting future increases in migration. A primary focus will be documenting the impact of new and understudied factors contributing to migration, such as climatic changes and increases in violence. Particular attention will be paid to the timing between initial onset of a potential migration-increasing change and the manifestation of increases in migration to the United States and other countries. This emphasis on understanding time lags will allow us to identify leading indicators (early warning signs) of a potential increase in migration. Our analysis will also address interactions between “push” factors and traditional “pull” factors, asking whether pull factors operate differently depending on the underlying reason for migration. Finally, our work will uncover variation in the demographics of migrant flows into the United States based on the underlying push factors. The project will produce the following outcomes: (1) four academic papers—described below -- published in leading policy, policy, economics, and/or immigration journals such as *World Development*, *The American Political Science Review*, *Disaster*, and *International Migration Review*. At least one paper documenting data collection, cleaning, and model development will be prepared for publication in a journal such as *Scientific Data*. Preliminary drafts of these papers will be presented at forums including the American Political Science Association, the International Studies Association, the World Bank’s Annual Conference on Immigration and Development, and other policy relevant conferences. (2) A fully annotated, publicly available database structured according to acceptable standards will be posted in reputable repositories including the University of Virginia’s Alderman Library, the University of Michigan’s Interuniversity Consortium for Social and Political Research (ICPSR) and the Open Science Framework (OSF). The database will be accompanied with all R scripts necessary for replication. (3) A fully transparent user interface that will facilitate forecasting of future flows based on changes in underlying factors that contribute to migration—at a minimum we will develop a desktop version of the interface, if resources permit, we will port the interface for smartphones and tablets. (4) We will engage stakeholders via teleconference or comparable webinars to familiarize them with the final database and the user interface.

The security of the United States (and other countries) can be enhanced by a better understanding of the causes of emigration. Identification of the timing of migration relative to the onset of a particular type of underlying cause will allow forecasting of future migrant flows in response to changes that occur in potential sending countries. Homeland security planning will be facilitated through an enhanced understanding of variation in the choice of destination country and in the demographics of migrant flows based on underlying push factors. The remainder of this plan outlines the specific questions we will answer and methods we will use to fill existing gaps in scholarly understanding of migrant flows.

2. Research Question(s) being addressed

The project will address question 6.a.i from the RFP. Specifically, **we will address the causes of emigration, the choice of destination country, and variations in the characteristics of migrants arriving in the United States as a result of different push factors.** Our goal is to build a holistic approach to understanding migrant flows, synthesizing across various literatures that have each examined a piece of the migration question and integrating new measures for contributing factors that have been understudied in the scientific literature. We focus on the following questions:

- 1.) What factors push people to migrate? We will add to the literature by focusing on new and understudied determinants of out-migration, with a particular emphasis on violence-induced and climate-induced migration. We will also focus on timing, lagged effects, and threshold effects. The goal is to move beyond simply establishing relationships between variables and migrant flows, and to determine the thresholds that must be crossed to induce significant changes in migration and the timing between observing changes in a causal variable and the outflow of migrants to various destination countries. This will provide increased understanding of the causes and timing of changes to migrant flows, and insights into leading indicators that can be used to forecast future flows. We will use data from the Latin American Public Opinion Project (<http://www.vanderbilt.edu/lapop/>), a publicly available, open source database of public opinion across Latin American countries. This data will be used to provide some external validity to more aggregate macro-level analyses.
- 2.) What pull factors determine the choice of destination? We will move beyond a country-to-country analysis of migrant flows to assess the choice of a particular destination from a menu of alternatives; that is, we will explicitly model the sequence of decisions: in stage one, the individual decides to emigrate while in stage two the migrant decides upon a destination. Existing studies ignore that migrants often have choices across destinations and these choices often reflect both push factors and pull factors.
- 3.) What measures can be used to forecast future migrant flows into the United States (and other countries)? Incorporating the insights from examining questions (1) and (2), we will determine measures that can serve as potential indicators of future migration – early signs that increases in particular migrant flows into the United States are likely.

Do different push factors produce migrant flows with varying characteristics? We are particularly interested in assessing similarities and differences between planned economic migration and migration that occurs due to increases in political instability, social violence, economic crises natural disasters, and slow-onset climatic changes (more detail on these variables is contained below in section 4). The increase in unaccompanied minors and single women with children arriving at the United States southern border provides a telling example of a different composition of migrants based on a change in push factors. We seek to uncover generalizable patterns of migrant characteristics based on the underlying push factors that can help policymakers in preparing for potential future migrant flows.

We combine theoretical innovation with empirical rigor as we approach these questions. Extant models of labor migration assume that individuals will migrate if the expected wage in a destination (host) country exceeds the wage in the origin (home) country less transactions costs (Borjas 2015). This emphasis on economic determinants ignores the fact that labor migrants often migrate because they seek better political conditions for themselves and their families (Fitzgerald, Leblang, and Teets 2014). On the other hand, standard models of refugee flows and asylum seeking behavior focus almost entirely on political factors. Neumayer (2005), for example, argues that those applying for asylum seek out destinations with broad social welfare systems

and where there exists the possibility of connecting with fellow countrymen. He also finds, as do Moore and Shellman (2007) and political repression and the existence of civil conflict are key “push” factors that lead individuals to flee its homeland.

This academic literature ignores other environmental and social factors that may motivate individuals to leave their homes. Nongovernmental organizations such as the United Nations and the Norwegian Refugee Council have argued that environmental factors—climate change and/or natural disasters—generate the necessary, albeit not sufficient, conditions for population displacements that eventually generate refugee flows (e.g., Renaud, Bogardi, Dun and Warner 2007; Norwegian Refugee Council 2008). Likewise, there are regional/country specific factors that may generate flows of undocumented migrants and unaccompanied minors into the United States: in Central America these factors include homicides associated with the drug trade and gang violence, as well as the rash of kidnappings (Kandel, et al 2014).

Our project generates a dynamic model of migrant flows into the United States; a model that can account for flows of labor migrants, unaccompanied minors, refugees, and undocumented migrants. At present we are focusing on aggregate flows from specific countries but as data collection commences we hope to separate illegal entry from visa overstayers and to more specifically identify the entry points where migrants enter illegally. This determination will be based on our ability to generate accurate data. We incorporate a set of variables on the host and home side to account for the push and pull factors that generate these different types of migration. Beyond this development of a broad model, we also innovate in how we think about third countries; those countries which may serve as an alternative to the United States for potential migrants.

A simple example can help demonstrate. Following the surge in the United States of unaccompanied minors and asylum claims from El Salvador, Guatemala, and Honduras (the Northern Triangle of Central America), officials from the United Nations High Commissioner for Refugees (UNHCR) noted that asylum applications in third-party countries (non-United States) had increased several years in advance of the spike of migrant flows to the United States. This suggests a potential leading indicator of migrant flows that, to our knowledge, has not been systematically examined. As a preliminary assessment of the feasibility of this as an indicator, we examined data on asylum applications from the UNHCR for the three Northern Triangle countries. In particular, we compared asylum claims filed in other developing countries to asylum claims filed in the United States. While the underlying numbers of claims filed in developing countries is small relative to those filed in the United States, the differences in the trends are striking, as shown in Table 1. Asylum filings in the United States from these three countries declined every year from 2007-2010, after which point they increased for two years before a large spike in applications in 2013. Asylum claims from this same group filed in developing countries, on the other hand, began to increase as early as 2008 and experienced annual increases of near or over 100% for multiple years before the 2013 spike was observed in the United States.

Annual Percent Change in Asylum Filings from El Salvador, Guatemala, Honduras		
Year	% Change in Asylum Applications filed in Developing Countries	Percent Change in Asylum Applications filed in the United States
2007	-52%	-33%
2008	38%	-39%
2009	118%	-15%
2010	93%	-96%
2011	189%	52%
2012	0%	50%
2013	140%	1,185%

2014	134%	77%
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This does not appear to be a unique case. We also examined asylum filings in developing countries and the European Union (EU) for the top sending states involved in the surge of arrivals to the EU in 2015. For Syria, Afghanistan, and Iraq, filings in developing countries from each of these states rose by more than 100% in at least one year in the five years preceding the surge, and in all cases the large increases in filings in developing countries preceded any comparable percent increase in filings in the EU.

One possible explanation for the time lag is in the changing expectation of migrants regarding the nature of the violence in their homelands. Initial migrants may hope that the increased violence will be short-lived, and may choose to forego migration to a developed country in order to remain close to home and facilitate return when conditions improve. As the situation becomes increasingly intractable and long-lived, migrants may update their expectations regarding feasibility of return and so alter their choice of destination countries. Alternatively, later migrants may be responding to the limited capacity of nearby developing states to absorb migrant flows, moving on to more distant locations where better conditions are anticipated. Both of these explanations suggest that similar leading indicators for developed countries may exist in multiple unfolding migrant situations. For example, migration in response to climatic changes may follow similar patterns: initial relocation to nearby states, with more developed but more distant locations becoming increasingly attractive as the climatic changes appear more long-lived or conditions in the initial receiving states deteriorate for new migrants.

While not yet a systematic analysis, these examples are highly suggestive. They highlight the need to better understand the nature of migrant flows caused by under-analyzed push factors. They also demonstrate that the interaction of push and pull factors likely varies based on migrant expectations regarding underlying causes, and point to the need for better understanding of trends in timing across different push factors. Filling these knowledge gaps will be a key objective.

3. Goal and Objectives

- Build a publicly available database housed at the University of Virginia (with copies at the ICPSR) and conforming with the Open Science Framework which will be accessible through both a dedicated web address and via the University's Library and UVa's Frank Batten for Leadership and Public Affairs website. This database will facilitate study of current and previous migration and forecasting of future migrant flows. This database will include measures of refugee and labor migrant flows along with estimates of undocumented migrants by their countries of origin. The database will include all R-scripts necessary to replicate and extend our database overtime and will provide the components required for the inclusion of new variables. The database will be annotated to facilitate accurate third-party replication; a paper documenting the development of the database will be prepared for submission to the journal *Scientific Data*.
- Using this database, produce at least three academic papers as follows:
 - Paper 1: **Focus on new and understudied drivers of migration, including climate-induced and violence-induced migrant flows.** We will move beyond existing literature to examine nonlinear and threshold effects of the size of changes in push factors – after what point do changes in push factors indicate a likely change in migration? We will also address the importance of baseline values for assessing the impact of changes (e.g., the impact of changes in temperature likely depends on the baseline temperature). Particular attention will be paid to uncovering differences

across push factors in the timing between measurable changes and the onset of significant changes in migrant flows. For example, urbanization provides a necessary condition for migration; that is, does urbanization enable an environmental or civil conflict shock to generate a large outflow of migrants? This focus on timing will identify early warning indicators of increases in migrant flows.

- Paper 2: While the first paper will focus on new and understudied drivers of migration, the goal of this second paper is to **develop a macro-level model of migrant flows**. We plan to incorporate data on push factors, dyadic determinants of pull factors, and a measure of pull factors to alternative locations. This latter measure will be developed specifically for this project. It will allow the likelihood of migration from country A to country X (for example, the United States) to depend on the pull factors between country A and country Y (for example, Costa Rica). By construction, changes in pull factors for country Y (for instance, tougher migration laws) will be allowed to affect the likelihood of migration to country X. This will allow us to model the diversion of migrants – when pull factors change for one location, what happens in alternate destination countries? We will also allow for variation across types of push factors: emigrants leaving due to changes in climatic factors may follow different paths than the same number of migrants leaving due to increases in violence. The goal is to develop a statistical, macro-level model that is broadly applicable across source countries, destination countries, and variations in push factors. We provide detail on these factors in section 4, below.
- Paper 3: This paper will **focus exclusively on migration to the United States, examining characteristics of migrants themselves**. What are the characteristics of a traditional economic migrant? How are climate-induced migrants similar and how are they different? How are violence-induced migrants similar and how are they different? What are the implications of this for policy? We follow Van Hook & Bachmeier (2016), Baker and Rytina (2013), and Passel (2014) in applying the residual method to data obtained from the American Community Survey of the US Census Bureau to develop estimates of the size and source of the unauthorized population in the United States.
- Design and make available a web-based user interface that will provide DHS and other government agencies, researchers and additional stakeholders the ability to model outcomes based on various changes in inputs. The user interface will interact with the database assembled for this project, but will allow users to input changes to specific values and predict the likely changes to migrant flows across countries. Changes may be to push factors or pull factors, and changes in pull factors will be allowed to affect alternate receiving countries as well as the country experiencing the change.

4. Research Methodology

We will utilize a multi-method approach combining analysis of cross-national and cross-temporal statistical analysis based primarily on publicly available data and indicators that we will generate from these data. **Our primary objective is to generate real-time, dynamic forecasts of migration flows into the United States so that we can then examine, in a counterfactual setting, the types of policy tools that be used as effective deterrents.**

- Using publicly available data, we will compile a database to allow statistical analysis related to the research questions proposed above and carry out these analyses. Informed by gravity models (similar to those used in analysis of trade flows), we will model the origin and destination factors that generate migration flows. Important innovations include the introduction of indicators to capture understudied push factors, modeling of potential alternate

destinations, and allowing the impact of traditional pull factors (such as geographic proximity and existing social networks of prior migrants) to vary across push factors and over time within episodes of migration caused by the same push factors. Additionally, we incorporate variation in the propensity for internal (as opposed to external) migration through use of data on prior waves of urbanization. Finally, we incorporate changes in destination country factors – such as migration policies – and ask how these influence migration to both the state in which the change occurs and to alternate destinations for potential migrants.

- All of these datasets are publicly available. They include, but are not limited to:
 - Migration and Refugee flows across all countries from the United Nations High Commission (<http://www.unhcr.org/en-us/figures-at-a-glance.html>)
 - Macroeconomic conditions across the globe from the World Bank (<http://data.worldbank.org/>).
 - Immigration statistics for the United States available from the US Department of Homeland Security (<https://www.dhs.gov/data-statistics>)
 - Data on climate change from the National Oceanic and Atmospheric Association (<https://www.ncdc.noaa.gov/cdo-web/>)
 - Information related to political violence in migration source countries collected by the Center for Systemic Peace at the University of Maryland (<http://www.systemicpeace.org/inscrdata.html>)
- Our database will cover 210 countries that send migrants to the United States. We will collect annual data from 1980-2015. Our preliminary estimate is that we will have approximately 160 different variables covering:
 - attributes of migrants: number of arrivals by legal status (legal, illegal, refugee, unaccompanied minor) and broken down by age, gender and data of entry (if available);
 - attributes of sending countries: environmental factors (precipitation and temperature deviations from historical averages, natural disasters including famine, windstorms, earthquakes, tidal waves), political factors (repression, level of democracy, respect for human rights, freedom of movement, ability to obtain and cost of a passport/visa, change in political regime, revolutions, coups, civil conflict), economic factors (level of income at the individual and family level, economic growth, unemployment broken down by age and gender, level of inequality, availability of public assistance, primary industry, availability and cost of primary products), and social factors (availability of public assistance, frequency and severity of violence including homicides, prevalence of drug use, participation in the information sector, level of education broken down by age and gender);
 - attributes of the United States: border enforcement and patrols, frequency of ICE raids, employment and wages in agriculture, construction, and manufacturing, changes in US immigration policy including the availability of visas, the extension of provisions that impact migrant families (e.g., DACA), and the policy preferences of the president;
 - cross-border policies that connect the US and migrant sending countries: remittance flows, the provision and type of foreign aid, foreign trade and participation in trade agreements.
- The database will be built in such a way to enable the incorporation of additional variables and additional years when that data becomes available.
- The use of such a large database provides opportunities to have statistical results with a lot of power. But, because we will have a large number of variables representing push and pull

factors and because we have strong priors regarding the interactions between these factors, we will utilize Bayesian Model Averaging to guide statistical model selection. We will also utilize cross-validation to assess model fit and will use out-of-sample forecasts to see if there are areas where the model systematically misses. We will also validate the model using survey data from the LAPOP program described below.

- Survey data on attitudes and migration preferences will be acquired from the Latin American Public Opinion Project (LAPOP) at Vanderbilt University. We have also acquired the Gallup World Poll which contains a broader range of individual characteristics for a much larger sample of countries (n=180) that are source countries of migrant to the United States. We will use these datasets to identify drivers of migration in the region. In addition to providing important insights into migration in the region, this will inform our choices of indicators as we develop the more general database.
- The Batten School of Leadership and Public Policy at the University of Virginia has developed two research centers since the original submission of this project which will provide expertise relevant to the successful completion of this project. The Batten School's Global Policy Center has created a program in Humanitarian Policy and Leadership which is directed by Kirsten Gelsdorf. Gelsdorf brings extensive experience in the humanitarian assistance field with 19 years at the United Nations and NGOs; serving as Chief of Humanitarian Policy Analysis and manager of research teams; author of numerous high-profile policy reports; global connections to practitioners, policy makers and humanitarian operational actors. Gelsdorf will (1) provide insight into the role that IGOs and NGOs play in dealing with humanitarian crises, (2) help ensure that the technical reports and academic papers are written in such a way to be accessible to the policymaking community, and (3) play a key role in testing that the database and graphical user interface are usable by non-academics.
- The Batten School has also developed a Center for Simulation and Gaming under the leadership of Gerard P. Learmonth Sr. who is a Research Professor of Policy Informatics and Director of the Center for Leadership Simulation and Gaming and the Center for Large-Scale Computational Modeling at the University of Virginia. He holds a secondary appointment with the Department of Public Health Sciences in the School of Medicine. He also holds a courtesy appointment with the Department of Systems and Information Engineering in the School of Engineering and Applied Science. He designed and built the Global Sustainable Supply Chain Game for LAUNCH, a consortium of U.S. State Department, USAID, NASA, and Nike. Learmonth's center employs a team of data scientists who we will employ for data scrapping (data base construction) and the creation of a graphical user interface. The work will incorporate an interface developed at this Center to allow end-users to forecast changes in migrant flows based on changes in indicators specified by the user, including the ability to examine simultaneous changes for multiple variables. Our goal is for this to be an early model of migration forecasting, built with the ability to evolve as new data become available and new waves of research refine our understanding of the relationships between underlying factors and migrant flows.
- The Applied Research Institute (ARI) at the University of Virginia provides PMP certified project managers (PM) to assist in the development and execution of personnel, schedule and financial activities on government funded projects. For this effort, the PM will support project and schedule development; support the PIs in the sponsor/project champion quarterly meetings; coordinate the two planned stakeholder conferences; enable successful completion of deliverables; assist in any annual and final technical reporting; manage the financial reporting. The PM will attend all progress meetings of the research team.

5. Tasks

ID	Description	Completed by
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T.1	Quarterly meeting (video, teleconference, or in person) with program champion: discussion of goals of project; timing of workplan.	Month 3
T.2	Initial database construction complete: identification of variables and primary sources.	Month 6
T.3	Meeting with project champion; update on available data; update on policy changes from DHS side	Month 6
T.4	Estimate the size of the flow of unauthorized population by country of origin; Compare to DHS and Pew estimates	Month 9
T.5	Draft of paper 1 complete and presented at academic conference (MPSA/ISA); Estimate and refine the model	Month 9
T.6	Meeting with project champion to update on results from unauthorized estimates.; Write paper/tech report 1, present at the American Political Science Association Annual Meeting	Month 12
T.7	Write paper/tech report 2	Month 12
T.9	Paper 1 revised and submitted to academic journal for review	Month 15
T.10	Draft of paper 2 complete and presented at academic conference (International Political Economy Society); Perform out of sample forecasts.	Month 18
T.11	Meeting with project champion: update on database and identification of stakeholders for teleconference	Month 15
T.12	Database shared with attendees for upcoming teleconference	Month 18
T.13	Meeting with project champion; coordinate on feedback from teleconference; update on DHS policy changes.	Month 18
T.14	Develop a pilot version of Graphical User Interface. Send pilot to sample of end-users for feedback	Month 21
T.15	Draft of paper 3 complete and presented at academic conference (International Studies Association); Plan for rollout of interface	Month 20
T.18	Meeting with project champion; synthesize feedback with regard to interface	Month 21
T.19	Revision of paper 2 and submission to academic journal; Modify GUI to incorporate feedback	Month 24
T.20	Write paper/tech report 3	Month 24
T.21	Database revisions complete. User interface design complete and publicly available via the internet	Month 24

6. Milestones

ID	Description	Completed by
M.1	Draft of paper 1 complete (drawing on underlying database)	Month 9
M.2	Paper/tech report presented/submitted	Month 12
M.3	Draft of paper 2 complete (drawing on underlying database)	Month 15
M.4	Initial webinar to introduce stakeholders to database and modeling approach. Database sent to stakeholders to get feedback	Month 18
M.5	Draft of paper 3 complete	Month 21
M.6	; Final version of GUI complete to performance metric; dissemination of GUI to subset of stakeholders; hold Webinar to assess performance of the database and GUI	Month 21
M.7	Dissemination of online user interface for data analysis and forecasting by entire group of stakeholders; Perform updates to interface and models	Month 24

M.8	All papers under review (or accepted) at academic journals; Paper/tech report presented/submitted to Scientific Data	Month 24
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7. Deliverables (Outputs)

ID	Description	Completed by
D.1	Paper 1 focusing on new/understudied drivers of migration, posted online and submitted to academic journal	Month 4
D.2	Paper 2 focusing on holistic modeling of migration push and pull factors posted online and submitted to academic journal	Month 8
D.3	Technical report defining and describing the technique used to estimate the size of the unauthorized population completed and circulated to stakeholders	Month 12
D.4	Paper 3 focusing on characteristics of migrant flows to the United States posted online and submitted to academic journal	Month 24
D.5	Database with graphical user interface and user guide made publicly available via the internet; technical report submitted to Statistical Data.	Month 24
D.6	All data, code, and documentation files will be provided to OUP on electronic media (CD or DVD depending on size)	Month 24
D.7	Small stakeholder meeting hosted by S&T and/or BTI in Washington, DC	Month 24

8. Performance Metrics

ID	Description	Quantitative Performance Target	Achieved by
P.1	Modeling	Reliability test: does model achieve 90% threshold in cross-validation tests: are we able to identify trade-offs between false positive and false negatives based on the inclusion/exclusion of certain variables? Where does the model fail? Is the model more reliable for certain source countries and regions?	Month 12
P.2	Forecasting & Simulation	Achieve 95% in-sample accuracy. Then work to achieve 95% accuracy in out-of-sample forecasts. Can we identify the leading indicators of migration and refugee flows one to two quarters ahead? Work to identify the key leading indicators.	Month 18
P.3	GUI	Pilot test GUI using PhD and MA students at UVa along with end-users; perform end-user survey	Month 24

ID	Baseline Performance	How is baseline established?
	Not applicable	

ID	How will final performance be assessed?	
P.1	Statistical Modeling	Compare in-sample with out of sample forecasts; compare forecasts with observed data. Compare forecasting results with survey data and interviews. Modeling approach is considered successful is we hit 90% accuracy with a minimum of false negatives.

P.2	Forecasting & Simulation	Use cross-validation and out-of-sample forecast accuracy; fit of model to different types of migration
P.3	GUI	Users are able to operate GUI after a tutorial, but then independently

9. Stakeholder Engagement

Our project champion is the Science & Technology Directorate, US Department of Homeland Security. We have identified a large number of stakeholders from Nongovernmental Organizations (UNHCR, OCHA, Humanitarian Data Exchange, Migration Policy Institute), Government Organizations (Department of Defense, Lisa Troyer in the Army Research Office has been involved in some discussions about this project), The Bureau of Population, Refugees, and Migration at the State Department, The Bureau of Data Analytics in the State Department (Karl Wycoff, the Director of this Bureau has been involved in numerous discussions about this project), State and Federal Law Enforcement (US Immigration and Customs Enforcement, Texas Department of Public Safety), and academics working on immigration and/or demographic forecasting (e.g., George Borjas (Harvard), Margaret Peters (Yale), Helen Milner (Princeton), Gary Freeman (Texas), etc). Specifically, we will:

1. Hold two stakeholder conferences via teleconference and/or webinars. Teleconference #1 held at the end of year one to include academics and practitioners in the migration & refugee space; goal is to get feedback on model specification and alternative scenarios for simulations. Teleconference #2 held at the end of year two to include policymakers—DHS and state authorities—and academics; focus is rollout of the forecasting and simulation tool, publicizing academic papers, and developing steps for next set of projects. We will hold a small stakeholder meeting at the end of the project in Washington, DC hosted by S&T and/or BTI to share findings and results.
2. Generate and disseminate a research database and graphical user interface, both publicly available on the internet. A copy of the research database and GUI will be delivered to OUP on electronic media. The research database will be a static release that will allow for data analysis and replicability. The user interface will allow stakeholders to interact with the data, allowing them to change value of inputs and forecast the expected changes in migration flows as a result. The interface will allow users to map flows of migrants, including the forecast responses to changes in underlying variables. The website will also make available all statistical files to reproduce papers produced by us in association with this project and the published database.
3. Generate and disseminate a graphical user interface—including a global map—so that end-users can view (a) flows of migrants (unaccompanied minors, legal migrants, illegal migrants, and refugees) into the US from their countries of origin, (b) the routes that these different groups take into the US, and (c) the forecasted efficacy of the policy tool proposed. The underlying data will also be available.

10. Transition Approach

4. Webinars will be held with stakeholder groups from DHS and other interested agencies/groups to introduce them to the database, modeling approach, and GUI. This will serve as training for end users who will have the option to add different data and to perform different analyses. A Wiki-page will be developed where end users can disseminate the results of their modeling efforts. All video conferences will be recorded and archived to serve as a resource for all parties. We will also hold a small stakeholder meeting at the end of the project in Washington, DC hosted by S&T and/or BTI to share findings and results.

Scholarly works developed by the is project will be posted online—via the open access SSRN network—and will be submitted to academic journals such as World Development, the American

Political Science Review, International Migration Review, and Disaster. Publication will include links to all statistical files (including R-script Stata do-files) used in the analysis. All data, tools and work products generated in the course of this research program to be freely shared with any interested party from non-commercial entities. We do not anticipate any IP issues to be associated with the data, tools or work product generated. In general, the University of Virginia transitions any new technology with the guidelines defined by the UVA Licensing and Ventures Group. The database and graphical user interface will be made publicly available online through a dedicated URL and will be housed at the University of Virginia; all materials will conform with the Open Science Framework. A fully annotated user guide will be posted on the website. The website will also clearly identify contact information, so users can ask questions or provide feedback regarding the data or interface.

11. Impact/Benefit (Outcomes)

The movement of populations—whether seeking economic betterment, fleeing civil conflict or in response to flooding or drought brought on by climate change—is disruptive to the United States and to its interests abroad. This phenomenon will be a major challenge in the coming half century. Better tools, rooted in social science and data science, are needed to define the drivers of migration and to predict its consequences, so that United States, the Department of Homeland Security in particular, is prepared to meet this challenge.

- **DHS:** This research, the data, tools and work products generated will contribute directly to the one of the goals of the DHS Borders and Maritime Division (BMD) “to develop and transition technical capabilities that strengthen U.S. border security by helping to prevent illegal people from crossing a border” as described in the DHS Strategic Plan 2015-2019 Science and Technology Directorate.
- **US Department of State, DoD, ICE; NGOs; Local Governments:** Could begin to provide advanced warning of an migration issue, allow one to explore tools/policies to intervene/mitigate an unfolding crisis, prevention of migration crisis in first place.
- **Scientific Community:** Production of a usable open-source, fully annotated database for analytics and (counterfactual) forecasting; development and propagation of a set of models and empirical results that identify the sets of factors related to different types of migration. This database will be of use to NGOs, academics, and other governmental agencies—both foreign and domestic—who are impacted by migration flows.

12. Programmatic Risks and Mitigation Plans

The largest risk factor involved in the project relates to forecasting. Information on migration and availability of data on migration indicators are evolving, with new data becoming available over time. Yet many gaps remain, particularly for undocumented migration and for migration between developing countries. Thus, the precision of forecasts for some countries is likely to be low, with large confidence intervals around estimates. We acknowledge this limitation, and will build our database and user interface so that they may be easily updated as new data become available and as the scholarly knowledge regarding causes of migrant flows continues to evolve. We anticipate future iterations of the original database that will increase precision, based on scholarly findings and user feedback. We will solicit feedback at our second stakeholder conference and will setup a system for ongoing user feedback once the interface is publicly available.

Risk	Mitigation
Low quality/quantity data in early iteration	Collect stakeholder input and iterate; Collect new data and iterate; Collect user feedback and iterate

Information on migration and availability of data on migration indicators are evolving, with new data becoming available over time.	Employ an open-access database so data can be easily updated and can also be added by other sources
Precision of forecasts for some countries is likely to be low	Employ modular design so that a user can subtract or add a specific country's data as desired

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Missed Detections: From Data to Actionable Estimates

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Project Co-PIs: Paul Kantor, Research Director, CCICADA Center at Rutgers University
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1. Introduction

Questions Addressed: What methods can determine missed detections (of undocumented migrants, drugs, other contraband, etc.); inform decisions about countering illegal flows; and enable accurate measures of illegal flow volumes? DHS has developed several performance metrics for this problem, seeking to inform Congress and the executive branch about border risks and effective methods to reduce those risks and inform its own policy (see Argueta, 2016).

Borders cannot be 100% secure. Some persons, drugs, and fake or stolen goods will cross the border. Knowing how much is caught (or turned back) (which is observable and measurable) leaves open two crucial questions: how much crossed the border in spite of our efforts? How much was deterred and did not try to cross? Such unobserved events occur elsewhere; tax cheating is an example. Methods used to estimate unobserved events include: administrative records review; surveys; inspections, investigations and audits; experimental methods; and technical measurement (see, e.g., Whitley, 2012; Morral, Willis and Brownell, 2011).

Proposed Solution: The CCICADA Center, a DHS university center of excellence, will extend existing methods using formal tools of data science. While these extensions may not solve the problem completely, adapting techniques from ecology and operations research will break new ground. The resulting insights into missed detections will help CBP and other agencies to assess and document performance; get early warning of change; assess trends in a timely fashion; and understand the effect of specific resource allocations on deterrence and detection.

The research goals are clearly defined. The research will use synthetic data on interdictions and on effort, by station. Synthesized biometric and other data also provide, for the case of persons, information about repeat attempts. The two novel methods proposed to exploit these data (see Research Plan) are: Extended/multi-type models of the Capture-Recapture concept (ECR), both passive and active, and the optimization techniques of Data Envelopment Analysis (DEA).

Simple capture-recapture models have already been applied in this context. Persons who have been captured, and their biometric data “tagged,” once released may try to cross again. Indeed, statistics about recapture underlie some Border Patrol metrics. The density of “tagged” persons among all captures gives some indication of how many people are trying to cross the border. For example, if 100 persons are tagged, and one tenth of persons captured is already tagged, this suggests that 1,000 persons have tried to cross the border. This “naïve” Capture-Recapture assumes that all tagged persons try again, and are as likely to be caught as any other person. This project will develop more sophisticated ECR models of this complex process, define the data needed to apply it, and validate it with both available and simulated data.

The DEA method arose in governmental and non-profit settings where multiple “Decision Making Units” (DMUs) deal with similar problems. Examples are school systems, energy production, utilities, and even library systems. DEA recognizes that each DMU, such as a border station or sector, differs from other DMUs. Using mathematical techniques including Linear Programming, DEA identifies a set of “efficient units.” Technically, no other units produce better outcomes per unit of input. These results lead numerically to an “apparent efficiency” for

each unit. The management benefit of DEA is that specific units might have some more efficient policies and procedures to share with other units. The engineering and scientific challenges lie in adapting models to the peculiarities of the border security problem, and in dealing with practical operational limits on the data that are, or can be, available to decision-makers.

The project builds on our substantial existing linkages with multiple DHS agencies in CCICADA's work on related problems of metrics for border security and unaccompanied alien children. The team members have worked closely together on these border security issues; and on defining metrics and measures for "venue security" working with the DHS Office of SAFETY Act Implementation, and with multiple commercial venues and sports leagues.

Benefit to Homeland Security: Decision-makers at the national level seek total numbers for all illegal activities, across all the borders, for all modes of access (plane, vehicle, etc.). Decision-makers and managers with operational responsibility need different information. All need to know the trends in threats, and the trends in their own performance, in order to manage effectively. Knowing the percentage of people or drugs interdicted is vital to demonstrating success of investments in border security, detecting changes and trends, and assessing risk.

The results of the project should have significant practical value: ECR will improve the accuracy of illegal flow estimates, while DEA reveals relationships between the allocation of resources and the capture or deterrence effectiveness across many sectors and stations.

The principal goal of this research is to develop useful and usable tools that can process available data and provide actionable information to support planning, budgeting and resource allocation. The development process will include an emphasis on transition to operating agencies. The application of novel scientific approaches to these problems will also result in potentially influential scientific publications in the relevant journals and conferences.

2. Research Question(s) being addressed

The question addressed is "B.7(a)i. What methods can be used to account for missed detections in a way which can inform decisions regarding vulnerabilities from illegal flows while also enabling accurate measures of illegal flow volumes of drugs and undocumented migrants?"

3. Goal and Objectives

Goal 1) Develop and transition a validated Extended Capture-Recapture (ECR) Model.

Objectives: 1.1 Research, elicit and assemble available data on flows and captures; 1.2 Develop mathematical models and simulations programs for ECR Model(s); 1.3 Validate model(s) against simulated data; 1.4 Transition to at least one operating agency so model(s) can be validated against real data.

Goal 2) Develop and apply a Data Envelopment Analysis (DEA) Model. Objectives: 2.1 Develop suitable mathematical models for DEA. 2.2 Elicit constraints from SMEs. 2.3 Develop synthetic data sets. 2.4 Validate model(s) against simulated data. 2.5 Prepare prototype for transition to at least one operating agency so model(s) can be validated against real data.

4. Research Methodology

4.1. Qualitative Data Gathering

Both ECR and DEA modeling require some expert estimation, often of "soft" data such as estimates of undetected flows of persons or drugs or of the deterrent effect of prompt deportation. In projects on border metrics and venue security (Kantor, 2016, CCICADA, 2015, 2013, Rubio-Herrero, 2015), CCICADA has developed and applied efficient methods for

gathering such data, even if fundamentally soft in nature, and distilling it to quantitative form. Working with partners at DHS the team will elicit information on the relative importance of specific indicators of illegal flows (apprehensions, recaptures, coyote pricing, etc.). This will be used in analysis and integrated with quantitative data. These elicitations will reflect the role that differing stakeholder perspectives play in assessing the salience of specific indicators. Subject matter experts and expert practitioners (see Section 9) have agreed to work with us should this project be funded; their agreement does not constitute endorsement of the project.

4.2. Quantitative Data Gathering

CCICADA will work with CBP and other DHS agencies to identify data to be synthesized for the analyses described below. We have some familiarity with these data, from our work on metrics for border security (see e.g., Roberts 2016). Examples of data to be aggregated include: Daily Average Apprehensions; Percent that are Other Than Mexican; Percent that are “First Timers;” Amount of Different Drugs Interdicted; Percent that are Criminals; Staff Hours on Various Tasks.

4.3. Development of Mathematical Models

The proposed research will extend two methods for analyzing data to estimate the missed detections: Extended Capture-Recapture and Data Envelopment Analysis.

4.3.1 Extended Capture-Recapture (ECR). The essential idea of the statistical and ecological concept of Capture-Recapture is to “tag” a known number of members of a given species, e.g., brown bears, and then observe what fraction of the bears captured in the future are already tagged. The estimate for the total number of bears is the number known to be tagged, divided by the observed fraction. This method assumes: (1) that no bears are lost to death or migration; (2) that the tagged bears are uniformly mixed into the population of untagged bears; (3) that the tagged bears, even though they have been caught once, are just as likely to be caught again. Note that this is distinct from the approach called “randomized secondary screening” (Whitley, 2012), which cannot be applied to persons who are never seen. For the case of human migration, all three of these assumptions are difficult to justify.

There is a large literature on Capture-Recapture. Perhaps most relevant to the missed detection problem is the literature on estimating the number of species that have never been seen, and/or the size of those unseen populations. Some key papers in the extension of these methods from ecology to other domains are: (Chao, 1987; Chao et al., 1992; Jolly, 1965; Pollock, 1982). Other extensions, and models for the parametric distributions that are essential in all such analyses, are given by (Church and Gale, 1991; Gale and Sampson, 1995; Orlitsky et al., 2003).

Regarding “out migration,” in some settings, having been captured and returned home has a deterrent effect. This may be psychological (not wanting to be caught again, perhaps fearing greater penalties) or economic (the costs of an additional attempt are a larger fraction of a person’s remaining resources). Such deterrence is a desirable goal; models that include it, if they are validated by the data, will demonstrate effectiveness and guide policy. There is also a literature on deterrence, on which we will build, e.g., Roberts, 2015; Roberts, et al., 2010, 2013.

Do persons who have been captured “uniformly mix” in the population of new attempters? If they were returned to Central America then the answer might well be “not for a while.” But if they have for some reason been sent a short distance into Mexico, they are physically as close to the border as other potential border-crossers. This suggests that models will need additional

parameters to account for where the persons come from, and where they are “returned to” after they have been apprehended. We refer to these and other details as “personal history” and such models as “multi-type” models.

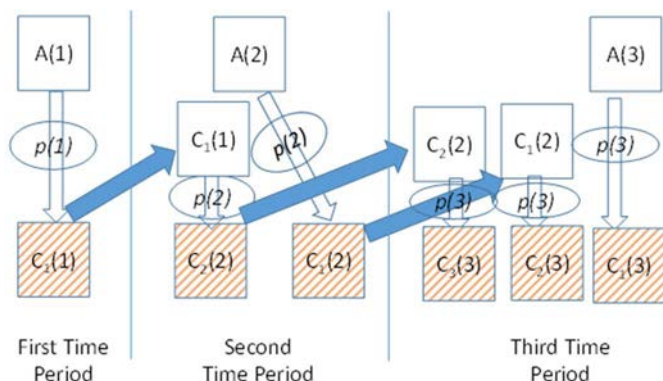


Figure 1. The Simplified Extended Capture-Recapture

Having been caught has a subtle effect on a key property of border-crossers: their (average) probability of being caught. This is a kind of pseudo-Darwinian selection. Those who have been caught (and sent back) were, and still are, ipso facto more likely to be caught than those who have not been caught before. This effect will be included in the ECR models. On the other hand, traffickers are known to send probe missions to learn more about our defensive posture. In that case the next

attempt by the same organization is less likely to be caught. Here the adversary is not an individual seeking to cross the border, but a transnational criminal organization, which can use individual shipments as probes, since individual mules or drivers are readily replaced.

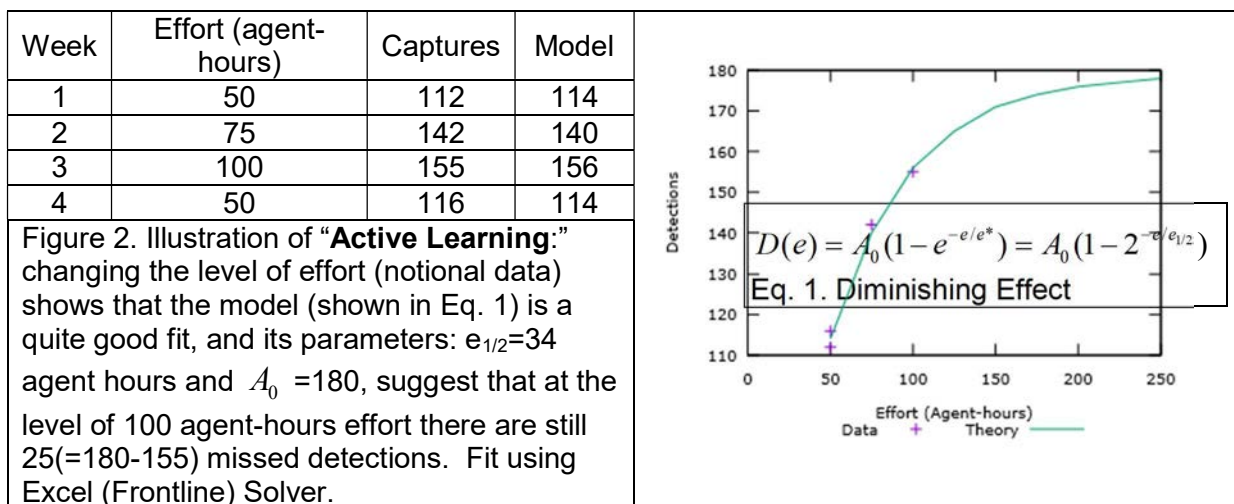
Mathematical Formulations. Figure 1 shows a simplified schematic for Extended Capture-Recapture. The problem of missed detections involves at least two unknowns, the number of first time attempts $A(t)$ during time period t , and the probability of catching an attempt $p(t)$. Let $X(t)$ be the number of attempts at time t . The known quantities are $C_i(t)$, the number caught for the i th time during period t . With one time period, there is only one known quantity (cross-hatched), not enough to determine either $p(1)$ or $A(1)$. Figure 1 assumes all captured persons are sent back, and try again in the next time period. Then the equation $C_2(2) = p(2)C_1(1)$ allows us to estimate $p(2)$. Suppose the chance of being caught is the same in each time period. Then we know $p(1)$ from $p(2)$ and $A(1)$ is found from $C_1(1) = p(1)A(1)$ and $A(2)$ from $C_1(2) = p(2)A(2)$. Then $X(2) = C_1(2) + A(2)$ gives us $X(2)$. We have used 3 equations.

Moving to 3 time periods gives us 6 equations, which, if $p(t)$ is constant, can be used to estimate $X(3)$ as $C_1(3) + C_2(3) + A(3)$, and so on for higher t .

We will study how to relax various assumptions in this simplified model. One strong assumption is that $p(t)$ is constant. Weakening it recognizes that persons in some groups are more and others less likely to be caught. A second strong assumption is that parameter p depends only on t and not on i . Those caught for the i -th time in period t may not have the same probability of being caught the next time they try as those caught for the j th time in period t or those in $A(t+1)$. This may be true because of the “Darwin” effect, but also because of consequences they have endured. If we weaken either the first or second assumption, nonlinear modeling and regression analysis may be required to estimate $X(t)$. Another strong assumption is that all those captured in a given time period will try again in the next one, which disregards the fact that people might be deterred or discouraged from trying again (at least for a while). If $A(t)$ is constant, we can explore cases in which only a fraction of those captured in a given time period try again in the next. The fraction may vary with history (e.g., how often and when they were caught before); our more complex models will study the history of attempts and captures. If $A(t)$ is not constant, i.e., if the number of new attempts may change with circumstances, then we may need to retain the assumption that $p(t)$ is constant.

In work applying capture-recapture ideas to border security challenges, Espenshade developed a CR model (1995a,b), and Espenshade and Acevedo (1995) stressed the importance of individual factors. Massey and Singer (1995) used repeated tries until crossing with constant probability of detection and used historical data to estimate $p=0.35$. The proposed research aims to express the qualitative observations of that early work in rigorous quantitative form.

Extensions of Capture-Recapture can take two forms, both of which we will use in this work:



Multi-type populations (Passive). This approach treats the flow as being of various notional “species.” These species may, first of all, be characterized by “inverse cleverness,” or probability of being captured. If the number of new attempters is constant from period to period, or varies in a predictable way (e.g., seasonally), then with enough recaptures of the same persons, the parameters of the probability distribution can be estimated as shown above. More realistic models may add one or more kinds of observation, and as the number of observables increases, the added information can be used in regression analysis to estimate the goodness of fit of the model (using Akaike or Bayes Information Criterion) (Bishop, 2006). This added information is an indication of how much the model can be trusted in the future. We may say such models are “passive” since they take data as it comes.

Discrete Interventions (Active). The second ECR approach depends on the fact that interventions tend to have diminishing returns (non-linear effects). An almost universal model for this kind of diminishing effect is the exponential formula (Eq. 1). In this formula, $D(e)$ is the detections; e is the effort; e^* is the parameter of the exponential formula; A_0 is the (unknown) number of attempts; and $e_{1/2}$ is the effort required to reduce the (remaining) missed detections by 50%. With Eq. 1 and data points for two levels of effort (e.g., the usual level of effort, and a brief surge at double effort), both parameters, especially A_0 can be estimated, as shown in Figure 2 (using notional data). Then $A_0 - D$ gives the number of missed detections. Additional experiments, or naturally occurring variations in effort, can validate the model, and provide estimates of the confidence in the estimated value of A_0 .

This “active learning” approach not only estimates missed detections; it also provides useful information about the relative effectiveness of alternative kinds of interventions. In practice, the parameter estimation can be done (as a constrained non-linear optimization), using the

Frontline Solver built into the Excel spreadsheet. So the technology for transition to CBP or other agencies is already on the analyst’s desktop. As we gather and explore relevant data as described in 4.1 and 4.2, we will iteratively build and refine ECR models and simulations that estimate the rate of missed detections.

4.3.2 Data Envelopment Analysis (DEA). DEA is a mathematical, management science approach used to compute a kind of “relative efficiency” of organizational units (termed “Decision-Making Units” or DMUs) in applications including: container ports (Schøyen and Odeck, 2013), university and research libraries (Reichmann and Sommersguter-Reichmann, 2006; Shim and Kantor, 1999), public schools (Ruggiero and Vitaliano, 1999), emergency service providers (Sommersguter-Reichmann and Rauner, 2015), energy and environmental industries (Zhou et al., 2008), and many more. DEA can compare organizations that have multiple non-commensurable performance measures.

Essentially, each DMU consumes a set of inputs (money, raw materials, man-hours, equipment for use, numbers of books held, square footage, etc.) and transforms them to a set of outputs (shipping container throughput, numbers of trips provided, number of library circulations, service hours available, etc.). Maximizing the efficiency h_0 (= ratio of weighted combination of outputs to weighted combination of inputs) for one DMU, by mathematically solving for its optimal weights while constraining the ratio for the other DMUs to 100%, one finds the relative efficiency of that DMU in converting inputs to outputs.

$\max h_0 = \frac{\sum_{r=1}^s u_r y_{r0}}{\sum_{i=1}^m v_i x_{i0}} \quad \text{subject to:}$ $\frac{\sum_{r=1}^s u_r y_{rj}}{\sum_{i=1}^m v_i x_{ij}} \leq 1; \quad j = 1, \dots, n$ $v_r, u_i \geq 0; \quad r = 1, \dots, s; \quad i = 1, \dots, m$ <p>Eq. 2. Data Envelopment Analysis</p>

The original DEA approach formulates the problem of finding the optimal weights for each DMU as shown in Eq. 2 (Charnes et al., 1978). Here, the y_{rj}, x_{ij} are the levels of outputs and inputs for the j th DMU (obtained from data), and the $u_r, v_i \geq 0$ are the weights that the optimization seeks. The value h_0 is the efficiency

of the given DMU. One then calculates the efficiency for every DMU in the same way (note that the weights obtained may be different). One compares DMUs by comparing their apparent efficiencies.

For detecting undetected migration, an initial DEA model will be used to compare the stations in a particular sector (or the sectors in an area). Inputs will be chosen in consultation with CBP, and could include levels of personnel or equipment available to detect migrants, etc.; outputs could include the rate of detection estimated as in the ECR work, the time to share information required for apprehensions, etc. The results of the DEA will provide an “estimated efficiency” for any specific unit – as the relation between effort (input) and output. This will also suggest which other units might benefit from useful procedures or best practices at a given unit.

We expect that our analysis of all available data will provide several differing estimates of the number of missed detections. These data also will represent many other significant metrics and goals of individual stations and sectors. It would be naive, and operationally unacceptable to claim that missed detections trumps all other measures, especially when there is still uncertainty about the accuracy of such measures. DEA is a way to put them into perspective with other salient metrics, particularly the ones that are respected at the operational level, and at the headquarters level. In DEA these are able to have station specific weights, which implicitly

recognizes the large differences in context, station to station. At the same time, DEA permits the inputs or resources used at stations to be individually weighted, to further recognize particularities. When the analysis is completed, along with the canonical efficiency measures, the data will show how salient the missed detections are for each station, and give some basis for estimating the beneficial or harmful impacts of adopting specific variations of the missed detection measure, to guide policy and resource allocation. In sum, DEA provides a principled and mathematical way to assess the operational potential of the findings of the ECR model.

The original DEA formulation has spawned a wealth of theoretical extensions (Cook and Seiford, 2009), driven by data requirements and DMU characteristics in specific application areas. Some that may prove relevant in estimating missed detections are: modeling the inner stages of “production” (turning inputs to outputs); separating discretionary and non-discretionary (fixed cost) inputs because decision-makers may not be able to proportionally reduce, e.g., the cost of vehicles; incorporating uncertain and/or time-series data; and the presence of both non-desired outputs (e.g., traffic delays) and desired outputs (e.g., drug detection) (Cook and Seiford, 2009; Zhou et al., 2008). We will explore such DEA modifications and extensions and apply available data regarding efforts to detect illegal flows such as undocumented migrants. We have obtained, and plan to use the software developed by Prof. Zhou, which can accommodate certain technical constraints into the proposed DEA analysis.

4.4. Validation of Mathematical Models on Available and Simulated Data

The DHS Office of Immigration Statistics will provide guidance on developing synthetic data sets concerning known flows (Apprehensions, Turn Backs, Got Aways), and recidivism. The Strategic Planning and Analysis Directorate of the Border Patrol will also help guide the synthesis of these and other data (e.g. Staff hours scheduled for tasks, time spent on various tasks). They have advised us that data at the station level rather than the zone level has the best integrity, so we expect to synthesize station data to improve the accuracy estimates when the model(s) are subsequently applied to actual data by CBP. For ECR, we will use these data to develop a baseline and then add the Active Learning component for further refinement. For DEA, we will start with one set of sectors or stations and use it to refine the modeling choices, then take this to another set of sectors or stations and try to achieve similarly satisfactory (explainable) analysis. For some analyses additional simulated data may be required. Data will be simulated using probabilistic parameters (deterrence rate, capture rate, and model prior distributions for the probability of capture, etc.) and Monte Carlo methods. No new data collection is planned.

5. Tasks

Prof. Dennis Egan (PI), an experienced Project Manager, will be responsible for Management, with assistance of CCICADA Director Fred Roberts (CoPI). Prof. Paul Kantor (CoPI), will develop the mathematical models, and guide the analysis, with input from Egan, and Roberts.

Specific Tasks

ID	Description	Completed by month
T.M.1	Identify persons to interview, and data sources	6
T.M.2	Manage the research and preparation of reports	Throughout project
T.M.3	Meet with project stakeholders (first meeting face to face; at least one meeting potentially virtual)	At least every 4 months

T.E.1	Define models	4
T.E.2	Synthesize data and conduct initial interviews	6
T.E.3	Fit models to synthesized data/evaluate/validate	8
T.E.4	Initiate and support transition	12
T.E.5	Support transition, including assisting CBP in running model(s) in their environment with DHS collected data	13-36
T.E.6	Prepare scientific publications	12,24,36
T.D.1	Define mathematical models	12
T.D.2	Synthesize data and evaluate models	24
T.D.3	Initiate Transition, including assisting CBP in running model(s) in their environment with DHS collected data	25-36
T.D.4	Prepare scientific publications	20,28,36
T.M.4	Prepare final technical report	36
Note: M denotes management; E denotes ECR; D denotes the DEA component		

Based on interviews and publically available literature, we expect to be able to synthesize data for both the ECR and DEA analyses. The DEA model can, in principle, be applied within a single sector, to the stations in that sector, but we are aiming for broader uptake and analysis.

We propose to start with the stations in one (large) sector to be determined by USBP (e.g. one possibility is Big Bend, with 11 stations). The notion of “statistical confidence” in DEA analysis poses some challenges. There are no straightforward answers (such as the polling formulas relating sample size and confidence intervals.) We intend, at least initially, to follow the practical path outlined by (Barnum et al., 2012, 2008) which cites the landmark papers and provides a number of approaches to estimate confidence intervals using data over several time periods, and to present that data in visually compelling ways (showing how the confidence interval does, or does not, include 100% efficiency.) Results of the analysis in the first sector will give us a better understanding of the relation between “number of stations” on the one hand, and “precision of the estimates” on the other. As described in the proposal, we will then validate and extend our method to several other sectors with a considerable number of stations, such as El Paso Sector or Rio Grande Sector

For the ECR task we can develop models on a “measure by measure basis” first. Then, as the set of measures becomes complete, we can look for interactions among the measures, which may affect the internal parameters representing effects such as deterrence. An example is the anecdotal reports that the imposition of “consequence” seems to have deterrent value in some sectors. It may, however, be redirecting attempts to other neighboring sectors.

6. Milestones

Project Milestones

ID	Description	By	ID	Description	By
M.1	Working code for ECR models	6	M.6	DEA results and eval	24
M.2	Initial stakeholder interviews done	7	M.7	Stkhlder progress review	24,30
M.3	Simulated/ data for ECR Models	12	M.8	Transition plans complete	33
M.4	Stakeholder progress review	7,13,19	M.9	Final Stakeholder review	35
M.5	Working code for DEA models	18	M.10	Final technical report	36

7. Deliverables (Outputs) for Period 1

ID	Description	Completed by (MPSD)
D.1	Report and usable Excel code for ECR methods	12
D.2	ECR Conference and Journal Publications	12, 24, 36
D.3	ECR refinement; active models; pilot of DEA methods	24
D.4	DEA Conference and Journal Publications	20, 28, 36
D.5	Reports; usable DEA and refined ECR codes	36

We will work with staff identified in the Strategic Planning and Analysis Directorate of the Border Patrol and the OIS Analysis Division for delivery and transition of the software. Conference and journal publications will target the scientific and professional community.

8. Performance Metrics

Briefings to agency decision-makers and analysts throughout the project will help to find the measures of performance most critical to these stakeholders; and to collect comments from agency practitioners on the potential value of research products. We will aim for at least two briefings to agency decision-makers each year to ensure the finished products are tailored to the needs of the future (agency) users. Additionally, we will aim to have at least one conference presentation, and one journal article describing the work produced in each year of the project.

ID	Description	Quantitative Performance Target	MPSD
P.1	ECR model	Refined estimate of Missed Detections	12
P.2	DEA model	Analysis of station or sector relative efficiencies	30
ID	Baseline Performance	How is baseline established?	
P.1	ECR model	Missed detection estimates before Active Learning applied	
P.2	DEA model	Evaluation of initial set of sectors/stations whose data we will have worked with extensively	
ID	How will final performance be assessed?		
P.1	Feedback on missed detection estimate combining both ECR extensions		
P.2	Application of the baseline-tested model to a new set of sectors or stations		
P.3	One or more methods transitioned to a DHS agency.		

It will be very satisfying if we are able to quantify the improvement in accuracy of the estimate of missed detections. The underlying difficulty is that the accuracy of any such estimate cannot be known with more precision than we know the true number of missed detections. There is a limited theoretical literature on the coverage of specific scanning processes (Cfir, 2005; Szechtman et al., 2008), but that does not include relevant real world data. While there will be some potential for using internal consistency as a kind of validation of the projections (that is, does the whole time dependent variation of the computations fit together) we will also solicit expert practitioner assessment of whether the projections produced by the model reflects reality as they perceive it.

DEA models have been successfully applied with as few as one input variable (labor) and two output variables, in the pharmaceutical sector. However, when the number of variables is large, it is possible for all of the stations to lie on the Pareto frontier (particularly with variable returns to scale). While time series give many more “output variables” the desirability of using

contemporaneous analysis suggests that “more DMUs is always better³.” Therefore for the largest sectors we plan to synthesize data for all, or nearly all, of their stations. We plan to start with one large sector and expand to two other sectors. The model can, in principle, be applied within a single sector, to the stations in that sector, but we are aiming for broader uptake and analysis. We propose to start with the stations in one (large) sector such as Big Bend, with 11 stations. The notion of “statistical confidence” in DEA analysis poses some challenges. There are no straightforward answers (such as the polling formulas relating sample size and confidence intervals.), Yuma Sector is almost surely too small to analyze on its own, but might be sensibly combined with one other sector to add value to the analysis.

9. Stakeholder Engagement

CCICADA has extensive experience working with DHS components concerned with Border Security, including ICE, CBP, Office of Immigration Statistics (OIS), and the USCG. These contacts will help in finding key information sources, developing a transition path, and identifying project stakeholders. Stakeholders will be involved from the beginning, will be briefed at least semi-annually, and will comment on the pace, direction, and relevance of the project’s progress. Both the Strategic Planning and Analysis Directorate of the Border Patrol and OIS will be major collaborators in the project. The following have indicated that they will provide guidance and participate in elicitation; Anthony J. Kassekert: USCIS Fraud Detection and National Security Directorate; Isaac Maya: Research Director, CREATE Center (to be on IPA at USCG HQ); Deshonn Noble: Special Operations Supervisor, Blaine Sector, CBP Border Patrol; Sarah Price: CBP Policy & Planning; Carla Argueta: Analyst in Immigration Policy, Congressional Research Service; a number of individuals from Strategic Planning and Analysis Directorate, Border Patrol HQ (preferred not to be identified by name), including Assistant Chief; Bryan Baker: OIS Director of Analysis Division; Katherine Whitsman: OIS.

Third party Data to be used in the project: U.S. Border Patrol and the DHS Office of Immigration Statistics will provide guidance for our synthesis of data. We acknowledge that CBP will not provide actual data to us.

Purpose and characteristics of the data: The purpose of the synthesized data is to validate Extended Capture Recapture (ECR) models and Data Envelopment Analysis (DEA) models. The data will consist of known flow data for undocumented migrants (including Apprehensions, Turn Backs, and Got Aways), recidivism data, and data on staff hours scheduled and actually spent on tasks. Synthesized data will also include amounts, dates and locations of illegal drugs seized, specifically cocaine, methamphetamine, heroin, ecstasy, and marijuana. The synthesized data will be used by the Rutgers team in lieu of actual data that have been collected at the station level over at least the previous ten years.

Uses of the data: Synthesized data will be used to develop, establish and validate Extended Capture Recapture (ECR) models of missed detections, and develop, establish and validate Data Envelopment Analysis (DEA) models of station operations with an emphasis on success in detection.

³ In DEA, each station or other unit to be assessed is called a Decision Making Unit, or DMU.

Data source and Acquisition method: The CBP will not provide actual data to the project. Instead, the models will be tested with data synthesized by the project team in consultation with SMEs at CBP and the Office of Immigration Statistics. As part of the transition, the models will be delivered to CBP for their evaluation within their environment using the actual data collected by DHS.

Data owner's commitment letter: CBP informed OUP that they are not prepared to convert law enforcement sensitive data to data that can be publically released. However, DHS thinks there is a good deal to be learned from the research, and have proposed an approach to move forward, and the project team is amenable to this approach.

This approach means that the project team acknowledges that the data originally proposed to be provided by CBP is NOT going to be provided. Instead, the project team will create a synthetic data set. Additionally, we have added an interim and final model check task/milestone into the work plan – interim is against Rutgers's data set and the final outcome involves Rutgers providing the model to OUP and S&T/CBP to run the model in their environment using DHS collected data. The project champion will coordinate this with CBP/OIT and work closely with the Rutgers team throughout to project to ensure transition.

10. Transition Approach

CCICADA has been very successful in transitioning its work to partner agencies. That is because transition is discussed with partners from the very beginning of a project; we work closely with partners at every stage, make an early attempt to understand an agency's Verification, Validation, and Accreditation process, learn what available software and hardware the agency has so that our tools can be used immediately without the need to purchase specialized software, and involve partners in designing and testing our tools. Using this approach, we have successfully transitioned our boat and aircraft allocation tools to the Coast Guard (saving them up to \$120M over a 6-year period); our Web Archival Tool to the FBI for use in countering human trafficking; our COMSTAT II tool to the police at the Port Authority of NY/NJ; and our "best practices for stadium security" to the DHS Office of SAFETY Act Implementation for use by all major sports leagues.

Our budget includes funding for meetings with partner agencies and stakeholders both in Washington, DC and at the Southwest Border; those meetings will commence right after project kickoff. Throughout, in interviews and briefings with stakeholders, we will present software and/or methods that are candidates for transition, and we will engage some partners in working meetings to specifically design and test our tools. When judged ready, we will seek stakeholder help to set up meetings to present tools and/or methods to Agency decision makers. We will attempt to minimize transition costs to CBP, and will propose incentives for implementation. The goal is to have some project tools in use, at least on a trial basis, by the end of the project.

11. Impact/Benefit (Outcomes)

Benefit to DHS: This work directly supports DHS Goal 2.1 (Secure U.S. Air, Land and Sea Borders) of Mission 2 (Securing and Managing our Borders) as described in the DHS Strategic Plan 2012-2016. The work further supports the Borders & Maritime Division (BMD) Objectives Ports of Entry Security and Land Border Security, from the DHS S&T Strategic Plan 2015-2019.

Benefit to stakeholders. The novel models, methods and tools developed in this project should benefit stakeholders by providing them with more objective ways to estimate the level of missed detections, and to track and improve performance. This will aid and enhance the metrics that measure performance and aid in reallocating resources and measuring progress. Building a stronger, smarter border enforcement system remains an area of ongoing priority and emphasis; the results of this project should assist stakeholders in “using the resources we have in a smarter way.” (2014 QHSR).

12. Programmatic Risks and Mitigation Plans

Three key risks are: (1) **Difficulty getting data from agencies.** CBP and DHS S&T have proposed a path forward in which the Rutgers team will develop synthetic data sets for evaluating the models developed by the project. Part of the transition will involve delivering these models to CBP so that they can evaluate the models in their own environment using the actual data DHS has collected. (2) **The proposed methods, with available data fail to give either useful estimates of the cross border flows or managerially useful information on the efficiency of border stations.** CCICADA will stress-test the methods and algorithms using simulated data (permitting at least scholarly publication). The simulations can show that “if certain additional data are gathered, the methods can produce useful results.” We would propose cost effective ways of gathering such additional data. (3) **With adequate real data and demonstrated useful results, we cannot complete transition.** Transition and implementation may have some associated costs for CBP. It will be important to identify such costs early in the project, and find ways to minimize and plan for them. This risk is worse in the later years; CCICADA will start with ECR, the tasks most likely to avoid risks (1) and (2).

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Participatory Operational Assessment (POA): evaluating and predicting the operational effectiveness of Cargo Security Processes at Ports of Entry

Project PI: Maria Burns, University of Houston

Project co-PIs (if applicable): N/A

Project Sub(s) (if applicable): N/A

1. Introduction

This project seeks to address the goals of the DHS to measure, assess, and predict the impact of security processes at U.S. Ports of Entry, and facilitate legitimate trade and travel. Over the past several years, U.S. trade entails the transportation of over two billion metric tons (2,000,000,000 MT) of cargo, comprising of fifteen million TEU Containers (15,000,000 TEU). The task of DHS/CBP in safeguarding our borders and the 328 Ports of Entry (PoEs) becomes more crucial each year, as the flow of goods grows exponentially, in positive correlation with the population growth, and trade agreements, such as the NAFTA agreement between the U.S., Mexico, and Canada.

During Period I and II of this project, the research focused on selected Southern Ports of Entry (POEs), with Laredo and Eagle Pass, TX being the principal testbeds. A number of research findings of Period I and II, strongly recommend an in-depth research, mainly focused in the following areas:

Question 1: What are the delays, disruptions and illegitimate activities on the Mexico side, and to which extend do they cause delays and disruptions at U.S. Ports of Entry? **Solution:** This research will gather primary and secondary data to investigate the reasons and quantify the impact by means of an econometric/ ANOVA/regression analysis.

Question 2: What are the key security risks entailed in the outbound (southbound, i.e. U.S. to Mexico) containerized cargo transport process? What are the differences and similarities between the inbound (Mexico to the U.S.) and outbound (U.S. to Mexico) trade? **Solution:** A Risk Assessment method will be constructed based on the findings of Questions 1 and 2 above.

Question 3: What are the recommendations for improvement to all the above challenges? **Solution:** The Participatory Operational Assessment protocol and the Delphi method will provide first-hand information on the best practices, and risk areas at Ports of Entry.

For all the above questions, the cause-and-effect analysis proposed will recommend improvements in the following inter-related sectors:

- a) supply-chain networks and processes
- b) regulatory framework, implementation and compliance;
- c) technological, infrastructure and superstructure issues.

Benefits to DHS

The DHS/CBP will benefit from the above 3 tools: a) geospatial and econometric mapping of patterns and activities, b) risk assessment tool, and c) Best Practices and recommendations for improvement.

The deliverables of this research are expected to enhance existing DHS practices and optimize their applications pertinent to infrastructure and superstructure investment and applications, cargo security risk assessment. The CBP through the Container Security Initiative (CSI) aims to increase the cargo scanning ratio of inbound cargoes at Ports of Entry with ultimate goal the scanning of 100% of inbound containers.

This project addresses a significant DHS mission, as stipulated in the 2014 Quadrennial Homeland Security Review: to secure and enhance the borders at ports of entry. The 2018 QHSR is scheduled for submission to Congress in December of 2017⁴. This project will also support the Immigration and Customs Enforcement (ICE), in identifying transportation and infrastructure vulnerabilities.

2. Gap/Challenge Question(s) being addressed

This proposal meets the DHS/CBP strategic goals to (1) Support our nation's counter-terrorism efforts; (2) Safeguard our borders, (3) enhance U.S. economic competitiveness and (4) Promote integration, innovation and agility. It also addresses questions and objectives stipulated in the RFP-17-02 call funded by DHD, and announced by the Borders, Trade, and Immigration Institute⁵, namely:

Objective 3.2: Facilitate Legitimate Trade

A. Policies and Concepts of Operations

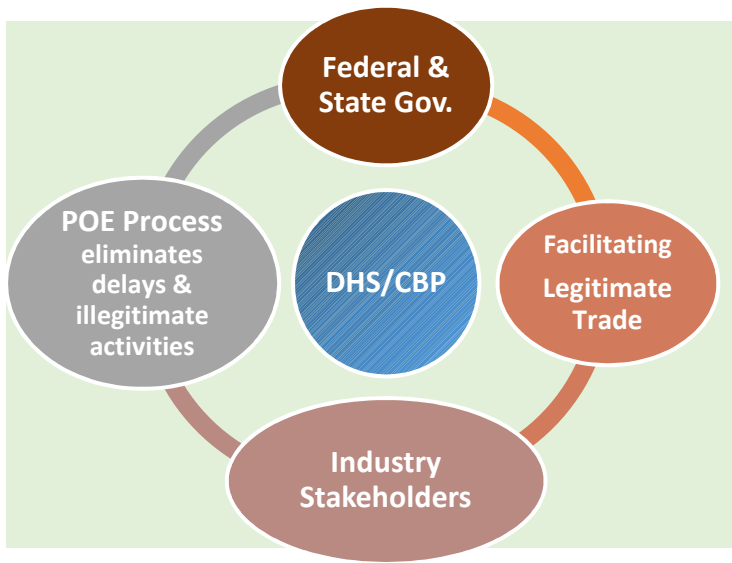
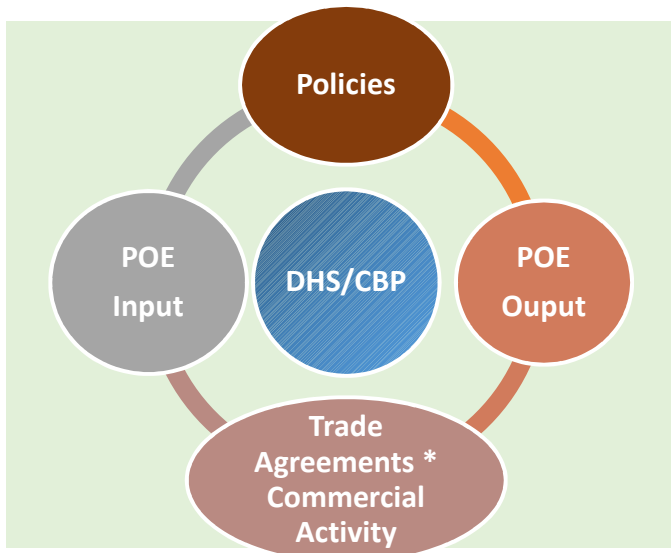
1. What policy or process opportunities could help streamline the flow of legitimate trade?

While Period I and II research focused on border crossing times, this year's research recognizes that the factors affecting delays at POEs go well beyond the border regions and expand throughout multinational supply chains. The following diagrams, as presented to CBP Stakeholders during Period II of the research, identify the critical task of DHS/CBP to eliminate delays, identify and eradicate reasons for delays and illegitimate activities, some of which are generated beyond the border.

This research will work on policies and process opportunities that can empower DHS/CBP. This can be achieved by actively engaging industry stakeholders, and encouraging their participation in Public/Private programs and partnerships that facilitate trade and combatting illegitimate activities.

⁴ DHS (2017) Quadrennial Homeland Security Review. (QHSR). Official website of the Department of Homeland Security. Available at: <https://www.dhs.gov/quadrennial-homeland-security-review> Last accessed in July 17, 2017.

⁵ UH BTI (2017) Request for Proposals for Borders, Trade, and Immigration Research RFP-17-02, Borders, Trade, and Immigration Institute, University of Houston, Available at: www.uh.edu/bti/partnerships/RFPs/RFP-17-02 Last accessed in July 17, 2017.



Figures I and II: the impact of Policy and Trade Agreements on Ports of Entry, and the Government's power to facilitate legitimate trade with the industry's support.

Source: M.Burns (2017) T.1.3. Project, Annual Presentation to CBP, June 2017.

As reflected on the above Figures I and II, Period II of this project identified such challenges for inbound containers, and also mapped illegitimate activities of Transnational Criminal Organization for cargoes imported from Mexico into the U.S. The current research aims to analyze data on the outbound supply chains, and identify the impact of Transnational Criminal Organizations to the outbound vs. inbound cargoes.

In addition, the project constructs statistical analysis to compare and contrast:

- Inbound versus outbound border security operations;
- Trucking versus Rail transportation;
- Different PoEs on the Southern Border, but also an overview of the north border vs. south border differences and similarities.

Most important, the project will engage with industry stakeholders in order to support the DHS/CBP mission in optimizing border crossing procedures, and re-examining the policy and process opportunities to help streamline the flow of legitimate trade.

This proposal aims to support the ongoing effort of DHS/CBP in alleviating PoE challenges that are hard to control or resolve, because they are generated beyond the U.S. territory, hence beyond the DHS/CBP jurisdiction. This project will gather and analyze primary and secondary data to clearly depict the challenges rooted overseas, and yet severely impacting our borders. Another challenge for DHS is to address their day-to-day operations, while predicting constant change in patterns, trade flows and cargo volume, supply chain partners and networks, changes in infrastructure, political and regulatory changes, as well as changes in the patterns of illegitimate activities overseas.

The expected new capabilities pertain to the multi-disciplinary investigation of the trade flows, i.e. from a regulatory, technology/infrastructure, financial, commercial and socio-economic perspective. The topic is a priority due to the radical, yet continuous changes occurring at our nation's border that may severely affect the DHS/CBP strategy, operations and resource management. If the challenges go unmet, or if the solutions are delayed, there may be a mishap between the day-to-day operations of DHS/CBP officers at the border, and the compelling need to diversify strategy, according to the new challenges. For this reason, timing is very important for this project.

Optimizing the inbound processing time by implementing an improved operational method is a significant challenge, with ample generalization possibilities to encompass sea and land border crossings and multimodal transportation. The deliverables of this research can be used by the DHS / CBP agents in different POE configurations, with different infrastructure and superstructure, and diverse cargo handling operations.

3. Goal and Objectives

This study will develop a Participatory Operational Assessment (POA) model that evaluates and predicts the operational effectiveness of outbound containerized cargo flows, specifically southbound, i.e. U.S. exports to Mexico and Latin America.

Operational effectiveness is hereby defined as the best operational practices that allow a PoE to utilize its inputs in the best possible manner. This study will also improve processing times of outbound containerized cargoes through the elimination of transport delays, errors and waste occurring at PoEs.

This research aims to improve the efficiency of outbound, containerized cargo operations at Ports of Entry (PoEs), and consequently reduce the costs of the implementation and execution of operational configurations. The deliverables for period III of the research will apply to land border containers transported via trucks and rail.

Testbeds for this research will be the major Ports of Entry on the southern border, namely: 1) Laredo, TX; 2) Eagle Pass, TX; 3) El Paso, TX; 4) Brownsville, TX; 5) Hidalgo, TX; 6) Calexico, CA; yet the deliverables will be easily applied to other PoEs nationwide.

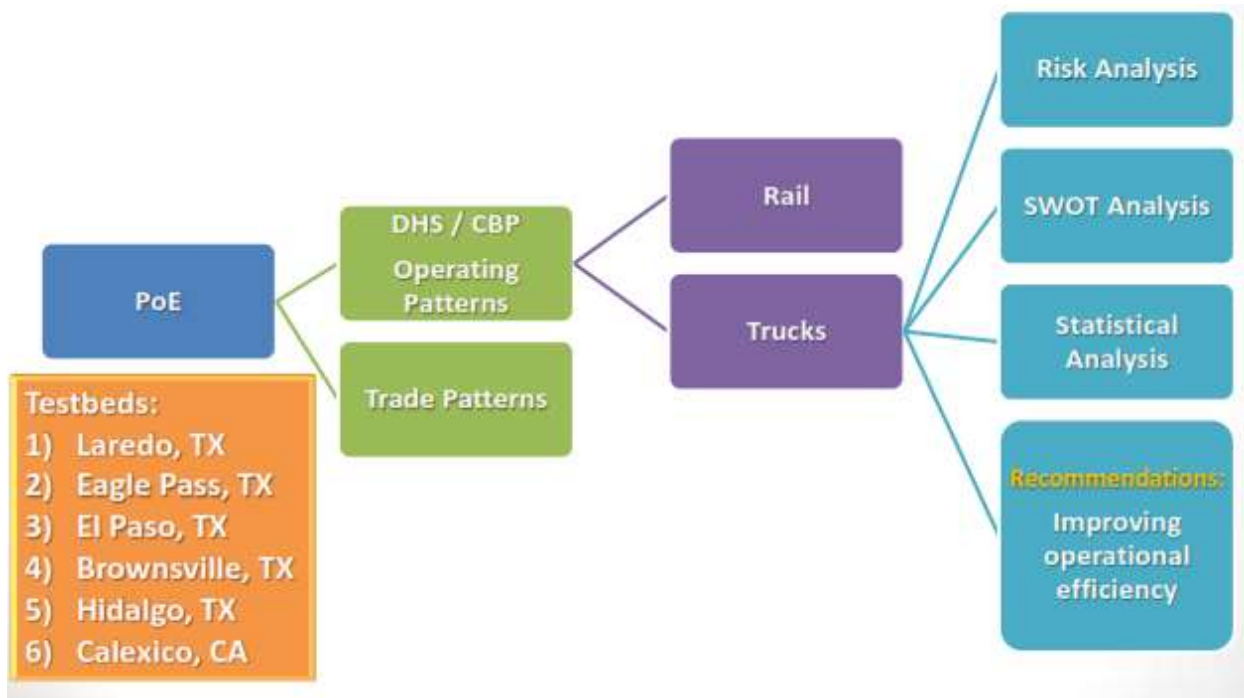


Figure III: Comparing the operational procedures on inbound vs. outbound cargo processing at Ports of Entry (PoEs).

- Research Period II: Improving efficiency of **inbound**, containerized cargo operations at PoEs.
- Research Period III: Improving efficiency of **outbound**, containerized cargo operations at PoEs.

Source: M.Burns (2017), T.1.3. Project, Annual Presentation to CBP, June 2017.

The findings of the outbound cargo flows will be duly compared and contrasted with the inbound cargo flows, as investigated in period II of the research.

Objectives include, but not limited to the following:

- (i) Determine the efficiency of **outbound** containerized cargo operations; identify cause for delays, and improve cargo processing times;
- (ii) Formulate guidelines and techniques for a Participatory Operational Assessment (POA) protocol by means of the Delphi Method, whereby the industry stakeholders' feedback will assist the DHS / CBP / ICE personnel in eliminating border waiting times.
- (iii) Establish a dissemination strategy for the transfer of the research deliverables, and future applications for diverse Ports of Entry.
- (iv) Compare and contrast the **outbound vs. inbound** containerized cargo flows at the southern border, and identify similarities and difference in operational patterns.

- (v) Organize meeting/workshop with CBP champion and industry stakeholders to present preliminary project findings, seek for solutions, and make policy recommendations that will facilitate legitimate trade at PoEs.
- (vi) Based on the research findings, consider future research directions, focusing on cargo security processes at POEs. For example (a) the development of training courses for POEs based on identified vulnerabilities and training gaps related to cross-border trade and transport; and (b) alternative applications of this methodology in other DHS-related cargo security technologies and processes.

Recommendations on systemic vulnerabilities, and the findings of multi-facet interdependencies across the border, including but not limited to operational, regulatory, socio-economic and technology-human factor correlation, will assist the DHS in developing an improved cargo process.

The POA protocol will help the DHS eliminate areas of waste (time, resources, processes) at land border crossing.

However, the DHS/CBP ability to process cargoes with utmost security and limited delays, depends to a great extent upon the private sector stakeholders, such as manufactures, energy companies, intermodal transportation companies, logistics, warehousing & distribution centers, container box companies, cargo stakeholders, etc. The areas of waste may be identified in different industrial processes of the supply chain: by improving efficiencies in the private sector, the DHS/CBP processing times will also improve, as the public sector will have less industry-generated challenges to tackle.

4. Methodology

Process selection: The research is based on tests and evaluation of the outbound containerized cargo processing times on a point-to-point basis. Testbeds of this research will be the major Ports of Entry on the southern border, with high trade volume and value. Namely: 1) Laredo, TX; 2) Eagle Pass, TX; 3) El Paso, TX; 4) Brownsville, TX; 5) Hidalgo, TX; 6) Calexico, CA.

Field visits will be made to Laredo, Texas, whereas primary and secondary data related to processing times and cargoes, will be gathered for all the above ports. The deliverables of this research will be easily applied to other PoEs nationwide.

The findings of this study combined with the recommendations and conclusions on best practices may allow for generalization of the study results to land Ports of Entry nationwide. As part of the recommendations and conclusions, stratified sampling applied to POEs for land-border crossing will ensure the research is more representative of the processing time patterns per strata. Hence, the findings of this random process selection will have national and global applications among POEs.

As stipulated by DHS S&T OUP, this research will not seek access to CBP premises, and will not use CBP data.

The following distinct process is envisioned to be assessed in this research, subject to DHS approval:

Research Approaches: Participatory Operational Assessment (POA) entails a process of engaging DHS and private industry stakeholders (POE authorities and multimodal transportation companies) with the purpose of constructively enhancing the deliverables of this study.

Participatory assessment entails to a public-private sector approach and critical evaluation of the challenges and solutions leading to improved border processing times.

Three distinctive research approaches will be used to produce the Risk Assessment and Participatory Operational Assessment methodology:

(A) the empirical process testing approach:

Stage 1: Measurement of baseline performance, i.e. measurement of outbound containerized cargo processing times before the new POA methodology is applied;
Stage 2: Identifying systemic improvements, entailing time delays, errors or waste;
Stage 3: Developing a standardized POA methodology;
Stage 4: Measurement of the new POA processing times, based on site visits and/or data gathered from private or public entities (public domain, no security clearance needed).

In this stage, researchers have addressed areas for improved operational efficiency. Measurements of operational performance will focus on Key Performance Indicators and the monitoring of inputs (i.e. resources available) vs. output variables (i.e. processing times related to cargo volume of container boxes exported via the POE).

(B) the participatory assessment approach will engage DHS/CBP and private industry stakeholders by sharing the empirical and scientific findings of the research for an Agency-specific assessment, monitoring and assessment of the project's value.

PA requires the development of a DHS Advisory Board that periodically conducts conference calls to discuss the research findings, and to facilitate the use of POA tool at various POEs (or within distinct DHS agencies).

The Delphi Method will be used as an interactive forecasting tool heavily based on the DHS Advisory Board's feedback to evaluate the cargo operational efficiency⁶.

The development of a DHS Advisory Board will ensure continuous engagement with stakeholders that will facilitate the transition of POA to be incorporated into distinct DHS agencies over diverse ports of entry in diverse geographical regions.

Subject to DHS approval, the private-public sector Advisory Board will share best practices for different PoEs; whereas identify solutions to help DHS/CBP resolve border-crossing challenges. Private sector stakeholders may include cargo importers/exporters, manufacturers, logistics, transportation and warehousing stakeholders.

The findings of this study will take into consideration land transportation, i.e. trucks and rail transportation, and a comparison between these modes will also be discussed.

The recommendations and feedback received by the DHS and other transport security stakeholders at the end of each Milestone will be used to fine-tune the research as to specific POA requirements and emerging challenges that need to be addressed in the operational performance research. The POA metric tools and methodology to be developed will have national and global application.

⁶ Dalkey, N.; Helmer, O. (1963). "An Experimental Application of the Delphi Method to the use of experts". *Management Science* 9 (3): 458–467. [doi:10.1287/mnsc.9.3.458](https://doi.org/10.1287/mnsc.9.3.458).

- (C) the STEM research approach, where researchers will employ a wide array of statistical and econometric tools used by different Participatory Assessment (PA) institutions, with the purpose of comparing, contrasting and evaluating the findings of these different methodologies.

Meeting the Validity and Generalizability Goals

The research needs to address two significant issues: validity and potential for generalizability.

- a) Validity will test if the variations in processing times indicate a measurable difference in input. A time study at regional PoE(s) will measure point-to-point processing times for inbound containers on ships and trucks. The findings will form aggregate measures.

Venn diagrams and hierarchical cluster analyses will be developed to demonstrate the performance patterns of cargo processing times, through different stages of the supply chain within the PoE. A set of matrices will measure operational performance, cargo volume, cargo handling processes, space and time, while comparing security threat patterns with systemic vulnerabilities.

- b) Generalizability, entails the ability of research outcomes to be applied to other PoEs, and possibly multimodal transportation.

The Design of Experiments approach will facilitate the development of strategic planning, performing, evaluating and construing performance tests. In particular, a generalizability (G) study will be performed to allow generalization from the particular selection of PoE processing times, to a wider range of operational patterns (universe of interest). The use of a conceptual G framework will help assess the areas of measurement error within the POA methodology.

The ANOVA technique (N-Way Analysis of Variance) will be used to test the effect of two or more independent variables (cargo volume, value cargo origin) on a time-varying covariate (time-dependent covariate), i.e. monthly or annual fluctuations.

Furthermore, the findings from the ANOVA technique will lead to the study performing multiple comparisons of means to analyze mean processing times patterns of cargo processes at various POEs.

The following post hoc tests will be applied:

- The Bonferroni method will be applied when pairwise comparisons are of interest, without requiring equal sample sizes.
- The Scheffé method will compare all possible linear combinations of contrasts, yet when making pairwise comparisons, the confidence intervals will generally be wider compared to other comparison methods.

The findings of the N-Way Analysis of Variance will perform multiple comparisons to analyze the processing times patterns, and explain time delays per hour.

5. Tasks

Specific Tasks

ID	Description	Duration (Start and end as # of months past start date)
T.1	Meeting with DHS/CBP project champion(s) (*in person or conference call)	10/17
T.2	Development of a DHS Advisory Board that meets at least quarterly (*in person or conference call) to discuss the research findings and to facilitate the use of the Risk Assessment and POA tool at various POEs.	10/17
T.3	Background research Data collection. Visiting the US-Mexico border crossing PoE (Laredo) and conducting time measurements.	10/17
T.4	Meeting with DHS/CBP project champion(s) (*in person or conference call)	01/18
T.5	Data analysis and evaluation of processes and time. Comparison with Baseline. Recommendations on process improvement.	04/18
T.6	Organizing meeting or workshop with champion and industry stakeholders to present preliminary project findings and seek for solutions.	06/18
T.7	Meeting with DHS/CBP project champion(s) (*in person or conference call) Presenting research findings and recommendations.	06/18

6. Milestones

ID	Description	Completed by
M.1	Land Border Crossing, outbound containers: Baseline performance: Visiting the US-Mexico border crossing PoE (Laredo) and conducting time measurements.	10/17
M.2	Risk Assessment and POA Methodology completed.	06/18
M.3	Y2 Report completed. Comparison between baseline and improved methodology.	06/18

7. Deliverables (Outputs)

ID	Description	Completed by
D.1	Risk Assessment & POA methodology report for Land Border Crossing. * Outbound containers on Trucks at PoE, US-Mexican Border (Testbed: Laredo, TX).	06/18
D.2	Project reports and video footage of visits at selected points-of-entry. * baseline timing vs. improved timing including new processes, and implemented solutions.	06/18
D.3	Annual report	06/18

8. Performance Metrics

ID	Description	Quantitative Target	Performance	Achieved by
P.1	Improve time at land border crossing for outbound containerized cargoes on trucks.	>3% less time at land border crossing for outbound containerized cargoes on trucks.		06/18
P.2	Improve time at land border crossing for outbound containerized cargoes on rail.	>3% less time at land border crossing for outbound containerized cargoes on rail.		06/18

ID	Baseline Performance	How is baseline established?
P.1	Unknown	Our team will develop its own baseline performance (by 10/17) that measures processing times for outbound containerized cargoes exported <u>by trucks</u> from a Texas Point of Entry. The time factor will be measured during point-to-point processing of cargoes, from the moment the truck arrives at land PoE until the cargo is released to its owners. The findings will form aggregate measures.
P.2	Unknown	Our team will develop its own baseline performance (by 10/17) that measures processing times for outbound containerized cargoes exported by rail from a Texas Point of Entry. The time factor will be measured during point-to-point processing of cargoes, from the moment the truck arrives at land PoE until the cargo is released to its owners. The findings will form aggregate measures.

ID	How will final performance be assessed?
P.1	By using a Texas Point-of-Entry (Laredo, a Mexico-US Land Border) we will conduct a time study that optimizes cargo handling processes for <u>outbound containerized cargoes via trucks</u> . The cargo handling time between the existing baseline measurements and the proposed processing will be compared. The study will seek to eliminate non-value-added processes, and the findings will form aggregate measures. Time will be measured across the outbound logistics process (horizontal analysis), and within a single logistics task (vertical analysis).
P.2	By using a Texas Point-of-Entry (Laredo, a Mexico-US Land Border) we will conduct a time study that optimizes cargo handling processes for <u>outbound containerized cargoes on rail</u> . The cargo handling time between the existing baseline measurements and the proposed processing will be compared. The study will seek to eliminate non-value-added processes, and the findings will form aggregate measures. Time will be measured across the outbound logistics process (horizontal analysis), and within a single logistics task (vertical analysis).

Standards of Measurement, or baseline metrics that are required in the present research, include readings that were taken over the past year or so, to measure cargo processing times.

The aforementioned baseline metrics will be developed by the research team, and will encompass container boxes on trucks and rail at POEs, as the processing times and operational protocols may vary.

Once this information becomes available, the researchers will examine the baseline rates to evaluate vulnerabilities and areas for improvement. These findings will be used to develop the Participatory Operational Assessment.

The researchers will seek to verify the performance improvement ratios, through the development of the following “objective evidence” metrics:

- a) Developing a video for outbound containerized cargo at POEs, entailing trucking and rail transport. The video will depict the cargo processing times, performance measurement and validate the POA methodology.
The video will support the capture of processing time metrics, and enable understanding of the different cargo processing variations. The video will also enable the documentation of performances over time, and allow comparison later to final benchmark in processing times.
- b) Respectively, a white paper for Land Border POEs, pertinent to the findings of this research, will be submitted to the DHS. Subject to DHS approval, this work or segments of this work may be published in academic journals and/or presented in security conferences.
- c) Respectively, a video pertinent to the findings of this research, will be forwarded to the DHS Sponsors/Stakeholders and distributed to selected resource partners, at the DHS discretion. Selected professionals will use the videos to learn about the improved operational assessment tools.

9. Stakeholder Engagement

Researchers will coordinate their work with the following DHS stakeholders, to ascertain that the research deliverables align with particular DHS requirements, specifications and qualities.

- Cargo Security and Controls, CBP, DHS
- Cargo and Conveyance Security, CBP, DHS

10. Transition Approach

This project focuses on Port of Entry (PoE) wait times, as it identifies and aims to alleviate the factors that affect border crossing times. The outcomes are useful to several DHS agencies, in particular the CBP. An industry Advisory Board will be formed as part of the Participatory Operational Assessment methodology, so that the private sector stakeholders can be involved in discussions. Ultimate goal is to identify solutions that improve border crossing times, initially at the Laredo testbed, and potentially in other PoEs and cross-border applications.

This is a Notional Transition proposal, where the tasks, milestones and deliverables are subject to approval from the project’s Champion(s) at CBP, Cargo Security and Controls division. The PI will work with the CBP stakeholders in order to verify the most useful and appropriate transition plan for this project. Any DHS/CBP recommendations will be incorporated in planning.

11. Student Involvement

This project will involve three (3) students, i.e. one Graduate student and two Undergraduate students. Their effort will not be in partial fulfilment of the requirements for a degree.

Undergraduate students: two students will be recruited, to assist with literature review, secondary data gathering and digital media related to Mexico supply chains and U.S. Ports of Entry.

Graduate student: one student will be recruited, to assist with data gathering from Mexico supply chains and U.S. Ports of Entry, with subsequent analysis.

All students involved in this project will gain valuable experience that will help them employ their current skills and knowledge for the benefit of Homeland Security.

12. Impact/Benefit (Outcomes)

- **DHS**
 - A risk assessment and POA methodology will be developed to assist DHS / CBP employees, in mitigating outbound risks.
 - Improved efficiencies and elimination of procedural complexities will shorten cargo processing times, without compromising security issues, or overall quality.
 - The research findings will help the DHS /CBP stakeholders and HSE professionals :
 - a) identify the optimum processing methods, and eliminate areas of waste or error or duplication of effort;
 - b) recommend improvement features needed to strengthen cargo security and eliminate systemic vulnerabilities.
 - c) identify areas where the industry stakeholders can support the DHS.
- **Stakeholders/HSE/Others**
 - Industry stakeholders will form an Advisory Board that will actively engage with the project throughout its duration. The industry stakeholders will support this CBP project, and will help resolve industry-related challenges, such as bottlenecks and delays at the border, cargo theft, drug-cartel violence, etc.
 - Subject to DHS approval, the private-public sector Advisory Board will share best practices for different PoEs; whereas identify solutions to help DHS/CBP resolve border-crossing challenges. The private sector stakeholders may include cargo importers/exporters, manufacturers, logistics, transportation and warehousing stakeholders.

13. Programmatic Risks and Mitigation Plans

Laredo and Eagle Pass (TX) will be used as the main testbeds for this research project, as these two PoEs combined are the busiest PoE at the Southern Border, with infrastructure and superstructure capable of sustaining large-scale cargo processing operations.

Due to the high volume of cargoes processed on a daily basis, time constraints may not allow the on-site data gathering. However, researchers must carry out the assessment methodology without causing delays or disruptions of the cargo delivery and transportation. To mitigate this potential challenge, visits to the POE will be scheduled at times and days convenient for the cargo operators and private stakeholders. In instances of unexpected heavy traffic, security risks and operational performance may still be assessed, in a non-disruptive, non-intrusive manner.

Another risk may entail the difficulty in obtaining sensitive data from private sector employees, due to competition or confidentiality reasons. For this reason, the POA methodology proposes the Delphi method for data gathering, since anonymous information or private discussions will enable primary data gathering, without jeopardizing relations with public or private stakeholders.

14. References

- (1) DHS (2017) Quadrennial Homeland Security Review. (QHSR). Official website of the Department of Homeland Security. Available at: <https://www.dhs.gov/quadrennial-homeland-security-review> Last accessed in July 17, 2017.
- (2) Dalkey, N.; Helmer, O. (1963). "An Experimental Application of the Delphi Method to the use of experts". *Management Science* **9** (3): 458–467. [doi:10.1287/mnsc.9.3.458](https://doi.org/10.1287/mnsc.9.3.458).
- (3) UH BTI (2017) Request for Proposals for Borders, Trade, and Immigration Research RFP-17-02, Borders, Trade, and Immigration Institute, University of Houston, Available at: www.uh.edu/bti/partnerships/RFPs/RFP-17-02 Last accessed in July 17, 2017.

Secure and transparent cargo supply chain: enabling chain-of-custody with economical and privacy respecting biometrics, and blockchain technology

Project PI: Weidong (Larry) Shi

Project co-PIs: Lei Xu, Eleftherios Iakovou (Texas A&M University, subcontractor leader), and Jeffrey O. Baldwin (senior personnel)

1. Introduction

International trade has been and continues to be a powerful engine of United States and global economic growth. To secure US's economic prosperity and protect the welfare and interests of the American people, it is necessary to strengthen the global supply chain [1]. As a critical part of the global trade, the maritime supply chain is a complex system involving multiple parties (e.g., owners, buyers, sellers, shippers, carriers, port authorities, different logistic parties, and insurance companies). Currently, bill of lading is used for cargo tracking, which is very inconvenient and does not support different parties to have a full picture of cargo transportation. It is also hard to guarantee that the bill of lading carry complete information of the cargo, which may lead to various problems including frauds and trade incompliance [2] [3] [4] [5] [6] [7]. Electronic bill of lading [8] improves the situation but it still faces challenges. Because the number of parties involved is large and they are geographically distributed over the world, it is often impossible to have a centralized service that connects all of them and stores every piece of information in one place. Even if such a centralized system could be set up, security of the transportation information stored in such centralized system becomes a major concern (e.g., the records could be modified, removed, or added illegally by malicious cyber actors or insiders [9] [10] [11] [12] [13]).

The project aims to increase maritime trade compliance, efficiency and security by providing an open platform and biometrics enabled chain-of-custody approaches for all parties involved in maritime supply chain to share cargo information while providing adequate level of confidentiality and privacy protection. We plan to **address following problems:** (i) improving the maritime supply chain information flow to support better visibility of goods (transparency); (ii) connecting cargo to people using cost effective biometric enabled techniques and achieving holistic chain-of-custody in both physical world of supply chain and the cyber space counterpart of information flow; (iii) protecting sensitive data related to supply chain and customers by preventing unauthorized access; (iv) overcoming potential transition barriers and sustainability challenges to improve financial acceptance by proposing economical and ecosystem friendly chain-of-custody solutions.

The proposed solution leverages the *blockchain technology* [14] [15] to support information sharing in a fully distributed, auditable and immutable manner [16]. We also develop novel cryptography based tools that can be integrated with blockchain to protect sensitive data during the flow of supply chain information. Last but not least, our design takes advantage of the progress in biometric based security techniques. The process of biometric verification is integrated with NIST's Personal Data Storage System (PDS), which is a result of the federal government's efforts on improving the security of identity in cyberspace [17], to facilitate privacy respecting biometric based chain-of-custody. Components directly handling biometric

information act as plugins; and the system for chain-of-custody use them as inter-operable components that can be easily integrated. Besides the NIST PDS, other third party components that manage personal information (e.g., employer's HR system) can also connect to the blockchain based supply chain management system to facilitate functionalities such as providing employee information for cargo handling. Each legitimate party involved in maritime supply chain **can benefit from the system because: (i) cargo supply chain transparency is greatly improved (buyers, sellers, and logistic parties are offered with end-to-end full chain-of-custody during cargo transportation); (ii) no one can manipulate or alter chain-of-custody records in the blockchain and government agencies can easily audit any trade incompliance issues (immutable and auditable chain-of-custody).**

2. Research Question(s) being addressed

The research questions addressed by the proposed efforts are 3.a.i and 3.a.ii. *Enabling secure, transparent, holistic chain-of-custody in maritime supply chain and cargo security by integrating biometric techniques is by no means a trivial task.* Challenges that need to be addressed are:

- **Financial acceptance challenge:** Cost and budget constraints may prohibit wide adoption of these biometric approaches that are expensive in maritime supply chain management. Detailed cost – benefit analysis or aggressive approach of cost reduction is necessary to make the solution economically viable;
- **Privacy and trust challenge:** There are privacy and trust concerns associated with biometric data collection, processing, and storage by public and private sector stakeholders in maritime transportation and supply chain industry. Agencies incur security costs and liabilities for maintaining personal biometric information in order to connect cargo to people;
- **Security challenge:** Secure chain-of-custody tracking is essentially a type of cyber - physical system. The evolving threat from cyber space makes chain-of-custody no longer a pure physical security issue as falsification and tampering of supply chain transactions can occur in digital space with cascading effect to the physical world;
- **Transparency challenge:** The complexity of maritime supply chain management creates information silos, which prevents stakeholders from gaining global and holistic view of chain-of-custody; and
- **Operational challenge:** The dynamic nature of maritime supply chain management introduces hurdles and barriers from operational aspects. Integrating biometrics as rigid cargo security measure reduces flexibility and efficiency, consequently increases cost and undermines trade.

3. Goal and Objectives

The objectives of the project include:

- *Developing revolutionary holistic chain-of-custody solution by leveraging the blockchain technology that is secure (against both attacks in physical world and cyber space), decentralized (no single point of failure), financially acceptable (e.g., minimal stakeholder investment, low total ownership cost), open, resilient to attacks, auditable, and immutable;*
- *Implementing flexible (e.g., support of broad operational scenarios and use cases), low cost (e.g., bring your own biometric device), and privacy respecting (e.g., prevention of unauthorized access to supply chain information of cargos and leveraging well established biometric technologies) process to prevent cargo theft and supply chain fraud;*
- *Demonstrating total chain-of-custody by integrating third party biometric solutions and physical process with the secure decentralized supply chain system;*
- *Engaging and establishing partnership with maritime and supply chain stakeholders (both private and public sector customers) at all levels (regional, state, national, and international) to incorporate their needs and feedback from early stage of research;*

- Disseminating the research outcome, findings, and tools to the stakeholders through publications, presentations, open source release, technology showcase and prototype demonstration; and
- Transitioning the research prototype into commercially viable products and services.

Innovations	Concepts	Characteristics and Benefits
Blockchain-based tracking of chain-of-custody	A distributed system for tracking supply chain flow and chain-of-custody by leveraging the blockchain technology which is a decentralized, secure, immutable, public ledger.	Decentralized, secure, resilient to attacks, reduced exposure to insider threats, <i>low cost due to sharing economy, immutable, open information sharing environment.</i>
Personal Data Store	Secure and trustworthy management of identity data in cyber space by leveraging NIST's PDS framework.	Improved trust, support for 3 rd party apps, IoT gadgets, <i>reduced stakeholder burdens and concerns on collecting, storing, and processing biometrics and personal identifiable information.</i>
Chain-of-Custody with open biometric protocol interface	Personal Biometric Data Store provides an open service interface that supports 3 rd party apps and IoT gadgets to enable chain-of-custody using biometrics.	Standard interface based, <i>avoiding biometrics vendor lock-in</i> , reduced cost, enabling rich collection of biometric capable clients and IoT gadgets, <i>improving sustainability by facilitating an ecosystem of chain-of-custody solutions.</i>
Bring your own devices	Innovative protocol supported by the Personal Data Store that enables scenarios that allow people involved in supply chain to bring their own devices to leverage biometric information for chain-of-custody tracking.	<i>Reduced cost, elimination of privacy concerns (no need for stakeholders to collect, store, and process biometric data).</i>
Linkage between supply chain physical world and cyber space	The system integrates supply chain physical security in the real world with supply chain information security in the cyber space.	Holistic chain-of-custody <i>addressing both physical risks/threats to cargo security, and cyber risks (e.g., insider, falsification in the cyber space).</i>

4. Research Methodology

Blockchain is at the core of the crypto-currency, Bitcoin, and a major technology contributor to the success of Bitcoin over a community of distributed peers. It is believed by technology evangelists that blockchain based technology will revolutionize many industries and in particular

transform supply chain industry [18] [19] [20]. Based on the concept of “proof-of-work”, blockchain has THREE important features: *(i) public accessibility* (All information stored with blockchain is publicly accessible to everyone); *(ii) immutability* (It is impossible to modify, alter, or remove information that has been added to the blockchain [21] [22]); *(iii) resilience* (Each participant of the system keeps a whole copy of the blockchain and no single point of failure can affect the availability of the stored information). These properties make blockchain an attractive building block for connecting cargo to people and construction of secure chain-of-custody. *The basic idea is to use blockchain to record cargo chain-of-custody and each player can report their activities to the blockchain.* **Figure 2** shows the working principles of blockchain.

4.1 Overall Design of Blockchain for Secure Chain-of-Custody

The research team proposes to achieve a secure chain-of-custody by leveraging the blockchain technology [16], where blockchain is used to keep cargo transaction information for improving supply chain visibility and transparency (as showed in **Figure 3**). When a sender ships a cargo to the recipient, it generates a record that describes the cargo and transaction, and the record is preserved by saving it to the blockchain system through its mining process. When the cargo is transferred from one place to another place (e.g., from the sender to a harbor, or from the harbor to a ship), a new record will be created for each action and preserved by the blockchain. When the cargo is delivered to the final recipient, a record will be created and added to the blockchain system.

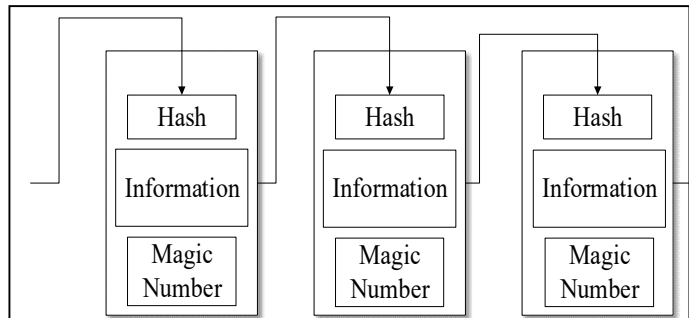
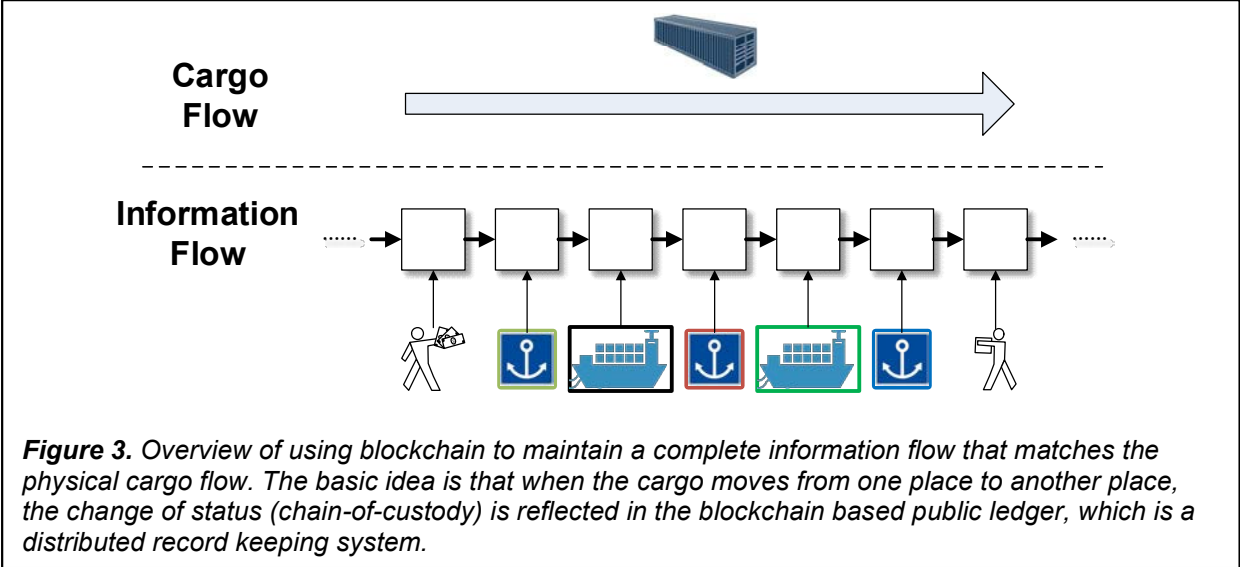


Figure 2. Basic working principles of blockchain. Information is embedded into a block, which also contains a hash value from the previous block and a magic number. The magic number is found out through a “mining” process, i.e., one searches all possible values of magic number to make sure the hash value of the triple (previous hash value, embedded information, and magic number) satisfies pre-defined condition (e.g., the hash value has certain number of leading zeros).

Because each party has access to the blockchain system, everyone involved in the transaction can check the status of the cargo in real time (confidentiality assurance is covered in the next section). An attacker, even an insider, is not able to tamper the existing cargo transaction records to compromise the integrity of cargo information flow. For instance, after a party receives the cargo and the transaction is recorded by the blockchain system, no-one in the world could succeed attacking the system to remove/modify the record (e.g., deny that the



cargo has been delivered to the person). As the system is fully distributed, it is extremely difficult for an attacker to disable the service (e.g., launching DDoS or ransomware attacks [23] [24]) to prevent the involved parties from checking status of the cargo. This approach greatly improves supply chain and cargo visibility and is a powerful tool to combat supply chain related transnational organized crimes.

4.2 Security and Privacy Protection Design

Protection of Record Authenticity. All records saved to the system should reflect the physical status of cargo chain-of-custody and parties involved. To protect authenticity of the records, digital signatures are added to each record. With the existing public key infrastructure (PKI), each party can obtain a public/private key pair, and the private keys are used to generate digital signatures of the records. **Figure 4** depicts the structure of a record stored in the blockchain system with multiple digital signatures. The record contains information about the cargo itself (e.g., identity and description of the item, the original sender, and final recipient), the last handler identity, the current handler identity, and the status description. The cargo information is fixed. Its authenticity and integrity are guaranteed by two signatures. The parties involved in each step of cargo transportation generate their own digital signatures and attach them to the record.

Protection of Confidentiality. Due to the public accessibility support of blockchain, all information stored by the blockchain is in public. This raises confidentiality concerns as involved parties may not be willing to disclose any information of the cargo they are handling. To mitigate this concern, we apply a per-transaction key, *dek*, to encrypt all sensitive information stored in the blockchain to protect confidential supply chain information. The sender and recipient work together to pick *dek*. The sender encrypts *dek* using the next handler *H1*'s public key to encrypt *dek*. After *H1* receives the cargo, it can retrieve the corresponding records from the blockchain system and decrypt with its own private key. Then *H1* can generate a new record, encrypt the sensitive information with *dek*, and encrypt *dek* with the next handler *H2*'s public key. In this way (analogous to physical shipping of encryption keys), the encryption key is passed to all involved parties step by step, and only these parties involved in the transaction have access to the information contained in the records.

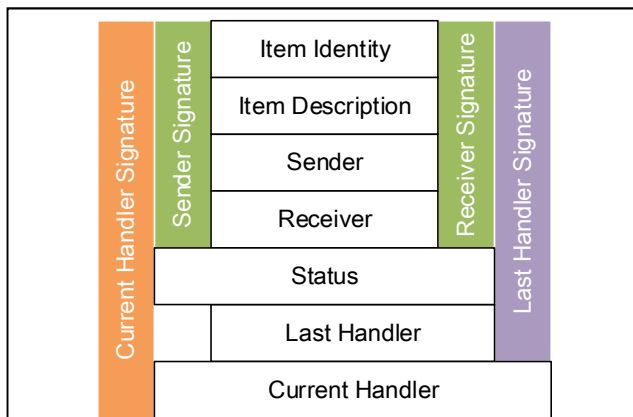


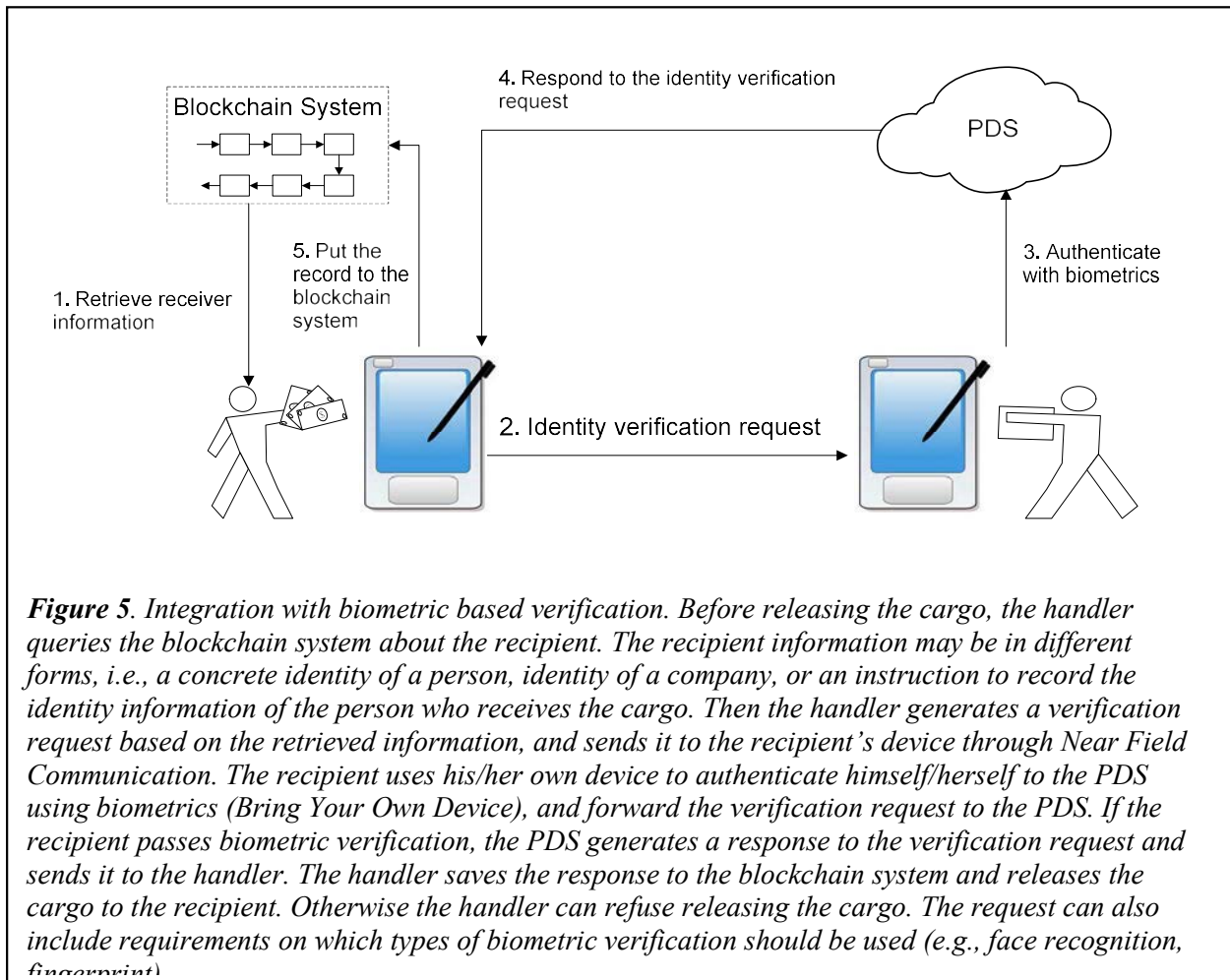
Figure 4. The record structure for tracking flow of cargo. Item related information is fixed and its integrity is guaranteed by digital signatures of the recipient and sender. When the cargo is transferred from one handler to another handler, handler information, status, and related signatures are updated.

4.3 Integration with Biometric based Identity Verification: Connecting Cargo to People

Identity verification is critical for security of chain-of-custody. Biometric based verification provides adequate assurance that can be integrated with the proposed chain-of-custody. DHS has supported several efforts to improve the reliability/accuracy of biometric based identity verification. Because biometric data is sensitive, due to privacy concerns, it is better not to keep it together with cargo transportation records or directly expose it to the involved parties. To overcome this obstacle, we plan to integrate biometrics

with PDS system [17] for authentication and verification. PDS is a system for storing personal information and helping third parties to verify a user's information through different approaches (e.g., hardware token, biometrics). The workflow is as follows: A cargo handler generates a request to verify the recipient's identity, which may contain information such as time stamp, cargo identity (e.g., bill of lading), and the recipient's identity. The request is then sent to the recipient, and the recipient authenticates his/her identity to the PDS using biometrics and asks the PDS to generate a response to the handler. After the handler successfully verifies PDS's response, the handler can release the cargo and the PDS's response is saved as part of the record and put into the blockchain system. **Figure 5** summarizes this process. The PDS system can also be implemented in a distributed manner to prevent single point of failure.

For reducing cost, the recipient can use his/her own certified biometric device for identity verification and communication with the PDS, which further minimizes the risk of biometrics data leakage. These devices are registered at the PDS; and the PDS only responds to requests generated by registered devices.



If a device is compromised, the owner can report the incident to the PDS to remove it from the list which disables its usage. In addition, PDS can analyze history of all transactions and uncover compromised devices (similar to credit card transaction fraud detection). Existing products that support certain types of biometrics in supply chain usually focus on recognition of specific individuals (e.g., PSSS [25]), and do not provide enough flexibility (e.g., allowing unspecified employees in advance from a transportation company to transfer cargo). However, these scenarios are common in international transportation and our approach supports a wide range of use cases such as claim verification, identity tracking during cargo handling (only disclosing handler's identity by the PDS if something is wrong), and different biometric modalities (e.g., fingerprint). The approach also supports non BYOD use cases when cost is not a constraint.

The proposed system leverages and integrates mature biometric technology as component; and we illustrate this with a simplified example of custom warehouse handler (*M*) and receiver (*D*),

where *D* goes to the warehouse to pick up a container (*c*), which is summarized in **Table 1**. *B* stands for blockchain based cargo management system. *The protocol applies an approach similar to two factor authentication to verify D's identify*. In order to retrieve the cargo and complete the transaction, *D* must be the right person to pick up the cargo and possess the right security token.

Table 1. A Usage Scenario of the Proposed System.

1	<i>D</i> → <i>M</i> : Request to pick up <i>c</i> .	The request includes information about <i>c</i> , for instance, <i>blockchain based bill of lading with necessary extensions</i> .
2	<i>M</i> → <i>B</i> : Check and verify the request.	Checking by <i>M</i> includes verification of the request by comparing with data stored in the blockchain based cargo management system (<i>B</i>) and extraction of pick-up information.
3	<i>M</i> → <i>D</i> : Request to verify identity information of <i>D</i> .	<i>M</i> scans bill of lading and sends a verification request to the cargo management system, <i>B</i> . As a response, <i>B</i> will, (i) send a verification request to <i>D</i> ; and (ii) send additional transaction information to <i>M</i> for <i>M</i> to verify <i>D</i> 's identity such as photo ID, face picture.
4	<i>D</i> → <i>M</i> and <i>D</i> → <i>B</i> : Provide identity information.	<i>D</i> verifies his/her identity by completing the transaction based on his/her biometric identity, for instance using a certified 3 rd party mobile device (e.g., a smart phone or tablet). The 3 rd party device applies biometrics for unlocking the device or confirming a transaction issued from the cargo app (similar to how biometric is applied for mobile payment using biometric capable smartphones). After verification, the device generates a proof (<i>p</i>) for <i>D</i> 's identity, which can be a digital signature. Proof <i>p</i> is then sent back to <i>B</i> as response; and <i>B</i> will send a confirmation message back to <i>M</i> . Note that the blockchain based cargo management system (<i>B</i>) itself does not process or store any biometric information from the user. Blockchain is used as a decentralized information sharing platform. For instance, companies' HR systems can connect to the blockchain and provide information of employee identity (e.g., employee badge). In this case, blockchain only stores link to the company's databases.
5	<i>M</i> : Accept the transaction.	Based on information retrieved from <i>B</i> , <i>M</i> visually verifies <i>D</i> by comparing the person with face pictures or photo ID (e.g., employee badge, driver license). In addition, <i>M</i> anticipates a confirmation message from <i>B</i> after <i>D</i> completes the request from <i>B</i> . When both conditions are met, <i>M</i> releases the container to <i>D</i> . The identity verification process is in fact a <i>physical two-factor identity verification process</i> . <i>D</i> must be the right person (face biometric) and possess the right security token (e.g., smartphone).
6	<i>M</i> and <i>D</i> : Submit record to <i>B</i> to complete the transaction.	After <i>c</i> is released to <i>D</i> , <i>D</i> confirms completion of the delivery process with <i>B</i> . <i>M</i> and <i>D</i> generates a new record together to put into the blockchain based cargo management system.

In the last few months (since late 2016), there have been several initiatives attempting to develop blockchain based bill of lading system [49]. These efforts primarily focus on support of bill of lading using blockchain, not the binding of cargo and people who are handling the cargo and offering an end-to-end tracking capability for chain-of-custody. However, our system can benefit from these efforts and integrate any planned or future blockchain based bill of lading.

4.4 Financial Acceptance and Evaluation

Financial Acceptance of Blockchain based Chain-of-Custody. Records of cargo transportation and chain-of-custody are added to the blockchain through mining process (e.g., brute-force searching pre-image of hash function [14]) which requires computation resources. Storage of the records requires storage resources. These costs may be covered by transaction fee, i.e., when a handler generates a new record and wants to insert it into the blockchain system, he/she has to pay a small amount of price for this activity. According to the study of Nicolas Houy [26], the cost of a similar activity in Bitcoin system is only about 40 cents. For permission based blockchain or blockchain using proof-of-stake, the cost will be many times cheaper. Furthermore, transaction cost will eventually go down because of competition and sharing economy, i.e., many parties may try to earn the transaction fees and they will compete with each other. The one with lower cost (e.g., using resources more efficiently) will win and all other parties have to achieve the same level of cost in order to compete. Note that besides the parties involved in maritime supply chain, it is possible to include other participants who only help on generating blocks to hold chain-of-custody records. They can help to reduce the transaction latency of adding new records to the blockchain system.

Economic Viability of Biometrics. Introducing biometrics into maritime supply chain management will certainly increase cost. Each party not only has to purchase biometric sensing devices, but also has to maintain a system for processing the captured biometric data, which raises privacy concerns and compliance issues regarding handling of personal identifiable data. *Our approach leverages existing PDS infrastructure for biometric information storage and processing, therefore does not require extra investment. For biometrics sensing devices, our approach supports the concept of BYOD, which reduces both cost and risk of biometric data leakage.*

5. Tasks

PI. Shi has many years of industrial experiences of creating commercial technologies and advanced prototypes for world-leading high tech companies, and has conducted extensive research on biometrics and identity management [27 - 41]. He is responsible for project management and overall design. Dr. Xu has experiences in applied cryptography, key management, and cloud security [42 - 47]. He is responsible for issues related to security and privacy. Mr. Baldwin has both front-line and rich leadership experiences directing CBP field operations related to maritime and port security. Dr. Eleftherios Iakovou is the Director of Manufacturing and Logistics Innovation Initiatives at the Texas A&M Engineering Experiment Station (TEES). Dr. Iakovou brings his maritime transportation, port and cargo management expertise to this project. Dr. Iakovou has extensive research and practice experiences in areas of maritime transportation and supply chain management. Since 2016, Dr. Iakovou sits at the Editorial Board of Maritime Economics and Logistics. He has served as a member of the National Committee on Logistics of the Hellenic Ministry of Transport and Communications, and as a member of the Advisory Committee of EUREKA (Brussels, Belgium), the pan-European network for market-oriented, industrial innovation and R&D. Houston has the largest container

port in Gulf Coast, and Port of Houston is the 1st in volume of foreign tonnage. There are a large number of local private companies participating international cargo supply chain. Besides working closely with stakeholders from DHS, the research team will also leverage this advantage to reach out to private companies who are involved in international cargo supply chain operation to collect demands, share new technologies, conduct TCO study, and evaluate the developed technologies. In **Figure 6** a general view of the cargo supply chain process is shown. A symmetrical process is noticed where same activities are done in both sides, origin and destination place. Due to symmetry, it is possible to leverage what is done in the origin side for the destination side. The activities performed by the Origin Agent (see **Table 2**) are complex enough to demonstrate our unified platform through evaluation in the field.

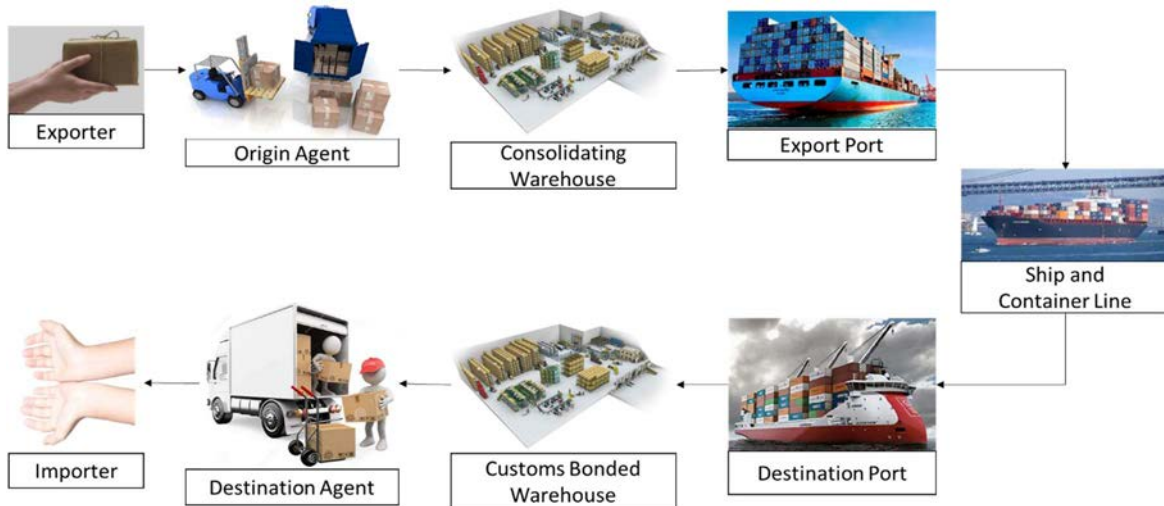


Figure 6. Block diagram of the cargo supply chain via ocean freight.

Table 2. Entities and Tasks Involved in the Cargo Supply Chain via Ocean Freight.

	Origin Agent	Consolidating Warehouse	Export Port	Ship and Container Line	Destination Port	Customs bonded Warehouse	Destination Agent
<i>Visual Survey</i>	X						
<i>Quoting</i>	X						X
<i>Pack and load Shipment</i>	X						
<i>Export Documents</i>	X		X				
<i>Bill of Lading</i>	X						
<i>To be licensed</i>	X						
<i>Wait until container is filled</i>		X					
<i>Export Customs</i>							

<i>Fees</i>	X		X	X	X		X
<i>Master Bill of Lading</i>				X			
<i>Online Tracking</i>				X			
<i>Unload Goods</i>					X		
<i>Goods held until customs is cleared</i>						X	
<i>Release goods</i>							X
<i>Deliver to final address</i>							X

ID	Description	Completed by (# of months past start date)
T.1	Conduct kick-off meeting and communicate regularly with project champion. Communication with the project champion. Regular meeting will be set up to communicate with the champion from the beginning of the project to the end to discuss directions/progress of the project, and other related issues to make sure the project will be on the right track.	1, 3, 6, 9, 12, 15, 18, 21, 24
T.2	Communication with BTI representative. Regular meeting will be set up to communicate with BTI representative for project progress and feedback collection.	3, 6, 9, 12, 15, 18, 21, 24
T.3	Partner selection and field study/cost analysis plan development. The research team has discussed with our consultants to identify potential partners including carriers, logistic brokers, and port operators to assist evaluation. The team will talk with these companies to select a partner.	4
T.4	Plan development for field study and financial impact study. The research team will collaborate with the selected partner to develop the plan: (1) A field study will be used to demonstrate our developed blockchain based cargo management system in realistic operation environment. Therefore, we will map the process for international cargo shipping to different classical scenarios and show how the developed system operates. As mentioned in Section 4, the system integrates 3 rd party biometric verification (biometric based device or app unlock) as integrated component to protocol of cargo handling. For demonstration purpose, we will use public data sets as much as possible and when necessary. (2) Because there is no system on the market yet that provides the same set of features, the financial impact study will focus on modeling and estimating cost for adopting the system by the stakeholders, including acquisition cost, transaction cost, and maintenance cost. The research team will work with the selected partner to evaluate the cost estimation model and whether the cost of the developed system is acceptable from operational perspective.	5
T.5	Design of blockchain based chain-of-custody that records complete information of cargo. e.g., companies and persons handling them, sending/arriving information, and custom information. The research team will incorporate current technology to the cargo blockchain system to bind tracking information with physical cargo (e.g., using tokens to bind cargo and people information).	8
T.6	Design of integration with biometrics and privacy protection mechanism that prevents unauthorized access to information stored in blockchain. A transaction is an activity that occurs between two entities, A and B. In our application, use of physical multi-factor identity verification including visual verification (e.g. photo ID, facial image) by cargo handler will ensure that the handler is interacting with an actual person with known identity. The project development does not collect nor store biometric information from the users. For	12

	demonstration purpose, the system may use already existing datasets or pictures (e.g., photo ID, pictures from social media) and these pictures will be permanently removed after demonstration. Unlock or verification via fingerprint will be handled by third-party devices and software. In operational environment, visual verification may rely on retrieved information from cargo handler's employers (e.g., HR databases). In this case, blockchain is used as an information sharing backbone. The task is to demonstrate that the developed technology can leverage biometric information; and provide adequate protection and security.	
T.7	Development, test and evaluation of the prototype for block chain-based cargo supply-chain system software. The evaluation is divided into two categories: (i) <u>Technical test and evaluation</u> , which include testing software functionalities (correctness of responses to inputs) and performance such as latency/throughput evaluation, and resource consumption evaluation; (ii) <u>Operational utility evaluation</u> , which includes evaluation of usefulness of the system in practice or operational environment. This study will be done by subject matter experts with operational knowledge.	20
T.8	Review full/expedited/exempt IRB submission. The research team is not developing nor collecting any biometric information from individuals. To conduct field study or field demonstration, individuals may interact with our system and they will be asked for feedback/comments. Then the University's IRB committee will determine if an expedited or exempt IRB is required prior to the project kickoff and/or evaluation. The team has discussed with University of Houston Division of Research and an IRB request is under review.	20
T.9	Conduct field study and financial impact study with selected partner, and collect feedbacks.	22
T.10	Final report preparation.	24

6. Milestones

ID	Description	Completed by (# of months past start date)
M.1	Completed partner selection, system requirements analysis, and filed study/cost analysis plan.	4
M.2	Completed system design.	12
M.3	Completed initial prototype.	20
M.4	Completed field study.	22
M.5	Completed final report.	24

7. Deliverables (Outputs)

ID	Description	Completed by (# of months past start date)
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D.1	Requirement and performance definition.	4
D.2	System design document including biometrics integration and privacy protection mechanism for blockchain.	8
D.3	Prototype of blockchain based holistic secure supply chain system. This prototype is a blockchain based client that includes all necessary features for supply chain management (adding record, querying record, and auditing operations). The prototype will be delivered as source code and design document.	20
D.4	Prototype of personal biometric integration and handling. This prototype consists of components (interfaces) needed to handle biometric information, in this case face pictures, photoIDs. It also includes component to protect biometric data from unauthorized access. The prototype will be delivered as source code and design document.	20
D.5	Prototype of integrated secure chain-of-custody with biometric support. This prototype is a middleware that allows blockchain based supply chain system to interact with biometric data storage system for operations like querying, verification, and authentication. The prototype will be delivered as source code and design document.	20
D.6	6 publications in relevant conferences, magazines and journals.	23
D.7	Report on field study and cost analysis.	23
D.8	Final evaluation report covers system performance, findings, evaluation, and lessons learned.	24

8. Performance Metrics

The proposed system will be evaluated from three perspective: (P.1.) System performance such as throughput or latency of adding a new record as well as delay for completing a transaction. (P.2.) Financial impact to the operators. (P.3.) Effectiveness on securing cargo supply chain.

ID	Description	Quantitative Performance Target	Achieved by (months past start date)
P.1	System performance, which is further divided into: (i) Latency of adding records to the system. Latency will be measured when the information is uploaded to the blockchain. The timestamp of a request is compared with the timestamp of the ending of the transaction. (ii) Throughput. Throughput will be measured by the number of records that the system can handle in a given time period.	System performance targets include: (i) Latency: maximal 1 second delay; (ii) Throughput: at least 1,000 records per minute.	18
P.2	Financial impact of end-to-end chain-of-custody using biometrics and blockchain.	Because there is no comparable or equivalent system available in the market yet, the analysis will be determined by consulting with selected project partner.	23
P.3	Reduction of cargo fraud/thefts that are related to cargo management IT	The system includes decentralized immutable	23

	system. Specifically, the developed system will provide following features: (i) an adversary cannot delete a transaction record stored in the system; (ii) an adversary cannot alter or modify an existing transaction record.	ledger that comprises multiple nodes. If majority of the nodes are honest or trusted (permission based blockchain) and an adversary only has bounded computation and storage capability, it is guaranteed that these features be satisfied.	
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ID	Baseline Performance	How is baseline established?
P.1	System performance baseline include: (i) Latency of adding a transaction record is less than 2.5s; (ii) Throughput of the system is no less than 1,000 transaction records per minute.	On average, the system should be able to achieve a latency of 3s for each record to meet its requirements. Otherwise it will affect its utility. According to the World Shipping Council, 120,000,000 containers were shipped in 2013 worldwide. On average, 228 containers were shipped each minute. The system should have the capability to process at least 500 containers per minute.
P.2	Financial burden and acceptance.	As there is no existing system that offers similar features or equivalent multi-factor physical security for cargo handling, the baseline of financial acceptance will be established by subject matter expert from the selected partner.
P.3	Same to the targets.	The security features are all-or-nothing for cargo fraud/theft reduction. Therefore, the baselines and the targets are the same.

ID	How will final performance be assessed?	
P.1	System performance.	The performance parameters will be assessed by measuring performance of the developed prototype.
P.2	Financial impact level.	Cost includes acquisition, transaction and maintenance cost. The cost is assessed according to acceptance analysis developed by subject matter expert or partner.
P.3	Impact to cargo loss/theft.	The performance will be assessed by analyzing whether the developed system can prevent an adversary from removing or altering records from the cargo management system.

9. Stakeholder Engagement

To ensure partnership and engagement with the stakeholders, our team comprises experienced project manager and consultants with extensive CBP and HSE backgrounds for coordinating the stakeholder engagement efforts.

DHS Components: The research team will work closely with the project champion to reach out to DHS component customers such as U.S. Coast Guard and CBP for establishing contacts and managing engagement with DHS components. **Stakeholders/Homeland Security**

Enterprise/Nonprofits: The team will establish formal partnership with private industry stakeholders (e.g., CargoNet, FreightWatch), engage port authorities, and team with leading

nonprofit organizations, consortiums in maritime supply chain and cargo security industry (e.g., Maritime Security Council, National Insurance Crime Bureau, Supply Chain – Information Sharing and Analysis Center, National Cargo Theft Task Force, *American Institute of Marine Underwriters*). **Sibling CBTIR Teams, Research Organizations, and Relevant DHS COEs:** The research team also plans to take advantages of the synergy and partner with other relevant CBTIR teams (e.g., biometrics, port security). For broader collaborations, the team will seek partnership regarding research with relevant DHS COEs and other academic/industry research organizations including MIT supply chain management research group, Maritime Academy of Texas A & M at Galveston, IBM Hyperledger research division, etc. **International:** In addition, the team will engage international stakeholders and agencies tasked for maritime security and fighting transnational supply chain organized crimes (e.g., TAPA EMEA, TAPA APAC, International Maritime Organization, INTERPOL, World Customs Organization).

10. Transition Approach

Dissemination of Research Outcome and Findings to Stakeholders. The research team will develop a viable transition plan by 12 months of workplan approval. The research team will ensure the broadest dissemination of knowledge and research outcome to the stakeholders, and maximize real-world impact of DHS S & T sponsored research. In addition to knowledge dissemination through relevant seminars (e.g., Marine Insurance Day Seminar), publications in workshops, conferences (e.g., Homeland Security Conference), and industry magazines (e.g., Risk Management published by the Risk and Insurance Management Society, Security Magazine), the team plans to organize workshop seminars at relevant venues, perform demonstrations to the stakeholders, and conduct other transition activities such as pilot.

Potential End Users and Customers: U.S. Coast Guard, Customs and Border Protection, Port Authorities, Law Enforcement Agencies, Cargo Theft/Fraud Investigators, National Crime Information Center, Cargo and Supply Chain Risk Managers, Maritime Insurance Providers, Commercial Shippers, *Maritime Cargo Carriers* & Importers, National Insurance Crime Bureau.

Commercialization. Taking advantage of the market need of affordable, open, ecosystem friendly, and secure solutions for strengthening supply chain security and fighting against cargo fraud/thefts, the team plans to eventually commercialize the developed technologies. The developed solution has the potential to *enable a broad range of application scenarios and use cases for both government sectors and private industry stakeholders*. Enabled third party applications (e.g., maritime IoT) can in turn help to increase the adoption of the developed platform and facilitate a sustainable market of secure supply chain solutions and auditable chain-of-custody.

11. Impact/Benefit (Outcomes)

- **DHS.** Each year, more than 11 million maritime containers arrive at US seaports, that's about 10% of the containers shipped worldwide. DHS CBP is responsible to check whether it poses risk to the American people [48]. The proposed system provides CBP the capability to connect cargo to people, auditable supply maritime chain intelligence, and early warning capabilities.
- **Stakeholders/HSE/Others.** For stakeholders in the maritime supply chain, the proposed technology provides a holistic, economical, and resilient platform for tracking chain-of-custody and improving supply chain visibility and transparency. It also helps to prevent frauds that include illegal modification of transportation history, and has the capability to be compliant with regional customs programs and international standards. Furthermore, the proposed system will foster an ecosystem where third party applications related to the chain-of-custody can be built on top.

12. Programmatic Risks and Mitigation Plans

To ensure project success, the team will strive to identify project risks from the very beginning of the project, continue assessing the project risk and barriers throughout all phases of the research, and develop appropriate mitigation strategies. The risks are further mitigated by strategies below,

Risks	Explanation	Mitigation
<i>Security and privacy</i>	Privacy concerns related to biometrics and personal identifiable data.	The solution employs Personal Biometric Data Store as a service that minimizes exposure risks of biometric or personal identifiable data, eliminates liability concerns, and improves trust from the public.
<i>Stakeholders</i>	Risks of stakeholder support and involvement.	The team will engage and partner with critical stakeholders to develop concrete use cases, and ensure stakeholder buy-in within first year of project. An end-to-end based approach will be adopted to involve the stakeholders from early stage of technology development.
<i>Financial acceptance level</i>	The cost associated with adopting new technology may prevent the adoption of the system.	The team will develop cost reduction strategies to ensure that the developed system will have reasonable cost (e.g., bring your own biometric devices, leverage existing mature biometric techniques) and acceptable for users.
<i>Compliance</i>	Contract compliance	The team will work closely with the University Research Office to ensure compliance before starting work.

The Impact of Central American Child and Family Migration on U.S. Communities

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1. Introduction

Increased Central American child and family migration is impacting communities across the U.S. These local communities are responsible for ensuring the welfare of this growing immigrant population as they navigate the immigration process and for promoting the integration of those deemed eligible for immigration benefits (White House Task Force on New Americans, 2015). Despite this shared obligation, receiving communities' capacity to respond to this ongoing humanitarian situation is uneven and, in many cases, likely insufficient. Targeted research is needed to analyze varying levels of capacity and response across diverse community contexts; to map the landscape of local government and community services available to this population; and to determine how those factors are shaping newcomers' ability to adapt and integrate. Such work is critical to enhancing local communities' capacity to respond, by offering evidence-based recommendations for how best to leverage existing resources to strengthen and sustain community preparedness.

The Center for Latin American & Latino Studies (CLALS) at American University (AU) is strategically positioned to lead a multidisciplinary team of experienced researchers based in top-receiving communities across the U.S. to conduct this work. The proposed study will build on our team's ongoing portfolio of research on Central American immigrants' access to and impact on local school systems, health and human services, and legal services, and will draw heavily on already established connections with key stakeholders in local governments and nonprofit community-based organizations (CBOs). The proposed study will also benefit from our research team's demonstrated ability to generate useable knowledge and to effectively transition research findings into compelling, accessible deliverables for use by policymakers and practitioners. This includes our 2014 report (Stinchcomb & Hershberg, 2014) on factors driving Central American child and family migration and of federal and local-level policy responses, which has garnered significant attention and continues to be widely cited and used by an array of stakeholders.

2. Research Questions

The proposed study will address research questions 8.b.i-iv as specified in RFP-16-01:

- i.* What is the impact of Central American immigration on local governments and communities, including with respect to healthcare, and education? What may be the short- and long-term costs and benefits to U.S. communities of Central American immigration?
- ii.* How strong is the infrastructure for providing services to the population in the U.S.? Which agencies are providing services, and what are the gaps in services?
- iii.* Are immigrants or refugees being released into U.S. communities adapting and becoming integrated into their local communities, or are they struggling? What are the health, mental health, and educational outcomes of immigrants or refugees being released into communities in the U.S.?
- iv.* How is DHS handling the increase in arrivals, especially women and children? In particular, how is Immigration and Customs Enforcement's (ICE) new Family Case Management

Program (FCMP) performing? What are the outcomes of families with histories of trauma enrolled in the program?

A comprehensive approach to tackling research questions 8.b.i-iii requires thorough analysis of community-level impact and response across three service areas: education; health and human services; and legal services. Analyzing these questions will also shed light on matters of safety and security, a key DHS priority articulated by reviewers of an initial version of this proposal. In addition, to address question 8.b.iv, a parallel component of this study will investigate DHS response, with a focus on ICE's FCMP. For each of the three service categories and the parallel component on DHS response, we provide a brief summary of the current state of knowledge on the topic, identifying key gaps in understanding around these complex issues as they pertain to the experiences of recent Central American arrivals, and underscoring the rationale for our multidisciplinary, multisite approach. Where limited research has been done or is currently underway, we clarify in this and/or subsequent sections how those findings will inform our approach, complement our data collection activities, and be incorporated into project outputs tailored to the needs of a wide range of stakeholders.

To be sure, as noted by reviewers taking on three service areas and the FCMP is an ambitious undertaking given the limited budget for the project. However, the effort will build on pilot studies in which participating researchers are involved, and will generate descriptive data that promise to be of utility to scholars and practitioners alike. While the project does not aspire to advance a methodological literature, it draws on widely used and accepted social scientific techniques to provide reliable findings based on accessible data.

Education: With schools often serving as the first point of contact in receiving communities, school responses and education policies are key barometers in assessing the impact of immigration on localities and their capacity to integrate newcomers (Fix, Zimmerman, & Passel, 2001). Free public K-12 education is the only locally-funded service mandated by federal law for which the majority of Central American newcomers are eligible (ED, 2014), and thus represents the most significant short-term expenditure for communities. The high cost of facilitating school enrollment and providing basic education and related support services (e.g., bilingual education, afterschool programming, mental health resources, cultural accommodations, etc.) has been widely reported (Campo-Flores & Jordan, 2014), but research is lacking on whether access to federal assistance through Title I, Title III, and IDEA funding is helping to mitigate those costs. It also remains unclear to what extent unaccompanied children (UACs) are foregoing schooling in order to enter the labor market and how this trend may be offsetting projected expenditures (Goździak, 2015). Furthermore, preliminary research has emphasized the need for work examining how contextual variables such as immigrant reception climates and varying levels of institutional capacity, public funding, and familiarity with the challenges posed by large immigrant student populations have led to divergent school responses across U.S. communities (Pierce 2015; Chen, 2014). Members of the research team at both AU and the University of Houston (UH) are conducting pilot studies of local school district responses and UAC integration in their respective locations. Both of these inquiries will contribute valuable data to the proposed effort study to be supported by BTI.

Health and Human Services: Unauthorized immigrants are generally ineligible for federal assistance programs, meaning that states and localities are left to decide what public benefits, if any, to offer and to whom. As with education, local community contexts vary widely in terms of policies and programs providing a range of possible services to Central American children and

families, including health care, mental health services, municipal identification cards, and driver's licenses (Hunter & Shklyan, 2016). Several top-receiving states and counties (e.g., California; New York; Washington, DC; Montgomery County, MD) have existing publicly-funded health care programs for income-eligible adults and children lacking immigration status (Radnofsky, 2016; Pierce, 2015). Yet there is little data on a number of pressing questions, including the effectiveness of post-release services granted to a limited number of UACs (Roth & Grace, 2015); whether newcomers are utilizing available services; and how increased demand may be straining local budgets. Many UACs are being placed in mixed-status families, which are known to have disproportionately lower access to and use of health and human services programs—factors that have been demonstrated to adversely affect a wide range of well-being and integration indicators (Yoshikawa, Godfrey, & Rivera, 2008; Capps & Fortuny, 2006). In communities where publicly funded assistance programs are limited or non-existent, research is needed to understand to what degree nonprofit CBOs are filling the gap. Furthermore, with large numbers of UACs receiving Special Immigrant Juvenile (SIJ) Status (2014 Humanitarian Crisis at our Border, 2015) and subsequent legal permanent resident (LPR) status, data is needed on how trends in this population's eligibility for relief from removal will impact budgets for state and local-funded benefits. The University of North Carolina-Chapel Hill (UNC)-based member of the research team is a nationally recognized expert on Latino immigrant access to and utilization of health and human services.

Legal Services: Though the federal government, states, and localities are under no obligation to guarantee legal representation for UACs or family units, practice has demonstrated that access to low-cost or pro-bono legal services is linked to significantly higher rates of compliance with immigration obligations (American Immigration Council, 2016). For this and other reasons, the Obama administration took steps to ensure legal representation for UACs who remain in the care of the Office of Refugee Resettlement (ORR), and has launched pilot programs through the Department of Health and Human Services (HHS) and the Department of Justice (DOJ) to enable legal aid organizations in communities across the U.S. to take on thousands of additional cases (White House, 2014). However, despite these efforts, representation rates remain low, at 53% for UACs and 46% for family units with pending cases. As a result, the number of in absentia removal orders continues to climb, exceeding 32,000 for all cases filed since the start of FY2014 (TRAC, 2016). Recognizing this critical service gap and the impact of unauthorized status on integration outcomes, some localities have taken proactive steps to provide legal representation for UACs by establishing public-private partnerships to fund case management (New York City Council, 2015, White House, 2014). Research is needed to understand how these and similar initiatives across the country are promoting compliance with immigration obligations and shaping overall integration experiences. Through a partnership with its Washington College of Law and Center for Latin American & Latino Studies, AU is engaged in ongoing work analyzing the impact of legal and expert assistance on case outcomes for Central American immigrants, and has established contacts with legal service providers across the country. The UH-based researcher is also involved in the Houston Immigration Legal Services Collaborative, a nonprofit organization offering legal services to UACs in Houston.

Safety and Security: Localities are also faced with the challenge of ensuring the safety of growing immigrant communities. Lawmakers and government officials have attested to the demand that increased Central American migration is placing on federal and local law enforcement resources, citing in particular the vulnerability of Central American UACs to human trafficking, child abuse and neglect, sexual exploitation, and criminal gang recruitment in their communities of resettlement (Permanent Subcommittee on Investigations, 2016). No data exist, however, on how communities are allocating resources to protect newcomers or on whether recent arrivals are engaged in criminal activities post-release. Local jurisdictions in the

Washington, DC metropolitan area have, for example, reported a reemergence of the MS-13 gang, fueled by ramped-up recruitment efforts targeting prospective members in high schools situated in communities with significant Central American populations (LaSusa, 2015; Jouvenal & Zapotosky, 2014). These and similar reports have coincided with federal indictments linking MS-13 members to dozens of homicides and cases of extortion, rape, and assault in Maryland and Virginia suburbs and other U.S. cities.

While the budget for this study does not allow for systematic gathering of data on safety and security, our final report will illuminate such matters by drawing on findings of other research in which we are engaged as well as on insights gleaned from data gathered through this project with respect to conditions in schools and access to both health and legal services. AU is completing a multiyear DOJ-funded study on the transnational criminal capacity of MS-13 in Washington, DC and Los Angeles, through which it has established productive ties with federal and local law enforcement agencies and CBOs providing gang prevention services to at-risk Central American youth. This research will provide material to enable us to include some attention to these issues in BTI-supported publications on Central American immigrant incorporation, even while resources do not enable us to make this a core focus of the research supported by the funding from BTI or of a free-standing project publication.

DHS Response and FCMP: The Central California District Court ruling in *Flores v. Lynch* and resulting injunction have required DHS to fundamentally restructure its handling of Central American family units and to comply—in all cases involving minors—with standards initially set for the release, detention, and treatment of UACs. In adhering to short-term custody standards, DHS has expanded the use of alternatives to detention (ATDs) for families awaiting removal proceedings, and is exploring less restrictive, more holistic community-based ATD models. One such pilot ATD is ICE’s new Family Case Management Program (FCMP), which provides select family units in five metropolitan areas with comprehensive case management by tracking and monitoring compliance with the immigration process while also offering assistance in accessing legal services, housing, education, and mental health services. Given the program’s novelty, no studies to date have assessed its performance or evaluated family outcomes.

3. Goal and Objectives

The main goal of this study is to provide an up-to-date, thorough understanding of the impact of Central American migration on U.S. communities and to map varying levels and forms of support services and their effect on newcomers’ integration experiences. The specific objectives in support of this goal are to:

1. Gather data in three major receiving communities to assess community impact and response across three service areas that play an integral role in immigrant incorporation: education; health and human services; and legal services.
2. Use representative case studies to determine key factors shaping communities’ capacity to respond to ongoing migration and to describe the ways in which those factors create distinct reception contexts that, in turn, contribute to variable trajectories for newcomers.
3. Identify best practices and innovative solutions deployed by local governments and nonprofit CBOs across the country to build safe, welcoming communities.
4. Provide an overview of DHS’ handling of new arrivals along with an evaluation of ICE’s new Family Case Management Program.
5. Transition project findings into recommendations and resources for dissemination through various channels, including not only publications but also the CLALS website and social media platforms, to relevant constituencies via case studies, service area briefs, and in-person briefings hosted in Washington, DC and Houston.

Relevance: We underscore, in terms of relevance that the impact of recent and ongoing Central American migration on local communities with respect to the full range of service areas in question will not diminish in the short or mid-term. Regardless of whether or not migration levels remain at historic lows, the number of arrivals during the past five years alone represents an unprecedented influx of immigrants whose integration is critical. Between October 2011 and February 2017, over 180,000 unaccompanied minors from Northern Triangle countries were apprehended at the Southwest border and subsequently transferred into the care of the Department of Health and Human Services and family sponsors throughout the U.S., where the majority remain at present. And since October 2014, nearly 105,000 family units have been apprehended, a significant number of whom have passed initial screenings for asylum or other immigration benefits and have been released pending resolution of their immigration cases. These numbers alone bear witness to the relevance and timeliness of research questions i.-iii. We would also note that these figures fail to account for those immigrants who manage to enter the U.S. undetected, yet whose presence in U.S. communities is of equal consequence for DHS, other federal agencies, and local governments.

Furthermore, the majority of recent child and family arrivals from Central America will remain in the U.S. for many years, and a significant subset of those will remain permanently. Unaccompanied minors and family units released into local communities will continue to depend on local governments for schooling, safety, and other services at least until their immigration cases have been decided. Their cases have overburdened an already resource-starved immigration adjudication system, and as of February 2017, cases involving unaccompanied children and women with children from Central America accounted for over one-fourth (29%) of immigration courts' 542,000-case backlog. The Justice Department's decision last February to rescind the previous administration's policy of expedited hearings for recent arrivals has pushed hearing dates as far back as 2022, meaning that many youth and families could reside in the U.S. for up to five years as they await a court decision. In the interim, local communities are tasked with ensuring the welfare of this population as they navigate the immigration process. Moreover, based on recent trends, we can expect a significant number of Central American immigrants will be granted one or another form of immigration relief, allowing them to remain legally in the U.S. and to potentially solicit the legal entry of foreign-born family members. Thus, their integration will continue to pose a challenge for local communities for the foreseeable future. We would also note that grant rates for certain immigration benefits, particularly asylum, vary widely across jurisdictions, which lends further justification for the multi-site research design outlined in Section 4.

4. Research Methodology

Technical Approach: To meet these objectives within a one-year timeline and within the committed level of resources, the research team will conduct key informant interviews with government officials; community-based nonprofit service providers; and nonprofit advocacy groups across the three identified service areas. A similar approach will be used to assess overall DHS response and ICE's FCMP. Key informants will be selected on the basis of standardized criteria across organization types as indicated in Table 1.

Table 1. Key Informant Selection by Organization Type and Service Area.

Organization Type

Service Area	Government agency			Nonprofit (CBO) provider organization	Nonprofit advocacy group
	Local	State	Federal ⁷		
Education	✓	✓		✓	✓
Health and human services	✓	✓		✓	✓
Legal services	✓			✓	✓
Parallel Study Component					
DHS response and FCMP			✓	✓	✓

Our qualitative-based technical approach is designed to generate reliable, high-quality data capable of addressing the study’s complex, multifaceted research questions. In the absence of a cohesive set of quantitative metrics (Gelatt, Bernstein, & Koball, 2015) or available quantitative data (Waters & Pineau, 2015) with which to measure community impact, capacity, and response across diverse urban contexts, systematic collection and analysis of sound qualitative data remains the most effective means of assessing local impacts of immigration and of describing potentially disparate integration outcomes. This method also ensures that data collection activities will capture a wealth of descriptive data on an array of policy innovations and best practices for immediate use by stakeholders. Separate interview guides will be prepared for each of the three service areas as well as for the parallel component analyzing the FCMP.

Research Sites: Key informant interviews will be conducted across the three service areas in three major receiving communities: the Washington, DC and Houston metropolitan areas and North Carolina. Together these sites account for 21% of all UAC placements since the start of FY2014.⁸ They span four top-ten UAC-receiving states (TX, MD, VA, and NC) and include four top-ten receiving counties (Harris County, TX; Prince George’s and Montgomery counties, MD; and Fairfax County, VA). These three sites offer compelling comparative case studies that are representative of the diverse community contexts across the U.S. where the largest number of Central American UACs and families reside. In order to capture the broad range of receiving community diversity, these sites have been purposively selected on the basis of the following criteria: geographic diversity; differences in population size, immigrant concentration, and diversity of immigrant population; traditional immigrant gateway vs. emergent high-growth immigration sites; variation and innovation in programming across service areas; and variation in immigrant reception climate (i.e., welcoming vs. exclusionary).

Washington, DC Metropolitan Area: Continuing a decades-long history of Central American immigration, the Washington, DC metropolitan area has received just under 11,000 (10%) of all UAC placements since October 2013. As the only metropolitan area in the U.S. in which Central Americans—principally Salvadorans—are a majority of the immigrant population, Washington, DC offers a critical case study for understanding how traditional urban gateways, including Los Angeles and New York, are being impacted by and responding to increased flows of Central Americans. Like Los Angeles and New York, DC boasts an extensive network of immigrant-

⁷ Interviews with federal government officials are not essential to the data gathering, but are a supplementary source of data that we will endeavor to access as the project evolves.

⁸ All data on state and county UAC placements are from ACF 2016a, 2016b, respectively.

servicing nonprofits providing a wide range of programs and services to foreign-born communities, but rapid growth of the Central American immigrant population in the region's outer suburbs has distanced newcomers from traditional service providers, many of which are concentrated within city limits. As these organizations have attempted to extend their reach, their service portfolios and funding have been affected by local jurisdictions' distinct political environments and service infrastructures, promoting spatial variations within the metropolitan area that are likely to contribute to disparate integration experiences and outcomes (De Leon, Maronick, De Vita, & Boris, 2009). Washington, DC is also one of only five metropolitan areas served by ICE's FCMP, which is provided by GEO Care in partnership with CBO Bethany Christian Services. Thus, DC will serve as the site for the parallel study component addressing research question 8.b.iv.

Houston Metropolitan Area: The most diverse, fastest-growing major metropolitan area in the U.S., Houston has received over 7% of all UACs since the start of FY2014. With over 7,400 UACs, Harris County is the top receiving county in the country, surpassing Los Angeles County, CA by more than 1,200 placements. Like Los Angeles and New York, Houston's capacity to integrate newcomers has been bolstered by a strong labor market, a growing economy, and philanthropic support from foundations and corporate donors, yet little research has evaluated the impact of these factors on the experiences of Central American newcomers. Despite these advantages, Houston has a relatively low-wage economy, and the low incomes of Houston's immigrants—particularly Latinos—may present barriers to their integration and access to legal assistance, health care, and other needed services (Capps, Fix, & Nwsou, 2015).

North Carolina: Like Houston, North Carolina is one of fastest growing new immigrant destinations in the U.S. Resettled UACs are concentrated in three counties (Wake, Durham, and Mecklenburg counties) across two urban centers, Durham and Charlotte. While these counties have passed largely symbolic resolutions in support of integration efforts, relocated UACs and families encounter less established networks of nonprofit service providers and more restricted access to state and local services than in the other two research sites. As a result, fieldwork in North Carolina will afford key insights into the impacts of Central American migration on smaller, emergent destination communities across Southeastern states, such as Tennessee, South Carolina, Georgia, Mississippi, Louisiana, and central and northern Florida, which when combined with North Carolina account for roughly 14% of all UAC placements.

Data Analysis: Key informant interviews will be transcribed and coded for analysis according to a standardized protocol consistent across the three research sites. The project team will include a minimum of three coders based at each of the research sites. Sharing segments of data and emergent coding frameworks will be a core activity of research team meetings and will allow us to evaluate inter-coder reliability. We will also cross-check interim findings with interview respondents (i.e., respondent validation) to detect inherent biases and refine explanations. Meetings with stakeholders throughout the project period will also facilitate reiterative fact-checking and serve to validate raw data and findings. Qualitative analyses of interview data will be supplemented by published reports and publicly available data on community impact and response gathered during T.2. Data analysis will follow a two-tier approach. A first level of analysis will develop comprehensive case studies of the three research sites by examining findings across all of the service domains in each receiving community. A second level of analysis will group and examine data comparatively for each service domain across the three sites in order to identify key similarities and differences and their influence on integration experiences. Comprehensive community case studies will benefit from the multidisciplinary training of the research team, while comparative analyses of service domains will draw on individual team members' respective areas of expertise.

5. Tasks

ID	Description	Completed by
T.1	Start-Up Meeting with Project Coordinator	Month 1
	<p>The AU-based Project Coordinator has convened the members of the research team, Eric Hershberg (PI), Jodi Berger Cardoso (Co-PI), and Krista Perreira (Senior Consultant), via teleconference for a project start-up meeting. Representatives from BTI have provided considerable input, reflected in that discussion and in this revised project description. We have reviewed project objectives, tasks, deliverables, timelines, and reporting requirements.</p>	
T.2	Comprehensive Review of Existing Information	Month 2
	<p>We will synthesize the existing knowledge base on community responses and available services for newcomers, drawing on academic, local government, and nonprofit CBO reports, and publicly available data. As indicated in the service area summaries included in Section 2: Research Questions, our engagement in similar work gives us a head start on this task.</p>	
T.3	Meeting with Project Coordinator	Month 3
	<p>The research team will outline final steps to ensure completion of selection criteria for key informants (T.4.1) and the key informant interview guide (T.4.2).</p>	
T.4	Key Informant Interviews	Month 6
	<p>T.4.1. Finalize Selection Criteria for Key Informants Building on existing ties with local stakeholders, researchers at each site will identify at least 12 key informants in each service area. For the parallel study component on DHS response and ICE's FCMP, an additional 12 key informants will be identified in the Washington, DC metropolitan area. Selection criteria will ensure consistency of data collected across sites. We anticipate the following categories of informants:</p> <ul style="list-style-type: none"> • Elected and/or publicly appointed city/county officials; • School superintendents and administrators; • Administrators at local public agencies providing services to Central American migrants; • Managers of state and local health care services (including public health agencies, federally qualified health centers and other community health clinics and providers); • Nonprofit service providers, including faith-based organizations, engaged in service areas; • HHS-contracted CBOs providing post-release services for UACs; <p>For the parallel study component evaluating overall DHS response and ICE's FCMP, we anticipate interviews with the FCMP Compliance Officer assigned to Washington, DC/Baltimore, regional and field directors at GEO Care, administrators and staff at Bethany Christian Services, and stakeholders engaged in the referral process.</p> <p>T.4.2. Finalize Key Informant Interview Guide To ensure the comparability of collected data, we will develop a key informant interview guide,</p> <p>T.4.3. Conduct Key Informant Interviews We will conduct a minimum of 48 interviews in the Washington, DC metropolitan area, and 36 interviews in both the Houston metropolitan area and North Carolina (total n = ≥120).</p>	
T.5	Meeting with Project Coordinator	Month 6
	<p>The research team will report progress on key informant interviews, develop a standardized protocol for data analysis, and ensure appropriate data sharing mechanisms are in place.</p>	

T.6	Interview Transcription and Data Analysis	Month 7
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See Data Analysis under Section 4: Research Methodology.

T.7	Meeting with Project Coordinator	Month 9
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The team will discuss progress in drafting community case studies and service area briefs.

T.8	Community Case Studies and Service Area Briefs	Month 10
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Following data analysis, the research team will produce the following deliverables:

Three Community Case Studies: The three case studies will present comprehensive findings for all relevant research questions from each of the research sites—the Washington, DC and Houston metropolitan areas and North Carolina. Significant effort will be made to convey the representative nature of the selected cases by drawing parallels with similar community responses or service provision initiatives in other top-receiving locations. The DC case study will include findings from the parallel study component on DHS response and ICE’s FCMP.

Three Service Area Briefs: Utilizing a more succinct format, the three service area briefs will compare and contrast research findings within each service area (education; health and human services; and legal services) across the three sites. The intent will be to identify and describe the principal challenges confronting communities and highlight best practices and innovative solutions for addressing newcomers’ needs in diverse community contexts. These targeted briefs will feature recommendations for policy and practice along with roughly ten pages of narrative text with integrated graphics that distill key findings.

T.8	Stakeholder Briefings	Month 11
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In collaboration with local stakeholders, including service providers in the public sector and/or non-profit sector, we will host two public briefings to project study findings, one in Washington, DC and the other in Houston. To maximize the impact of these briefings to the largest group of interested persons possible, briefings will be either livestreamed or video recorded, and reference to them will be prominent on the CLALS website and social media feeds. Recordings will be uploaded to the project webpage for public viewing. In conjunction with the briefing in DC, a private briefing with DHS could be arranged if desired.

T.9	Final Report	Month 12
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Following completion of the case studies and issue briefs, we will produce a final report that includes a brief and focused summary essay structured around the research questions that synthesizes the key findings related to each question and describes interactions among the findings. Following this summary, the report will include the case studies and service area briefs and then a conclusion with recommendations. In addition, we will produce an executive summary that concisely addresses the overall context of the project and key findings and recommendations. We will submit the draft final report one month prior to the project end date. A final report will be submitted after incorporating comments and recommendations.

6. Milestones

ID	Description	Completed by
M.1	Completion of Comprehensive Review of Existing Data	Month 1
M.2	Completion of Key Informant Interviews	Month 7
M.3	Publication of Three Community Case Studies	Month 10
M.4	Publication of Three Service Area Briefs	Month 10
M.5	Submission of Draft Final Report	Month 11

7. Deliverables (Outputs)

ID	Description	Completed by
D.1	Three Community Case Studies: Washington, DC; Houston; North Carolina	Month 10
D.2	Three Service Area Briefs: Education; Health and Human Services; Legal Services	Month 10
D.3	Project Results Disseminate through CLALS website	Month 10
D.4	Stakeholder Briefings (Recordings)	Month 11
D.5	Final Report	Month 12

8. Performance Metrics

ID	Description	Quantitative Performance Target	Achieved by
P.1	Number of Key Informant Interviews	120	Month 6
P.2	Number of Interview Transcriptions	120	Month 7
P.3	Number of Attendees at Dissemination Briefings	150	Month 11
P.4	Number of Case Study Downloads	1000	Month 12
P.5	Number of Service Area Brief Downloads	1500	Month 12
P.6	Number of Project Webpage Visits	1000	Month 12
P.7	Social Media Engagement: Number of likes, shares, retweets, reposts, etc.	250	Month 12

In addition to the performance metrics listed above, during the initial months of the project we will ask local community stakeholders for quantitative indicators that would allow us to assess the usefulness and impact of project outputs on policy and practice.

Baseline Performance: For P.1-7, baseline performance is zero, as no research or dissemination activities have been initiated.

Final Performance Assessment: For P.1-3, final performance will be assessed based on achievement of the quantitative performance target. For P.4-7, every effort will be made to reach the quantitative performance targets by the end of the project period. However, dissemination activities and engagement with stakeholders will continue well beyond the duration of the project, meaning that indicators at project end will also continue to climb.

9. Stakeholder Engagement

Successful execution of data collection activities and transition of research findings will require sustained stakeholder engagement throughout the project. As noted previously, we are already engaged with an extensive network of stakeholders in each of the research sites. Though limited space precludes an exhaustive detailing of these contacts, an illustrative list includes:

Washington, DC	Houston	North Carolina
La Clinica del Pueblo, DC-MD-VA Coalition for Children Fleeing Violence; Center for Health and Health Care in Schools;	Houston, Spring Branch, Alief, and Clear Creek Independent School Districts; Legacy Clinic; Depelchin's Children Center; Refugee Services of Texas;	El Pueblo (Wake County); El Centro Hispano (Durham County); Latin American Coalition (Mecklenberg County); NC Justice Center;

Street Outreach Network

Central American Minors
Workgroup

Select Area High Schools

With offices across sites: Catholic Charities; Kids in Need of Defense; Lutheran Immigration Refugee Services; Tahirih Justice Center; U.S. Committee for Refugees and Immigrants

These stakeholders will play an essential role in providing reliable indicators to assess project impact, serving as key informants, and disseminating project outputs through their own organizations and beyond. Dennis Stinchcomb will serve as the AU-based Project Coordinator, and will be responsible for sustaining stakeholder engagement throughout the project.

10. Transition Approach

The research team has an established track record of delivering research findings in accessible formats to a broad range of end-users, including government agencies and community partners. For this study, our transition approach will be structured around the production of three community case studies and four service area briefs that synthesize project findings and offer recommendations for policy and practice. Following completion of the case studies and service area briefs, we will launch an aggressive dissemination campaign, including the creation of a project-dedicated webpage and the strategic use of social media. We will enlist the support of local community partners—both in the research sites and in other communities across the U.S.—to project research findings to the widest possible audience. These publicity efforts will be complemented by two public stakeholder briefings, one in Washington, DC and the other in Houston. The purpose of the briefings will be to re-engage with stakeholders who participated in the study, and to use that audience base to reach the larger community. Video recordings of the briefings will be made available along with other project reports and resources.

11. Impact/Benefit (Outcomes)

DHS: The proposed project will further the mission of DHS in at least four concrete ways. First, it will enhance DHS' collaborative engagement with state and local partners by promoting constructive discussion of the local impact of federal immigration policies pertaining to recent Central American arrivals. Second, it will provide DHS with data on whether and what gaps in services are impacting newcomers' compliance with immigration obligations. Third, project outputs will promote community response capacity by presenting useful data in a compelling way to key local stakeholders. Fourth, DHS will benefit from evidence-based outputs designed to offer strategic guidance on strengthening immigrant and refugee integration infrastructure at the federal and local levels.

Stakeholders/HSE/Others: Stakeholders in receiving communities across the U.S. will benefit from targeted research products that identify best practices and innovative solutions and offer recommendations for how to best leverage resources to meet newcomers' needs while building safe, welcoming communities.

12. Programmatic Risks and Mitigation Plans

We have extensive experience in the technical aspects of the proposed work, including recruitment and interviewing of key informants, the development of highly effective issue and policy briefs, and the convening of high-profile public forums. PI Hershberg has successfully lead several large-scale, multisite collaborative research projects based on fieldwork and the collection of in-depth qualitative data. Senior Consultant Perreira has conducted similar work on behalf of task forces, nonprofits, and federal and state agencies. Co-PI Berger Cardoso has been working with UACs directly and coordinating the Houston response since the 2014 surge. She was part of the original team that developed the proposal to establish a DHS Center for

Excellence at UH and has strong relationships with the administrative team. Given this experience, we are best prepared to mount this effort quickly and efficiently, anticipating and avoiding potential challenges, and swiftly resolving any that arise. The only fundamental challenge for the project is securing interview subjects, but our prior research in related areas makes us confident that this will arise relatively rarely, and when it does, we rely on our ability to identify and gain access to additional appropriate sources who we can interview. In addition to the quarterly meetings, the Project Coordinator will communicate with members of the research team in Houston and North Carolina on a biweekly basis to discuss any obstacles that arise. If any challenges are identified, he will meet with the PIs to develop and execute an action plan.

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Appendices

Appendix 1. White Paper

Items in red are instructions. Please remove when completing the document.
Use 11 point Arial font, or larger, throughout the document. Limit to 3 pages
Concept Papers must not contain proprietary information.

Title:

Author(s): Name and Affiliation

A. Challenge

Gap/Challenge: What are the specific Homeland Security Enterprise (HSE) challenges (problem/unknown/gap) that should be addressed? State the question that should be addressed

B. Rationale

Motivation: How did you identify the challenges? What evidence is there that they exist? What is their magnitude?

Relevance: How well do the specified challenges fit within the BTI Institute's mission? Choose and refer to an IPT category from the [DHS Integrated Product Teams R&D Report](#). Alternatively, refer to other policy documents from DHS (e.g., the [DHS 5-Year Strategic Plan 2015-2019](#), and the [Quadrennial Homeland Security Review](#)) or DHS components (e.g., the [S&T Visionary Goals](#), the [CBP Vision and Strategy 2020](#), or the [U.S. Border Patrol Strategic Plan](#))

Supporting Data:

Impact/Benefit: Does the research to meet those challenges have a strong potential for advancing the state-of-the-art and contributing significantly to the DHS mission? How will this work impact/benefit DHS and its component agencies? What are the expected new capabilities? What are the negative impacts if the challenges go unmet or the consequences if solutions are delayed?

Essentials for BTI Institute Funding: Challenges that are more appropriately addressed by efforts that are not within the mission of BTI Institute cannot be considered for competition topic areas. We are interested in why these HS challenges currently are not being adequately addressed or sufficiently funded. What funding gaps exist (either private or public)? What existing efforts are addressing the problem? What level of support (money, collaboration, or related research) currently exists to address this problem? Why are current approaches believed to be inadequate or not sufficiently timely?

C. Path to Addressing the Challenge

Transition Approach:

Deliverables (Outputs): State clearly and succinctly the types of deliverables (outputs) that could be produced by the kind of projects discussed above (e.g., Journal Publications, Conference

Publications, Hardware/Software Products, Systems, Data Sets, Policy Documents). Please specify why the desired outcomes are necessary in the context of the stated HS Challenges

Performance Metrics: Description of measures that could be used to evaluate project and progress performance – how could the BTI Institute quantify success in addressing the HS Challenges discussed? Please also specify how the BTI Institute could assess the potential impact of the deliverables (outputs) produced.

D. References (optional)

Appendix 2. Significant Activities Y3

Borders, Trade, and Immigration Institute SIGNIFICANT ACTIVITIES CALENDAR – Y3 As of July 21, 2017	
Date	Activity
August 29, 2017	Annual Report Submission
September	
September 1, 2017	Biennial Review (Material Deadline)
September 13, 2017	External Advisory Board Teleconference
September (3 rd Week)	Research and Transition Committees Progress Review of BTI Institute Projects (first of three this year)
September 28, 2017	Immigration and the Refugee Experience, Texas State University Witliff Collection and Center for Southwest Studies, San Marcos, TX (Dr. Luis Torres)
October 2017	
October 17-18	Annual PPI Meeting (Washington, DC)
October	Distinguished Speaker Series: The Scourge of Human Trafficking
November 2017	
November 5-8, 2017	Executive Program in Global Maritime Supply Chain Leadership
November 13-14, 2017	External Advisory Board Meeting
November	BTI Director attends Biennial Review Meeting
November	Distinguished Speaker Series: NAFTA
December 2017	
December	Distinguished Speaker Series: Refugees
January 2017	
January 25, 2018	External Advisory Board Teleconference
January	Risk Assessment Training
February, 2018	
February (1 st week)	Research and Transition Committee Progress Review of BTI Institute Projects (2 nd of three this year)
February	Distinguished Speaker Series: Honorable Alan Bersin
March 2018	
March (1 st Week)	Research and Transition Committee Work Plan Review
March 30	Work Plan Y4 Submission
March	Distinguished Speaker Series:
TBD	RFP 18-01
April 2018	
April 18-19, 2018	External Advisory Board Meeting
April	Distinguished Speaker Series:
May 2018	
May	BTI Fellows Orientation
TBD	DHS Showcase
May	Research and Transition Committees Progress Review of BTI Institute Projects (third of three this year)
June 2018	
June	Summer Internships begin

Borders, Trade, and Immigration Institute
SIGNIFICANT ACTIVITIES CALENDAR – Y3
As of July 21, 2017

Date	Activity
June	Student Summer Research Fellows
June	Summer Research Training Program
July 2018	
July 26, 2018	External Advisory Board Teleconference
August 2018	
August 29, 2018	Annual Report Submission