Strategic Study
Workshop Series

Advanced Development
for Security Applications

Next Generation Screening Technologies
and Processes for the Checkpoint

ADSA15
November 2016 Workshop
Final Report

ALERT
AWARENESS AND LOCALIZATION
OF EXPLOSIVES-RELATED THREATS

A Department of Homeland Security Center of Excellence

Northeastern University

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This report is dedicated to the memory of Richard Bijjani:
A luminary for his friends, colleagues, and the aviation security field.

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1. Executive Summary

A workshop focused on next generation screening technologies and processes for the checkpoint was held at Northeastern University (NEU) in Boston on November 15-16, 2016. This workshop was the fifteenth in a series dealing with advanced development for security applications (ADSA15).

The theme of this workshop was chosen in order to support the Department of Homeland Security's (DHS) objective of improving the performance of existing technologies and improving the passenger experience at checkpoints. Another goal of the workshop was to support DHS's objective to increase the participation of third parties, such as researchers from academia, national labs, and industry other than the incumbent vendors, in algorithm and system development for security applications.

The following topics were addressed at the workshop:

- Emerging hardware and algorithms
- Concepts of operations
- Protection of soft targets
- Data analytics – application to aviation security
- System architectures
- Business aspects of fusion
- Funding, innovation, and deployment models

These topics were addressed from the perspectives of the following stakeholders:

- Passengers
- TSA
- Airlines
- Airports

The key findings from the workshop on what can be done to improve the experience for the stakeholders at the checkpoint, per the editors of this report, are as follows:

- Silver bullets (i.e., single technology solutions) do not exist.
- Explore methods to collect and use more data about passengers.
- Determine which passengers can be trusted and hence subjected to reduced screening.

At the meeting, it was recommended that ADSA16 (May 2-3, 2017) should address the requirements for different stakeholders in transportation security.

2. Disclaimers

This document was prepared as an account of work sponsored by an agency of the United States government. Neither the United States government nor Northeastern University nor any of their employees makes any warranty, expressed or implied, or assumes any legal liability or responsibility for the accuracy, completeness, or usefulness of any information, apparatus, product, or process disclosed, or represents that its use would not infringe privately owned rights. Reference herein to any specific commercial product, process or service by trade name, trademark, manufacturer, or otherwise does not necessarily constitute or imply its endorsement, recommendation or favoring by the United States government or Northeastern University. The views and opinions of authors expressed herein do not necessarily state or reflect those of the United States government or Northeastern University, and shall not be used for advertising or product endorsement purposes.

This document summarizes a workshop at which a number of people participated in discussions and/or gave presentations. The views in this summary are those of ALERT and do not necessarily reflect the views of all the participants. All errors and omissions are the sole responsibility of ALERT.

This material is based upon work supported by the U.S. Department of Homeland Security, Science and Technology Directorate, Office of University Programs, under Grant Award Number 2013-ST-061-ED0001. The views and conclusions contained in this document are those of the authors and should not be interpreted as necessarily representing the official policies, either expressed or implied, of the U.S. Department of Homeland Security.

3. Introduction

The Explosive Division (EXD) of the U.S. Department of Homeland Security (DHS) Science & Technology Directorate (S&T), in coordination with the Transportation Security Administration (TSA), have the objectives of improving the performance of existing technologies, developing new technologies, and improving the passenger experience at checkpoints. One tactic that DHS is pursuing to achieve these objectives is to create an environment in which the capabilities and capacities of the established vendors can be augmented or complemented by third-party algorithm and hardware development. A third-party developer in this context refers to academia, National Labs, and companies other than the incumbent vendors. DHS is particularly interested in adopting the model that has been used by the medical imaging industry, in which university researchers and small commercial companies develop technologies that are eventually deployed in commercial imaging equipment.

A tactic that DHS is using to stimulate third-party algorithm and hardware development is to sponsor a series of workshops addressing the research opportunities that may enable the development of next-generation technologies for homeland security applications. The series of workshops are entitled "Advanced Development for Security Applications (ADSA)." The workshops are convened by Professor Michael B. Silevitch as part of the DHS Center of Excellence (COE) for Awareness and Localization of Explosives-Related Threats (ALERT) at NEU.

ADSA15 was held on November 15-16, 2016 at NEU. The workshop focused on next generation screening technologies and processes for the checkpoint.

This report discusses what transpired at the workshop and details a summary of the findings and recommendations.

4. Discussion

4.1 Objectives of the Workshop

The focus of the workshop was on next generation screening technologies and processes for the checkpoint. The topics that were addressed centered on the following points:

- Emerging hardware and algorithms
- Concepts of operations
- Protection of soft targets
- Data analytics – application to aviation security
- System architectures
- Business aspects of fusion
- Funding, innovation, and deployment models

The purpose of this chapter is to summarize the discussion and recommendations in response to these objectives and related questions that surfaced during the workshop.

4.2 Stakeholder Perspectives

The discussion at the workshop was centered on the perspectives and desires of the following stakeholders:

- Passengers (non-terrorist)
    - o Confidence that flying is safe
    - o Faster, predictable screening with reduced divestiture
    - o Fewer pat-downs and bag opening
- Airports
    - o Reduced total operating cost due to:
        - Labor
        - Purchase price and maintenance costs
        - Secondary inspection
    - o Do not want events at their airports
    - o Passengers, luggage, and cargo getting on their flights
- Airlines
    - o Passengers, luggage, and cargo getting on their flights and flights leav-

    ing on time
  - Passengers wanting to fly
  - Do not want events on their airline
- Government, TSA
  - No incidents
  - Reliable equipment, and manageable, cost-effective screening processes that deliver actual perfect detection and low false alarms
  - Terrorists deterred from trying to take down planes
  - No explosives detected because terrorists are not trying
  - Happy passengers, airlines, and airports
  - Systems designed with increased sensitivity and selectivity against a broader set of potential explosives and prohibited items

4.3 What Did We Hear?

We heard about the following topics:

- TSA's future vision for aviation security: "Keyboard to gate" security phases
- An environment created for innovation in TSA
- Recommendations that TSA have a technical advisory board
- TSA Requirements Analysis Platform (TRAP)
- UK carry-on luggage screening research programs - similar to TSA's Innovation Task Force (ITF)
- A panel discussion featuring airline, passenger, vendor, and terrorist actors
- Engagement of the general population for detection with ubiquitous sensors
- Metadata and cognitive computers
- Data analytics for health care and security applications
- Open platforms to enable fused solutions and engage third party contributions
- Coherent and diffraction X-ray systems
- X-ray screening of an entire airplane
- New behavioral detection techniques
- Deterrence

- Adaptive automatic threat recognition (AATR)
- Vendors setting detection specifications with their customers for non-aviation venues
- Lie detection using transdermal imaging and eye observations
- Zero-shot learning as a method to develop automatic target recognition (ATR) with minimal training data
- Development of explosive simulants
- Is present security necessary or sufficient?
- Advanced imaging technology (AIT) reconstruction
- Photoacoustic sensing of explosives
- Video analytics

4.4 What Did We Not Hear?

We did not hear enough about the following topics:

- Can cognitive computers increase security?
- Is 80/20 (PD/PFA) better than 70/5?
- How will new technologies be tested?
- How to conduct training and testing with little data?
  - Note that ALERT has transformed classified problems into equivalent unclassified problems and has unrestricted data to support the latter problem.
- Secondary and tertiary screening
- Operator fatigue
- Ticket-to-destination tracking and data mining
- Specification-driven design
- Methods for faster deployment of systems and algorithms, such as ATR
- Weapons detection
- Randomized screening
- Training systems employing deep learning
- Deterrence testing

4.5 What Can Be Done?

Recommendations for enhancing the checkpoint include:

- Explore methods to collect and use more data about passengers
- Determine which passengers can be trusted, and hence, subjected to reduced screening

4.6 ADSA16

The following topics should be considered for ADSA16 and other ADSA workshops in addition to the topics listed in Section 4.4.

- TSA needs
- Terrorists' perspective
- Cyber security
- Data analytics for security
- Threat shifting (displacement)
- Protection of soft targets
- Tag and track options(e.g., video tracking of passengers and divested objects)
- System architectures, networking, and CONOPs
- Improving statistical significance of testing
- Human in the complete loop
- Civil rights and privacy concerns
- Prize competitions
- Hand-held inspection devices (e.g., metal detectors)
- TSA deployment models and issues

5. Acknowledgements

The planning committee would like to thank the following people and organizations for their involvement in the workshop:

- DHS S&T for funding ALERT and sponsoring the workshop
- Doug Bauer, DHS (retired); Laura Parker, DHS; and George Zarur, DHS & TSA (retired), for their vision to involve third parties in the development of technologies for security applications
- Laura Parker, DHS, for coordinating DHS/ALERT activities
- NEU for hosting the workshop
- Suriyun Whitehead, Booz Allen Hamilton; and Harry Martz, Lawrence Livermore National Laboratory, for reviewing the final report

The workshop would not have been a success without the participants and the speakers. We extend our heartfelt thanks to them for their contributions.

6. Workshop Planning and Support

The planning committee for the workshop consisted of the following people:

- Carl Crawford, Csuptwo
- Harry Martz, Lawrence Livermore National Laboratory
- Michael Silevitch, Northeastern University

The workshop was moderated by:

- Carl Crawford, Csuptwo

The body of the final report was written by:

- Carl Crawford, Csuptwo

The final report was assembled by:

- Sara Baier, Northeastern University

Minutes were taken by:

- Suriyun Whitehead, Booz Allen Hamilton

Logistics for the workshop were led by:

- Melanie Smith, Northeastern University

Other logistics were handled by:

- Sara Baier, Northeastern University
- Deanna Beirne, Northeastern University
- Kristin Hicks, Northeastern University
- Anne Magrath, Northeastern University

7. Appendix: Notes

This section contains miscellaneous notes about the workshop itself and the final report.

1. The timing in the agenda was only loosely followed because of the amount of discussion that took place during the presentations and to allow for additional times for participants to network.
2. Some of the presenters edited their material (mainly redacted information) after the workshop.
3. The minutes were edited for purposes of clarity. All errors in the minutes are due to the editors of this report and not due to the speakers themselves. Minutes were only recorded during the question and answer period for each presentation.
4. PDF versions of the presentations from this workshop can be found at the following link: https://myfiles.neu.edu/groups/ALERT/strategic_studies/ADSA15_Presentations

8. Appendix: Agenda

8.1 November 15, 2016 - Day 1

TIME	TOPIC	SPEAKER	AFFILIATION
Introduction			
7:30	**Registration/Continental Breakfast**		
8:30	Welcoming Remarks - ALERT	Michael Silevitch	ALERT / NEU
8:35	Welcoming Remarks - Dean, College of Engineering	Nadine Aubrey	NEU
8:40	Welcoming Remarks - DHS	Laura Parker	DHS
8:45	Setting the Stage	Carl Crawford	Csuptwo, LLC
Aviation Checkpoint of the Future - Perspective			
8:55	Systems Architecture Activities	Keith Goll	TSA
9:25	TSA Innovation Task Force	Mara Winn	TSA
9:50	TSA Requirements Analysis Platform (TRAP)	John Morgan	General Dynamics
10:15	UK Perspective on Checkpoint Screening	Ben Jones	UK Government
10:40	**Break**		
11:00	EU Supported Security Research Activities	Paolo Salieri	European Commission
11:25	Perspectives on Checkpoint Security: Airline, Vendor, Passenger, Terrorist	Matthew Merzbacher, Jimmie Oxley, Harry Martz	Morpho Detection, University of Rhode Island, Lawrence Livermore National Laboratory
Venue Protection			
11:50	Insights for Mobile Radiation Detector Adoption	Michael Egnoto	University of Maryland/START
12:15	Adaptive Learning, Venue Protection and Experience at the Rio Olympics	Lisa Dolev	Qylur Security Systems, Inc.
12:40	**Lunch**		
Data Analytics			
1:10	The Importance of Meta-Data	Malcolm Slaney	Google
1:35	Scope, the Technical Challenges, and the Progress in Building Cognitive Computers	David Namahoo	IBM

TIME	TOPIC	SPEAKER	AFFILIATION
2:00	Data Analytics in Medicine and Possible Application to Aviation Security	Homer Pien	Philips Research
	Vendor Systems		
2:25	Tribute to Richard Bijjani	Michael Ellenbogan	Evolv Technology
2:30	Evolv's Products for the Checkpoint	Michael Ellenbogan	Evolv Technology
2:55	Analogic's Checkpoint CT System	Steve Urchuk	Analogic Corporation
3:20	**Break**		
3:40	IDSS's Checkpoint Scanner	Patricia Krall	Integrated Defense and Security Solutions
4:05	X-Ray Diffraction Imaging – Achievements and Challenges	Matthew Merzbacher	Morpho Detection
4:15	Prospects for Using Coherent X-Ray Scatter for Material Discrimination at a Checkpoint	Dan Strellis	Rapiscan Laboratories
4:25	Fast & Reliable Bomb Threat Clearing of Civil Airplanes	Mircea Tudor	TUDOR Scan Tech SA
	Behavioral Detection (Lying) and Deterrence		
4:45	Transdermal Optical Imaging: A New Frontier of Lie-Detection	Kang Lee	University of Toronto
5:10	Next Generation Screening Starts with the Eyes	Mark Handler	Converus
5:35	Deterrence: Is it Effective and How to Make it Better	Matthew Merzbacher	Morpho Detection
6:00	**Adjourn**	Carl Crawford	Csuptwo, LLC

8.2 November 16, 2016 - Day 2

TIME	TOPIC	SPEAKER	AFFILIATION
7:30	**Registration/Continental Breakfast**		
8:00	Call to Order	Carl Crawford	Csuptwo, LLC
8:05	DICOS 2A status	Steve Skrzypkowiak	Global Security Technologies

TIME	TOPIC	SPEAKER	AFFILIATION
Automated Threat Detection & Integrated Systems			
8:10	Adaptive Automated Threat Recognition	Harry Martz	Lawrence Livermore National Laboratory
8:30	Zero Shot Learning	Venkatesh Saligrama	Boston University
8:50	Accelerating Certification Testing by Creating an "Instrument Mode" Construct and by Avoiding Lorenz Attractors	Lee Spanier	DHS Transportation Security Laboratory
9:10	HME Simulant Development and Validation	Robert Klueg	DHS Transportation Security Laboratory
9:30	A Generalizable Radiography Algorithm Test Environment for NDE Applications	Andrew Wantuch	Sandia National Laboratory
9:45	Deep Learning Overview	Matthew Merzbacher	Morpho Detection
10:05	**Break**		
10:25	Estimation and Detection Information Tradeoff for X-ray System Optimization	Johnathan Cushing	University of Arizona
10:50	Integration of Bottled Liquid Scanners and Electronic Scanners in the Innovation Lanes	Tim Rayner, Pablo Prado	One Resonance Sensors
AIT Algorithms			
11:15	AIT Opportunities and Challenges	Carey Rappaport	NEU
11:35	Ray-Based Modeling for Material Characterization	Elizabeth Wig (student), Mahdiar Sadeghi (student)	NEU
Trade-offs and Solutions			
11:50	Safety Act - Specifics for Small Businesses and Academicians	David Paquette	DHS
12:00	Trade-Offs to Increasing Security and Adding Checkpoints	John Mueller	Ohio State/Cato Institute
12:25	**Lunch**		
12:40	Solving TSA's Problems Using an Exercise in War Gaming	Graeme Goldsworthy, Diederik Stolk	Goldsworthy, Stolk & Associates

TIME	TOPIC	SPEAKER	AFFILIATION
Emerging Hardware and Algorithms			
1:40	Photoacoustic Sensing of Explosives	Robert Haupt	MIT Lincoln Laboratory
2:05	Compton Scatter Imaging	Eric Miller, Brian Tracey	Tufts University
Video Tracking of Passengers and Divested Objects			
2:30	Attribute-Based Searching and 360° Surveillance Video	Cindy Fang	MIT Lincoln Laboratory
2:55	CCTV+Video Analytics-Based Passenger Flow Management System	Shawn Dagg	Crowd Vision
3:20	M&S/HD animation (Ani-Sim) in checkpoint security technology	Rodger Dickey	Global Systems Technologies
Next Steps			
3:25	Summary and Next Steps	Harry Martz, Suriyun Whitehead, Carl Crawford	Lawrence Livermore National Laboratory, Booz Allen Hamilton, Csuptwo, LLC
Closing Remarks			
3:50	Closing Remarks	Michael Silevitch	ALERT/NEU
3:55	Closing Remarks	Laura Parker	DHS
4:00	**Adjourn**	Carl Crawford	Csuptwo, LLC

Note: The timing in the agenda was only loosely followed due to the amount of discussion that took place during the presentations and to give additional time for participants to network.

9. Appendix: Previous Workshops

Information about the previous fourteen workshops, including their final reports, can be found at: www.northeastern.edu/alert/transitioning-technology/strategic-studies

10. Appendix: List of Participants

NAME		AFFILIATION
David	Atkinson	Pacific Northwest National Laboratory
Nadine	Aubry	Northeastern University
Paris	Babaheidarian	Boston University
Sara	Baier	Northeastern University
Douglas	Bauer	University of Connecticut
John	Beaty	Northeastern University
Moritz	Beckmann	XinRay Systems LLC
Simon	Bedford	Astrophysics, Inc.
Reg	Beer	Lawrence Livermore National Laboratory
Deanna	Beirne	Northeastern University
Charles	Bouman	Purdue University
Emel	Bulat	Northeastern University
Eric	Bush	Transportation Security Adminstration
Seyhun	Byrne	Department of Homeland Security
Avi	Cagan	New Mexico State University
David	Castañón	Boston University
Michael	Chan	MIT Lincoln Laboratory
Andrew	Cox	Sandia National Laboratories
Carl	Crawford	Csuptwo, LLC
Johnathan	Cushing	University of Arizona
Shawn	Dagg	Crowd Vision
Marianne	DeAngelus	MIT Lincoln Laboratory
Abdulla	Desmal	Tufts University
Rodger	Dickey	Global Systems Technologies
Charles	DiMarzio	Northeastern University
Dan-Cristian	Dinca	American Science and Engineering, Inc.
John	Doherty	Massachusetts Institute of Technology
Michael	Egnoto	University of Maryland
Michael	Ellenbogan	Evolv Technology

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Ryan	Ferry	E3 Federal Solutions, LLC
Amanda	Figueroa-Navedo	University of Puerto Rico Mayagüez
Alfred	Forbes	ScanTechIBS
Joseph	Frasko	TranScan Systems, LLC
Johnny	Galui	Transportation Security Adminstration
Colby	Gartner	Transportation Security Adminstration
Jeffrey	Gates	Presco
Patrick	Godfrey	Transportation Security Adminstration
Graeme	Goldsworthy	Goldsworthy, Stolk & Associates
Keith	Goll	Transportation Security Adminstration
Brian	Gonzales	XinRay Systems LLC
Bernard	Gordon	Photo Diagnostic Systems, Inc.
Chris	Green	ScanTechIBS
Adam	Grosser	Redlen Technologies, Inc.
Joseph	Han	Morpho Detection
Mark	Handler	Converus
Peter	Harris	Yankee Foxtrot, Inc.
Martin	Hartick	Smiths Detection
Tim	Harvey	Transportation Security Adminstration
Robert	Haupt	MIT Lincoln Laboratory
Thomas	Henry	Deloitte
Dominic	Heuscher	University of Utah
Kristin	Hicks	Northeastern University
David	Hinojosa	Stratovan Corporation
Peter	Howard	Triple Ring Technologies
Dmitriy	Ivashin	Implant Sciences Corp.
Edward	Jimenez	Sandia National Laboratories

NAME		AFFILIATION
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Ben	Jones	U.K. Government
Avi	Kak	Purdue University
James	Kane	Polestar
Clem	Karl	Boston University
Tracy	Kennedy	General Dynamics
James	Killmeyer	Transportation Security Laboratory
Sherman	Kisner	High Performance Imaging
Robert	Klueg	Department of Homeland Security
Julie	Korzh	Deloitte
Tom	Kowalczyk	Department of Homeland Security
Patricia	Krall	IDSS
Shiva	Kumar	Rapiscan Systems
Roderick	Kunz	Lincoln Laboratory
Jussi	Laurila	Detection Technology, Inc.
Kang	Lee	University of Toronto
Kenneth	Li	Department of Homeland Security
David	Lieblich	Aperio Solutions
Anne	Magrath	Northeastern University
Ignacio	Martinez-Moyano	Argonne National Laboratory
Harry	Martz	Lawrence Livermore National Laboratory
Barry	Masters	Department of Homeland Security
Chris	McBee	Morpho Detection
Sean	McGaughey	General Dynamics
Larry	McMichael	Lawrence Livermore National Laboratory
Henry	Medeiros	Marquette University
Matthew	Merzbacher	Morpho Detection
Nikolay	Metodiev Sirakov	Texas A&M University
Eric	Miller	Tufts University

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Alexander	Mrozack	Morpho Detection
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Angela	Naso	Deloitte
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Boris	Oreper	L-3 Communications - ESSCO
Jimmie	Oxley	University of Rhode Island
David	Paquette	Department of Homeland Security
Laura	Parker	Department of Homeland Security
Homer	Pien	Philips Research
Marzio	Pozzuoli	Nuralogix
Patrick	Radisson	Multixdetection
Robert	Rains	MITRE Corporation
Carey	Rappaport	Northeastern University
Tim	Rayner	Multixdetection
Kenneth	Ribeiro	Bruker Detection Corporation
Martin	Rommel	American Science and Engineering, Inc.
Paul	Ross	Transportation Security Adminstration
Mahdiar	Sadeghi	Northeastern University
Alysia (Lisa)	Sagi-Dolev	Qylur Security Systems, Inc.
Paolo	Salieri	European Commission
Venkatesh	Saligrama	Boston University
Mark	Saulich	Northeastern University
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Firas	Shaikh	Transportation Security Adminstration
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Sondre	Skatter	Morpho Detection
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Malcolm	Slaney	Google
Tim	Smith	Transportation Security Adminstration
Melanie	Smith	Northeastern University
Serge	Soloviev	Leidos
Samuel	Song	TeleSecurity Sciences, Inc.
David	Spada	Morpho Detection
Lee	Spanier	Department of Homeland Security
Rich	Stoddard	Morpho Detection
Diederik	Stolk	Goldsworthy, Stolk & Associates
Jonathan	Stone	Analogic Corporation
Dan	Strellis	Rapiscan Systems
Zachary	Sun	Boston University
Dan	Taylor	E3 Federal Solutions, LLC
Kyle	Thompson	Sandia National Laboratories
Jason	Thornton	Lincoln Laboratory
Brian	Tracey	Tufts University
Hoke	Trammell	Morpho Detection
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Mircea	Tudor	TUDOR Scan Tech SA
Steve	Urchuk	Analogic Corporation
Alex	Van Adzin	Photo Diagnostic Systems, Inc.
Seth	Van Liew	Passport Systems, Inc.
Lou	Wainwright	Triple Ring Technologies
Steven	Wallen	Department of Homeland Security
Zheng	Wang	NUCTECH COMPANY LIMITED
Andrew	Wantuch	Sandia National Laboratories

NAME		AFFILIATION
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Suriyun	Whitehead	Booz Allen Hamilton
Elizabeth	Wig	Northeastern University
Mara	Winn	Transportation Security Adminstration
Mark	Witinski	Pendar Tech
Horst	Wittmann	Northeastern University
Steve	Wolff	Wolff Consulting Services
Charles	Wynn	Massachusetts Institute of Technology
Dong Hye	Ye	Purdue University
Baihui	Yu	Csuptwo, LLC
Eric	Zanin	Self-Employed

Note: The list of participants reflects the individuals that checked-in for either Day 1 or Day 2 of ADSA15. Any errors are due to the editors of this report and not to the participants themselves.

11. Appendix: Presenter Biographies

Carl R. Crawford

JCarl R. Crawford, PhD, is president of Csuptwo, a technology development and consulting company in the fields of medical imaging and Homeland Security. He has been a technical innovator in the fields of computerized imaging for more than thirty years. Dr. Crawford was the Technical Vice President of Corporate Imaging Systems at Analogic Corporation, Peabody, Massachusetts, where he led the application of signal and image processing techniques for medical and security scanners. He developed the reconstruction and explosive detection algorithms for a computerized tomographic (CT) scanner deployed in airports worldwide. He was also employed at General Electric Medical Systems, Milwaukee, Wisconsin, where he invented the enabling technology for helical scanning for medical CT scanners, and at Elscint, Haifa, Israel, where he developed technology for cardiac CT scanners. He also has developed technology for magnetic resonance imaging (MRI), single photon emission tomography (SPECT), positron emission tomography (PET), ultrasound imaging (U/S), dual energy imaging, and automated threat detection algorithms based on computer aided detection (CAD). Dr. Crawford has a doctorate in electrical engineering from Purdue University. He is a Fellow of the Institute of Electrical and Electronics Engineers (IEEE), a Fellow of the American Association of Physicists in Medicine (AAPM), and is an associate editor of *IEEE Transactions on Medical Imaging*.

Johnathan B. Cushing

Johnathan B. Cushing is a graduate PhD student and SMART scholar attending the College of Optical Sciences at the University of Arizona. His research is focused on applying imaging science to the defense and security world. He began his work with defense by serving six years in the Navy as a nuclear propulsion operator. Then in order to build his theoretical knowledge he attended San Diego State University, earning a BS in physics. At the University of Arizona, he works with Dr. Eric Clarkson, exploring system optimization through the analysis of joint tasks-based information metrics, as well as the connection between Shannon information and ROC analysis. Johnathan Cushing has published multiple papers in the field of image science and has performed research for the DHS, DARPA and the department of the Navy.

Shawn Dagg

Shawn Dagg is a technology professional and executive with 20 years of experience in data management and analytics space. For the last 15 years, his expertise has been applied to the aviation security industry. Shawn was an award winning member of the IBM Emerging Business Opportunity (EBO) that became the current IBM Homeland Security business unit. During his time with IBM he led several aviation risk assessment and risk management programs as well as advised senior TSA and DHS officials. After IBM, Shawn spent time with CLEAR, the original third party US Registered Traveler program then Optosecurity, the creator of checkpoint remote screening. Shawn is now Vice President, Americas for CrowdVision, the leading automated pedestrian analytics and insights company. CrowdVision provides the most accurate and real-time pedestrian data for airports and other venues.

Rodger Dickey

Dr. Rodger Dickey has 30 years' experience in airport operations and management, aviation security, and security technology development, acquisition, and deployment. Dr. Dickey is a former senior executive at the Transportation Security Administration (TSA) and is currently a systems engineering consultant/specialist supporting GST and the TSA under TSA's Professional Engineering and Logistics Support Services (PELSS) contract. From 2001 to 2004 Dr. Dickey was the Director of the Security Technology Deployment Office (STDO) of the TSA, responsible for the 100% checked baggage security screening system rollout, including operationalizing and managing TSA's Letter of Intent (LOI) program, a series of multi-year cost sharing and reimbursement agreements between TSA and airports for the purpose of developing the physical infrastructure necessary to install and efficiently operate EDS in-line with airport baggage handling systems (BHS). In 2007 he was named Deputy Assistant Administrator/Chief Technology Officer for TSA within the Office of Operational Process and Technology (OPT).

Prior to the creation of the TSA Dr. Dickey was employed by the Federal Aviation Administration (FAA) as a member of the joint Industry/government Security Equipment Integrated Product Team (SEIPT). He was named SEIPT Lead shortly after 9/11/01 and managed the SEIPT's transition into TSA and the newly formed Department of Homeland Security (DHS). Dr. Dickey holds a Bachelor's degree from Baylor University (1983), a Master of Public Administration degree (1996), and a Ph.D. (2000) from the University of Texas at

Arlington, TX, and currently resides in East Texas on a small ranch with his wife and daughter.

Michael Egnoto

Dr. Mike Egnoto is a Risk and Crisis Communication Researcher and Assistant Clinical Professor at the University of Maryland START Center. He is a risk and crisis communication researcher who explores technology use and communication processes in risk and crisis situations. Mike focus on how individuals use, process, and disseminate risk and crisis information and how this insight can be used to design better risk and crisis communication systems and protocols. He evaluates these systems across various hazard types, with emphasis on terrorist actions and weather hazard scenarios.

Dr. Egnoto's research focuses on individuals and small groups of individuals who communicate with each other and organizations while crises are on-going. Largely, this fits into theoretical frameworks like Diffusion of Innovations, Social Exchange, Heuristic-Systematic Processing, and Framing, while integrating modern paradigms like the Social-Mediated Crisis Communication Model.

Michael Ellenbogan

Mike is founder and CEO of Evolv Technology. Started in August, 2013, Evolv is focused on reinventing physical security to help protect people and facilities by fusing together innovations in RF imaging and compressive sensing, advanced machine learning and human computation. Evolv is developing powerful, low-cost physical threat detection technology to support our national security efforts and keep people and places safe across the globe. Evolv is funded by Bill Gates, General Catalyst Partners and Lux Capital.

Prior to starting Evolv, Mike was an Executive in Residence at General Catalyst Partners, focusing on investing in early and later-stage hardware and software companies in analytical instruments, sensors and related services markets. Prior to General Catalyst, Mike was founder and CEO of Reveal Imaging Technologies, a leader in X-ray imaging and detection system technologies. Reveal was acquired by SAIC in 2010. Mike holds a Physics degree from Colgate University.

Cindy Fang

Cindy Y. Fang joined MIT Lincoln Laboratory in 2004 as an associate staff member of the Integrated Systems and Concepts Group and has worked on a number of programs related to security camera technologies and algorithms involving computer vision, image and signal processing work. She has worked closely with local law enforcement organizations and led demonstrations of novel imaging system prototypes at various events including the Boston Marathon in 2014. She has a BSEE from Rutgers University and an MSEE from the University of Illinois at Urbana-Champaign.

Graeme Goldsworthy

Graeme Goldsworthy is a Serious gaming design expert. He is expert in Operational Analysis (OA) Exercise design, Scenario writing and development. Graeme is also a trainer and consultant in the areas of International Development, Intelligence, Defence and Resource (Water) Conflict. Over the years, he has contributed to many of simulations for defence organisations concerning the Middle East crisis, Caucasus region, Eastern Europe and Africa, as well as the Comprehensive (or Integrated) Approach. Most recently he has worked on for a series of Corps level exercises for the NATO's 1st German-Netherlands Corps (1GNC) as well as the Joint Task Force planning exercise "Joint Challenge" for the Netherlands Defence Academy. He recently completed Exercise Adept Cormorant for the Advanced Command Staff and Command Course (ACSC) at the UK Defence Academy. Graeme is a member of the design team of the Rapid Campaign Analysis Toolset (RCAT) for the UK MoD Defence Science and Technology Laboratories (DSTL).

Graeme is an experienced Landmines and Explosive Remnants of War (ERW) clearance specialist who has worked since 1993 in the area of Humanitarian Mine Action in SE Asia, Latin America and Sub-Saharan Africa. He is a former Regular Officer in the British Army and has recently rejoined the service as an active Army Reserve Officer.

Keith Goll

Keith Goll has been with Transportation Security Administration from its inception. He is currently a Senior Technical Advisor in the TSA Office of Security Capabilities (OSC), and is responsible for establishing OSC's Next Generation System Architecture. In addition, he recently led the development of TSA's Five Year Technology Investment Plan in response to the Transportation Acquisition Reform Act, and is beginning the planning efforts for the first revision. He's held various leadership roles within OSC, including responsibility for technology deployment, test and evaluation, business operations and life cycle support. He also recently served in a detail with TSA's Office of Chief Risk Officer.

From his initial employment with Federal Aviation Administration starting in 1992 until now, his focus has been on the development, acquisition, deployment and operational support of Explosives Detection Systems and other security technologies (with a good bit of experience in policy and operational procedures background thrown in). Prior to his employment with TSA and FAA, Mr. Goll was a project engineer with Space and Naval Warfare Systems Command, and Marine Corps Systems Command, working primarily on development and deployment of command, control, and communication systems. Mr. Goll has a Bachelor of Science in Electrical Engineering from Virginia Tech.

Mark Handler

Mark Handler is an independent polygraph instructor and consultant, as well as director of professional services for Converus. He serves on the board of the American Polygraph Association (APA) and American Association of Police Polygraphists (AAPP). He has published over 50 scientific articles on the topic of polygraph and credibility assessment. Previously, he was a Deputy Sheriff in Montgomery County, Texas and a U.S. Navy nuclear submariner.

Robert Haupt

Rob Haupt is a staff scientist in the Active Optical Systems group at MIT Lincoln Laboratory and is also a research associate in the department of Civil and Environmental Engineering at MIT. His principal activities are developing optical sensing techniques to measure vibrations and acoustic phenomena in earth, man-made structures, and in medicine. His expertise is in seismology and acoustics in complex media, photoacoustic methods, non-linear acoustics, and laser Doppler vibrometry to measure these phenomena from significant standoff. He has an M.S. in Geophysics from Penn State and an M.S. in Civil and Environmental Engineering from Dartmouth with B.S. degrees in Physics and in Meteorology.

Over the past several years, Rob Haupt has been collaborating with Chuck Wynn from MIT Lincoln Laboratory to develop a rapid standoff laser technique to measure trace level explosive residue. This work has shown potential for civilian and military use and was a 2013 recipient of an R&D 100 award. Rob Haupt and Chuck Wynn have several U.S. patents and IP on photoacoustic sensing for a number of applications and have several publications on this topic for explosives detection.

Benjamin Jones

Dr. Benjamin Jones represents the Research, Analysis and Development team at the UK Department for Transport. The role of this team is to commission and undertake research to inform security policy and regulation with robust technical evidence. Dr. Jones' core research interest is in the central search aspects of aviation security, including security scanners, trace detection and the end-to-end cabin baggage X-ray operation, including technology, threat image projection, human factors and operator training.

Dr. Jones has worked in UK government security science and technology for over 7 years developing testing methodologies, evaluating detection equipment and overseeing external R&D on a range of research topics, including aviation security, screening for mass transit and parcel/post applications and also sensors for perimeter security.

Patricia Krall

Ms. Patricia Krall has more than 25 years of experience in aviation security, research science, chemistry and program management and has held several accomplished positions with high technology companies. As a member of the senior executive team at Integrated Defense & Security Solutions (IDSS), Ms. Krall plays a key role in strategic business development with a focus on worldwide marketing and government relations, analyzing and evaluating business opportunities and expanding the company's product offerings through both research and development and external strategic partnerships. Ms. Krall has extensive work experience in the technical, scientific, and management aspects of new product and business development. As a founding member of the L-3 management team in 1997, Ms. Krall initiated the development and was the principal investigator of the L-3 eXaminer TSA Certified Checked Baggage EDS which has been widely deployed throughout the U.S. and in many of the world's largest airports.

The successful development of the L-3 eXaminer led to the formation of L-3 Security and Detection Systems division, where Ms. Krall supported numerous worldwide opportunities, including the expansion of sales of the L-3 Pro-Vision Checkpoint Body Scanner. Prior to her current role with IDSS and L-3 Security and Detection Systems, Ms. Krall held managerial and technical positions with General Electric, Lockheed Martin and American Hospital Supply Corporation. Ms. Krall earned a Bachelor of Science from the University of South Florida and a Master of Science from the University of Florida.

Kang Lee

Dr. Kang Lee is a professor and Tier 1 Canada Research Chair in developmental neuroscience at the University of Toronto and a Researcher (full professor rank) at the University of California, San Diego. He is also the Chief Scientist of Nuralogix. For over 20 years, Dr. Lee has studied lying in children and adults using behavioral, computational, and neuroimaging methodologies. His work has led to legal reforms in Canada. Since 2016, across Canada, a mandatory procedure developed by his team has been used to admit children as witnesses to testify in the criminal court. Along with other top deception detection researchers in the world, Dr. Lee also served as an expert consultant for the US Department of Defense to develop a 10-year research agenda in deception detection and credibility assessment for homeland security and intelligence purposes.

Harry E. Martz

Harry Martz is the Director for Non-destructive Characterization Institute and a distinguished member of the technical staff at Lawrence Livermore National Laboratory. He is also Principal Investigator (PI) on Department of Homeland Security, Science and Technology, Explosive Division Projects and PI for Domestic Nuclear Detection Office, Nuclear and Radiological Imaging Platform and Passive And X-ray Imaging Scanning projects. Harry joined the Laboratory in 1986 as a Physicist to develop the area of X-ray imaging and proton energy loss computed tomography for the non-destructive inspection of materials, components, and assemblies. He received his M.S. and Ph.D. in Nuclear Physics/Inorganic Chemistry from Florida State University, and his B.S. in Chemistry from Siena Collage.

Harry has applied CT to inspect one-millimeter sized laser targets, automobile and aircraft components, reactor-fuel tubes, new production reactor target particles, high explosives, explosive shape charges, dinosaur eggs, concrete and for non-destructive radioactive assay of waste drum contents. Recent R&D efforts include CT imaging for conventional and homemade explosives detection in luggage and radiographic imaging of cargo to detect special nuclear materials and radiological dispersal devices. Dr. Martz has authored or co-authored over 300 papers and is co-author of a chapter on Radiology in Non-destructive Evaluation. He has also served on several National Academy of Sciences Committees on Aviation Security and was the Chair of the Committee on Airport Passenger Screening: Backscatter X-Ray Machines. Harry has been co-chair of the Awareness and Localization of Explosives-Related Threats, Advanced Development for Security Applications Workshops. Awards include 2000 R&D 100 WIT-NDA (Waste Inspection Tomography for Nondestructive Assay), 1998 Director's Performance Award Active and Passive Computed Tomography and Federal Laboratory Consortium for Technology Transfer 1990 Award of Merit.

Mathew Merzbacher

Dr. Merzbacher is Director of Product Qualifications at Morpho Detection (part of the SAFRAN group), where he is responsible for detection testing across Morpho's products for explosives and radiation detection. In addition to maintaining an active technical career, Dr. Merzbacher is chair of the ANSI standards group on image quality for CT-based explosives detection systems, and chaired the NEMA DICOS Threat Detection Working Group. He joined InVision Technologies in 2003 as a Research Scientist in the Machine Vision group before taking over as manager of that group. Dr. Merzbacher has a PhD in Computer Science from UCLA, specializing in data mining. He has several patents on image processing for explosives detection.

Eric Miller

Eric L. Miller received the BS in 1990, the MS in 1992, and the Ph.D. degree in 1994 all in Electrical Engineering and Computer Science at the Massachusetts Institute of Technology, Cambridge, MA. He is currently Professor and Chair of the Department of Electrical and Computer Engineering at Tufts University with adjunct appointments in the departments of Biomedical Engineering and Computer Science. From 2009-2012, Prof. Miller served as the Associate Dean of Research for Tufts' School of Engineering.

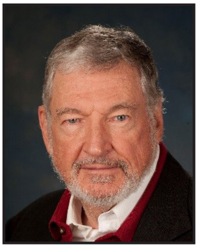
Dr. Miller's research interests include physics-based tomographic image formation and object characterization, inverse problems, statistical signal and imaging processing, and computational physical modeling. This work has been carried out in the context of applications including medical imaging, nondestructive evaluation, environmental monitoring and remediation, landmine and unexploded ordnance remediation, and automatic target detection and classification.

Dr. Miller is a Fellow of the IEEE and a member of Tau Beta Pi, Phi Beta Kappa and Eta Kappa Nu. He received the CAREER Award from the National Science Foundation in 1996 and the Outstanding Research Award from the College of Engineering at Northeastern University in 2002. From 2003-2015 he served as an Associate editor for the IEEE Transactions on Geoscience and Remote Sensing and was in the same position at the IEEE Transactions on Image Processing from 1998-2002. Dr. Miller was the co-general chair of the 2008 IEEE International Geoscience and Remote Sensing Symposium held in Boston, MA. He is currently a member of the Technical Liaison Committee for the IEEE Transactions on Computational Imaging and Chair of the SIAM Activity Group on Imaging Sciences.

John H. Morgan

Since 2012, John H. Morgan has been the Technical Lead/ Software Engineer for TSA's Security Technology Integration Program (STIP). He possesses an intimate understanding of the customer mission, process and technology space. In this position Mr. Morgan performs requirements solicitation and analysis, system architecture and design, software and systems engineering, integration and test, release management and operations support. His technical expertise includes multi-sensor integration, standards definition and application, data modeling, data fusion, and visualization. Prior to working with TSA, Mr. Morgan was a key member of the design, development and deployment teams for several Navy programs, applying principles of open architecture to solve complex system integration problems.

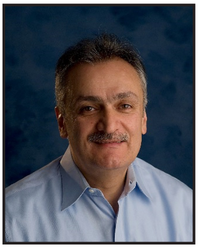
John Mueller



John Mueller is Woody Hayes Senior Research Scientist at the Mershon Center for International Security Studies of Ohio State University. He is also adjunct professor of Political Science at Ohio State and a Senior Fellow at the Cato Institute in Washington, DC. He is currently mostly working on terrorism and particularly on the reactions and costly over-reactions it often inspires, and on applying cost-benefit analysis to issues of homeland security. Working with engineer and risk analyst Mark Stewart, he is the author of Chasing Ghosts: The Policing of Terrorism (2016) and Terror, Security, and Money: Balancing the Risks, Benefits, and Costs of Homeland Security (2011). Their Are We Safe Enough? Measuring and Assessing Aviation Security will be published next year by Elsevier.

Among Mueller's other books are Overblown (2006), Atomic Obsession (2010), War and Ideas (2011), Astaire Dancing (1985), War, Presidents and Public Opinion (1973), Retreat from Doomsday (1989), Capitalism, Democracy, and Ralph's Pretty Good Grocery (1999), and The Remnants of War (2004). He is also the editor of a set of case studies, Terrorism Since 9/11: The American Cases, first published as a webbook in 2011 and updated and expanded each year since. Mueller has published hundreds of scholarly articles and opinion pieces, and has been a visiting fellow at the Brookings Institution in Washington, DC, the Hoover Institution at Stanford University, and the Norwegian Nobel Institute in Oslo. He is a member of the American Academy of Arts and Sciences, has been a John Simon Guggenheim Fellow, and has received grants from the National Science Foundation and the National Endowment for the Humanities. He has also received several teaching prizes, and in 2009 received the International Studies Association's Susan Strange Award that "recognizes a person whose singular intellect, assertiveness, and insight most challenge conventional wisdom and intellectual and organizational complacency in the international studies community."

David Nahamoo



David Nahamoo is an IBM Fellow. He is the IBM Research CTO for Conversational Systems, responsible for IBM Research directions in this area. He led the R&D of IBM Watson Dialog Service and Watson Conversation Service from Jan 2014 to Jan 2016. David joined IBM Research speech recognition effort in 1982. As the Head of the Human Language Technologies department at IBM Research during 1993 to 2006, he was responsible for delivering speech technologies to IBM Divisions for desktop, embedded, and server based products. He was IBM Research speech CTO between 2006 and 2014. David holds 55 patents and has published 70+ technical papers. David is a Fellow of the IEEE and ISCA. In 2001, he received the IEEE Signal Processing Best Paper Award.

Jimmie Oxley

Dr. Jimmie Carol Oxley is Professor of Chemistry at the University of Rhode Island (URI), former co-Director of the Department of Homeland Security Center of Excellence in Explosive Detection, Mitigation, and Response, and co-Director of the Forensic Science Partnership of URI. She earned a Ph.D. from the University of British Columbia (Chemistry) and joined the faculty of New Mexico Institute of Mining & Technology where she founded a Ph.D. program in explosives and created a Thermal Hazards Research group. Oxley's lab specializes in the study of energetic materials—explosives, propellants, pyrotechnics. Dr. Oxley is past chair of the Gordon Research Conference (GRC) on Energetic Materials; co-founder of Life Cycles of Energetic Materials and the GRC on Illicit Substance Detection. She has served on six NRC panels.

Dr. Oxley has authored 100 papers on energetic materials and worked on law enforcement issues--with the FBI simulating the World Trade Center bombing (1993), with FEL (UK) examining large fertilizer bombs, and with ATF studying the behavior of pipe bombs. She holds top secret and SCI clearances. In 2009 she was given the URI Outstanding Research Award URI; in 2005 she was named the Saferstein Memorial Award Lecturer, Northwestern; in 2005 and 2008 she was an invited witness to a US House subcommittee to testify about homeland security issues.

Laura Parker

Laura Parker is a Program Manager in the Explosives Division of the Science and Technology Directorate at the Department of Homeland Security (DHS) as well as the Program Manager for the ALERT Center of Excellence, a DHS-sponsored consortium of universities performing research that addresses explosive threats led by Northeastern University. She works on multiple projects for the trace detection of explosives and algorithm development for improved explosives detection. Previous to her present position at DHS, Laura worked as a contractor, providing technical and programmatic support of chemical and biological defense and explosives programs for several Department of Defense (DoD) offices. She also worked in several DoD Navy laboratories in the field of energetic materials. She obtained her PhD in Chemistry from the Pennsylvania State University.

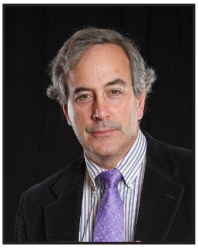
David Paquette

Mr. Paquette has been working in the Department of Homeland Security (DHS), Office of SAFETY Act Implementation (OSAI) for two and a half years. Prior to working for DHS, Mr. Paquette was a Research Associate at the Institute for Defense Analyses, providing analytical and research support to OSAI as a contractor for 6 years. As a graduate student at Catholic University in Washington, D.C. Mr. Paquette served as an intern with the National Defense University. His focus of study was terrorism and nuclear security policy.

Pablo J. Prado

Dr. Pablo J. Prado, co-founder and CEO of ORS, has more than 25 years of experience with NMR and developing explosives detection systems. Previous positions include: Senior Department Manager and New Product Introduction Lead at GE Homeland Protection (formerly InVision - Quantum Magnetics); VP Development at T2 Biosystems; VP Engineering at Quasar Federal Systems; CTO at Progression, Inc. A Certified Professional Project Manager, Dr. Prado has managed projects with DHS S&T, Army, ONR, TSA, USDA, and EPA. He is inventor on 10 issued patents and author of 2 book chapters and over 40 peer-reviewed articles.

Carey M. Rappaport



Carey M. Rappaport received five degrees from the Massachusetts Institute of Technology: the SB in Mathematics, the SB, SM, and EE in Electrical Engineering in June 1982, and the PhD in Electrical Engineering in June 1987. He is married to Ann W. Morgenthaler, and has two children, Sarah and Brian. Prof. Rappaport joined the faculty at Northeastern University in Boston, MA in 1987. He has been Professor of Electrical and Computer Engineering since July 2000. In 2011, he was appointed College of Engineering Distinguished Professor. He was Principal Investigator of an ARO-sponsored Multidisciplinary University Research Initiative on Humanitarian Demining, Co-Principal Investigator and Associate Director of the NSF-sponsored Engineering Research Center for Subsurface Sensing and Imaging Systems (CenSSIS), and Co-Principal Investigator and Deputy Director of the DHS-sponsored Awareness and Localization of Explosive Related Threats (ALERT) Center of Excellence.

Prof. Rappaport has authored over 425 technical journal and conference papers in the areas of microwave antenna design, electromagnetic wave propagation and scattering computation, and bioelectromagnetics, and has received two reflector antenna patents, two biomedical device patents and three subsurface sensing device patents. He was awarded the IEEE Antenna and Propagation Society's H.A. Wheeler Award for best applications paper, as a student in 1986. He is a member of Sigma Xi and Eta Kappa Nu professional honorary societies.

Mahdiar Sadeghi

Mahdiar Sadeghi is working as research assistant at ALERT, Northeastern University and the only master student awarded RA in ECE department, class of 2015. His thesis work is on millimeter waves, and during last summer he was working at Starkey, MN. He was a double degree undergraduate student of electrical engineering and physics at Sharif University of Technology. and the silver medal winner of the Iranian National Physics Olympiad in 2009. He also plays violin in Northeastern University Symphony Orchestra.

Alysia Sagi-Dolev

Dr. Dolev is an entrepreneur, inventor and business leader. She is founder and CEO of Qylur Intelligent Systems, where she used machine learning, social network of intelligent machines, and sophisticated IIoT to create solutions that address the intersection of high security with excellent guest experience at high-flow public venues. From an initial idea on a piece of paper, Dr. Dolev brought the Qylatron solution to production deployments at world-famous parks, stadiums, national monuments, mega events and airports across the world.

Prior to this, Dr. Dolev worked for more than a decade in defense research and development, where she managed multi-disciplinary and multi-national programs, including the first human focused Suicide Bomber Detection Program for IMOD. In parallel, she founded, managed, and consulted for early stage technology companies in the biomedical, high tech, and consumer markets. In 2002, Dr. Dolev was a recipient of a "Woman of the Year in Technology and Business" award. Born in San Diego, California, she holds a Ph.D. in Biomedical Engineering; has authored a number of professional articles; invented several technology-related patents behind the Qylatron self-service security kiosk; and has spoken on the topic of the future of security technologies.

Paolo Salieri

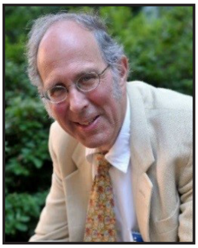
Paolo Salieri is a Principal Scientific and Policy Officer in the Directorate General for Migration and Home Affairs of the European Commission. As part of the Security Research unit he is responsible for the R&D activities in the area of Border and External Security. He has been working with the European Commission for more than 20 years (previously he was with the Directorate Generals of Enterprise and Research).

Before joining the European Commission, Paolo Salieri was a scientist in Quantum Optics at the Italian National Institute of Optics (Florence). In 1985-1986 he was research associate at the Department of Electrical Engineering of the University of Southern California. He holds a Laurea degree from the University of Pavia (Italy) and a Master degree from MIT (in Electrical Engineering and Computer Science).

Jens-Peter Schlomka

Dr. Jens-Peter Schlomka is the Director of Engineering at Morpho Detection Germany. He has been Program Manager for the development of the X-ray diffraction Imaging (XDi) system for cabin baggage application and manager of systems engineering at Morpho Detection since 2010. Prior to joining Morpho Detection, Jens-Peter worked on medical imaging and baggage inspection projects at Philips Research Germany, including X-ray diffraction CT, X-ray tubes, and Spectral CT for 11 years (1999-2010). He received his Ph.D. from Kiel University, Germany, in 1999 working on X-ray and Neutron diffraction applications for semiconductor material research. Effective November 1, 2016, he took over responsibility for the R&D department of Morpho Detection in Hamburg. At Morpho Detection Hamburg, X-ray diffraction imaging based baggage inspection systems for check-in and cabin baggage are being developed and manufactured.

Michael B. Silevitch



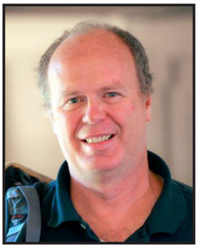
Michael B. Silevitch is currently the Robert D. Black Professor of Engineering at Northeastern University in Boston, an elected fellow of the IEEE, the Director of the Homeland Security Center of Excellence for Awareness and Localization of Explosives Related Threats (ALERT), and the Director of the Bernard M. Gordon Center for Subsurface Sensing and Imaging Systems (Gordon-CenSSIS), a graduated National Science Foundation Engineering Research Center (ERC).His training has encompassed both physics and electrical engineering disciplines. An author/co-author of over 65 journal papers, his research interests include laboratory and space plasma dynamics, nonlinear statistical mechanics, and K-12 science and mathematics curriculum implementation. Prof. Silevitch is also the creator of the Gordon Engineering Leadership (GEL) Program at Northeastern University, a graduate curriculum offered through the College of Engineering, with the mission of creating an elite cadre of engineering leaders. He and the current GEL Director, Simon Pitts, were recently awarded the 2015 Bernard M. Gordon Prize for Engineering Education by the National Academy of Engineering (NAE).

Stephen Skrzypkowiak

Stephen "Steve" Skrzypkowiak is presently employed by Global Systems Technologies (GST), Inc. as Senior Technical Specialist in the areas of X-ray physics and system architecture. Since 2002 Steve has been a consultant in various capacities to the Department of Homeland Security (DHS), the Transportation Security Administration (TSA), and the Transportation Security Laboratory (TSL). Through GST he supports the TSA in the technical review of various detection systems, revising the explosive certification standards, and developing various detection and procurement specifications. He also provides technical support for various research projects. He is the TSA Point of Contact and Co-Chairman of the DICOS 2A and 3 committees. He was a technical participant in the development of the IEEE N42.45 EDS imaging standard. He has developed various Computed Tomography (CT) evaluation phantoms for the TSA, including the CT Image Quality (CTIQ). Steve was also the Project Engineer for a major Explosive Detection System (EDS) manufacturer that successfully passed the TSL certification test.

Steve earned his Ph.D. in Electrical Engineer from the University of South Florida, where he also held various teaching and research positions. He has published papers in the areas of Digital Signal Processing (DSP) algorithm implementation, neural networks, and video coding algorithms. He is a Florida Professional Engineer, a Senior Member of the Institute of Electrical and Electronics Engineers (IEEE), and is a member of the International Society for Optical Engineering (SPIE) and the National Society of Professional Engineers (NSPE).

Malcolm Slaney



Dr. Malcolm Slaney is a research scientist in the Machine Hearing Group at Google Research, where he leads a project on saliency and attention. He received his PhD from Purdue University for his work on imaging with inverse scattering. He is an Adjunct Professor at Stanford CCRMA, and he has led the Hearing Seminar for more than 20 years. Dr. Slaney is also an Affiliate Faculty in the Electrical Engineering Department at the University of Washington. Dr. Slaney is a co-author, with A. C. Kak, of the IEEE book "Principles of Computerized Tomographic Imaging". This book was republished by SIAM in their "Classics in Applied Mathematics" Series.

Dr. Slaney is co-editor, with Steven Greenberg, of the book "Computational Models of Auditory Function." He has served as an Associate Editor of IEEE Transactions on Audio, Speech and Signal Processing and IEEE Multimedia Magazine and a guest editor for the Proceedings of the IEEE and ACM Transactions on Multimedia Computing. He has given successful tutorials at ICASSP 1996 and 2009 on "Applications of Psychoacoustics to Signal Processing," on "Multimedia Information Retrieval" at SIGIR and ICASSP, and "Web Scale Multimedia Data" at ACM Multimedia 2010. Before joining Google, Dr. Slaney has worked at Bell Laboratory, Schlumberger Palo Alto Research, Apple Computer, Interval Research, IBM's Almaden Research Center, Yahoo! Research, and Microsoft Research. Dr. Slaney's recent work is on understanding auditory perception and decoding auditory attention from brain signals. Dr. Slaney is a Fellow of the IEEE.

Diederik Stolk

Diederik Stolk (Dutch national) has extensive experience in the training and preparation of military staff for offensive and stabilization operations. Over the past years he has developed and executed several military exercises focused on the comprehensive approach for the Dutch as well as German Armed Forces, including: The Netherlands Defence Academy Advance Command and Staff course's Comprehensive Operations Planning Directive exercise Joint Challenge and several 1 German-Netherlands Corps/NATO exercises, including Exercise Reliable Sword and Noble Ledger.

Mr. Stolk has also successfully developed and implemented multiple training and exercise formats for the Dutch Ministry of Foreign Affairs as well as the Dutch Ministry of Security & Justice. His work predominantly focuses on enabling effective collaboration and information sharing within complex multi-stakeholder work environments, mitigating risk and using strategic insight for decision-making. Currently, Diederik is developing a crisis simulation for the Dutch ministry of defence to support Dutch members of parliament in defence related decision-making. Diederik has a background in International Relations and has worked as a consultant for multiple think tanks and NGOs. Diederik is a co-director of Goldsworthy, Stolk & Associates.

Mircea Tudor

Entrepreneur, researcher, serial inventor, Mircea Tudor is aiming to introduce new standards and procedures in civil aviation security. As CEO of TST and MBT, Mircea Tudor's ambition is to become one of the industry's trend setters, through breath of vision that only great entrepreneurs can demonstrate. He has won in 2009 and 2013 the Grand Prix of Geneva International Inventions Exhibition, being the only inventor in the world awarding twice the Grand Prix of the most prestigious competition of innovation, during 44 years of history.

The group of companies TST - MBT proposes to civil aviation a patented security solution, capable to scan a full aircraft within few minutes, as unique technological support for fast and accurate clearing of airplanes under bomb threat and for preventive security inspection of airplanes arriving from low security/high risk origin of fly, using X-ray detection of smuggling or any other hidden objects on board of an aircraft.

Steve N. Urchuk

Over the last two decades, Dr. Urchuk has contributed to the development of several leading hold and cabin baggage EDS systems, a rapid DNA analysis system and several medical CT and digital X-ray products. In his current role as Analogic's Vice President of Systems Engineering and Advanced Detection, he has management responsibility for Analogic's security and medical CT engineering organization. Dr. Urchuk graduated from the University of Toronto with a Bachelor's of Science in Engineering Science and a Ph.D. in Medical Biophysics. He also holds an M.B.A. from the D'Amore-McKim school of business at Northeastern University.

Andrew Wantuch

Andrew Wantuch is computer scientist at Sandia National Laboratories in Albuquerque, NM, where he works on algorithms and software development for non-destructive testing applications. Andrew received bachelor's degrees in mathematics and computer science from the University at Buffalo, as well as a Masters in computer science from the University at Buffalo.

Elizabeth Wig

Elizabeth Wig is a sophomore at Northeastern University studying electrical engineering. She works airport body scanner research with the ALERT Center, creating mathematical models to characterize explosive material on the human body. She is also a member of the ALERT Student Leadership Council (SLC), and is currently working on a publication with her faculty advisor, Professor Carey Rappaport, for the European Conference on Antennas and Propagation in 2017. Elizabeth is from central Massachusetts and is interested in all things math, space travel, and speculative fiction.

Mara Winn

Mara Winn is the Lead Program Manager of the Innovation Task Force (ITF) within the Office of Security Capabilities (OSC) within the Transportation Security Administration (TSA). In order to safeguard the nation's transportation systems, she is establishing an integrated approach to address the imperatives for change, providing an environment and focused resources to collaborate on innovation efforts for aviation security. Ms. Winn has extensive executive-level technical and management knowledge, skills, and abilities across highly complex and technical programs in the Homeland Security Domain.

Ms. Winn has over fifteen years of experience in all stages of acquisition management, systems engineering, project management and product development life cycles, from analysis through implementation and closeout. She joined TSA is 2014 and has served roles in OSC's Deployment and Logistics Division as the Quality and Branch Integration Lead and Mission Analysis Divisions as lead engineer for the Transportation Security Capabilities Analysis Process (TSCAP) and checked baggage technology research and development efforts. Prior to joining TSA, Ms. Winn was an Acquisition Specialist and Deputy Program Manager within the Schafer Corporation supporting the Domestic Nuclear Detection Office and Senior Program Manager for Zeichner Risk Analytics on Cyber Security Supply Chain Risk Management. She also spent 9 years as a Program Manager in Research and Development and Clinical Affairs for Abbott Diabetes Care. Ms. Winn graduated from Smith College with a Bachelor of Arts in Physics and Dartmouth College with a Bachelor of Engineering. In addition, she holds a Certificate in Project Management from Boston University, is a certified PMI® Project Management Professional (PMP), holds an ITIL® IT Infrastructure Library Foundations Certification, a graduate of AFCEA Leadership Training, and has DHS certifications in Project

Management, Systems Engineering, and Contracting Officer's Representative.

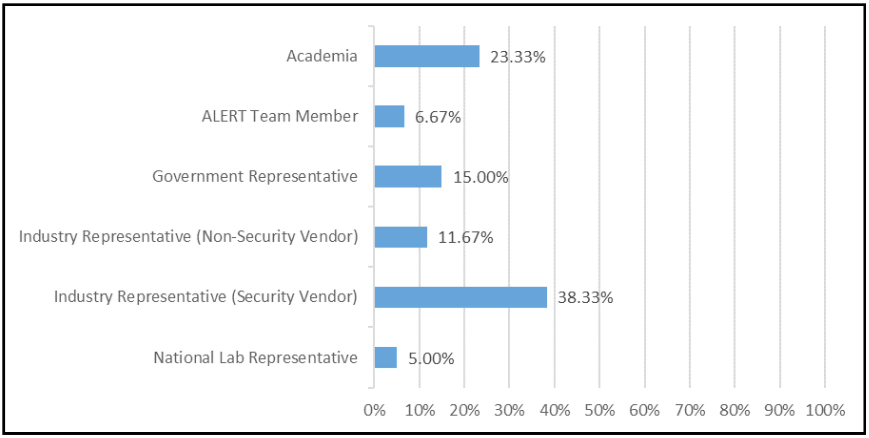
12. Appendix: Questionnaire

Attendees were asked to fill out a questionnaire providing feedback on the workshop. The questions are listed below; the answers appear in the next section. Responses are grouped by question and then by person; the first respondent is response A for each question, the second respondent is B, and so on.

1. What is your relationship to ALERT?
2. Which technologies discussed during this workshop show promise for improving the checkpoint?
3. Which emerging technologies for improving the checkpoint were not discussed at the workshop?
4. What applications are there for big data (data analytics) in aviation security?
5. What should be done to protect soft targets (e.g., baggage claim, check-in, rail stations and other transit venues)?
6. How satisfied were you with the topics and focus of the ADSA15 presentations and discussion?
7. Do you have any recommendations for future ADSA workshop topics?
8. How satisfied are you with the format of the ADSA workshops?
9. What did you like and dislike about this workshop?
10. What other comments do you have on the workshop?

13. Appendix: Questionnaire Responses

Question 1: What is your relationship to ALERT?



Respondents: 60

Skipped: 1

Academia – 23.33%

ALERT Team Members – 6.67%

Industry Representatives – 15%

Government Representatives – 11.67%

National Lab Representatives – 38.33%

Individual responses for "Other" category:

- "Industry – Security Reseller"
- "Sister Center – START"

Question 2: Which technologies discussed during this workshop show promise for improving the checkpoint?

Respondents: 38

Skipped: 23

Individual responses:

- "Possibly CV at the checkpoint and video analytics."
- "3D reconstruction, CT."
- "Biometrics which would allow TSA PreCheck passengers to be processed without a document reader and walk through based on their verification through facial recognition and automated document verification tied to e-gate. CBP seems to be ahead of everyone on implementation of this technology in conjunction with global entry and mobile passport using fingerprints right now but transitioning to facial. The integration of sensors, although it seemed as though some of the university joint development efforts were not as well developed to address the real operational issues associated with actual deployment."
- "Portable portals for screening large population in a short time."
- "Full CT instead of so-called AT scanners."
- "War gaming."
- "High speed trace detection, automated detection algorithms, checkpoint intelligence and tracking, automated screening lanes."
- "3D CT imaging."
- "Long-range standoff through photoacoustic sensing, convolutional neural networks, deep learning."
- "X-ray scanning."
- "CZT - Spectroscopic Diffraction (higher precision in effective atomic number) CZT - Photon Counting CT (multi-energy detectors) Platform Strategy to increase volume and reduce unit cost. OEM Integration: architecture, standardization, modularity, flexibility, support."
- "Multiple -- CT at checkpoint, advances in AIT systems, TRAP simulation environment, etc."
- "Deep Learning and Zero Shot."
- "Deep learning, video processing in surveillance cameras."

- “X-ray, Few View CT, Passive body scanners.”
- “Mm-wave imaging & stand-off chemical/explosive detection.”
- “Flat panel, portable AITs. ATs and EDS.”
- “Automated Screening Lanes.”
- “The higher speed imaging system from Evolv.”
- “CT but solutions to clear alarms in secondary need to be addressed. And on the fly/non-stop screening.”
- “Video analytics.”
- “PreCheck and other administrative techniques.”
- “Novel X-ray technology and integration.”
- “CT and automated lanes.”
- “Automated Threat Detection; Adaptive Algorithms; Tracking Targets; Classification Methods.”
- “Big data analytics, 3rd party algorithm development and open source architecture.”
- “Adaptive ATR/zero-shot learning photoacoustic standoff detection.”
- “Video tracking.”
- “New X-ray diffraction and scattering methods, new con-ops, i.e. example of designing holders for liquids LL photoacoustic work data analytics! Very important.”
- “Software based integration technologies.”
- “As a social scientist, I’m not sure I am qualified to make this call. I can say I was really interested in the Ontology work by Sirakov. That was more of a sidebar conversation though. I found Jimmie’s red-team panel absolutely fascinating, and would love to explore that more.”
- “Video analytics, CT for checkpoint screening, facilitating three party ATRs.”
- “Open architectures, walk-by sensing, machine learning and other algorithmic solutions, multi-modal fusion.”
- “TSAPreCheck, Integrated checkpoint, Zero shot learning.”
- “I liked the solution from Evolv. The standoff solution was interesting.”
- “Behavior detection capabilities, on the move people screening technologies, CT X-rays.”
- “Deep Learning Zero Shot Learning.”
- “Qylar technologies and their multiple instrument scanning lockers be-

> cause it was the only one that did have more than two instruments onboard with adaptive algorithms.”

Question 3: Which emerging technologies for improving the checkpoint were not discussed at the workshop?

Respondents: 24

Skipped: 37

Individual responses:

- “New approaches to trace sensing and sniffing.”
- “The impact of new sensors and biometrics and the impact to the layout and protocols associated with the checkpoint for better process flow. How to best address landside monitoring to determine if there are potential threats targeting the areas prior to the checkpoint. The smart analytics and resolution of CCTV cameras required to be able to examine against no fly lists. The prohibitive items list and should this be updated and automated? Are there new trace standoff detection which could be utilized as part of the process?”
- “Trace detection.”
- “Adaptive queue management.”
- “Total airplanes scanning technologies.”
- “Phased Imaging, Code Aperture and XRD.”
- “I think the technologies including machine learning approaches and deep learning were briefly discussed however applicability to the checkpoint problem was not discussed in depth. There are challenges to consider in using this technologies, including generating enough training data from the bags and building a universal software detection algorithm which can be customized for different CT scanners.”
- “I would like to see more check point talks and interaction between industry, government and the airlines.”
- “More facial expressions technologies.”
- “Mass Spec ETDs.”
- “Alarm resolution approaches, such as on screen resolution.”
- “Sniffers and hyperspectral imaging detectors.”
- “Additional contactless sensing technologies.”
- “Don’t know.”
- “Topics on ensuring the security officer has the required skills to work

with advancing technologies and automation."

- "Tracking Activities; Extracting Threat Containers from baggage."
- "Technologies used by the airlines to ID passengers and integrate airline ID with checkpoint security."
- "Advances in trace and vapor."
- "Hmmm....Most everything I can think of was covered."
- "Not confident I can answer this."
- "Software architectures, fusion and integration could have been discussed more."
- "Surprisingly, there was not any talk about Mass Spec."
- "Biometrics, IT security."
- "Infrared Spectroscopy and Quantum Cascade Lasers."

Question 4: What applications are there for big data (data analytics) in aviation security?

Respondents: 27

Skipped: 34

Individual responses:

- "The ability to better understand trends and potential events which might indicate a potential threat."
- "Online tracking of individuals."
- "Agency learning, training and simulations."
- "Adaptive screening, adaptive queueing."
- "Not in the domain."
- "Vast application -- the use of personnel to perform repetitive analysis tasks should be gradually replaced or augmented with narrow AIs which combat fatigue and poor training. While these systems can be embedded in the security devices, an even better approach is to have checkpoint-wide systems able to take input from multiple vectors and automate or aid decision making."
- "CT object detection. I personally don't think shape recognition would be valuable since the attacker can always manipulate the shapes or break it down to several pieces and put each piece into a separate bag. However, the emphasis should be on material recognition. In many cases, materials detected of small sizes are considered as false alarms, however, with the same rationale that the attacker might split the object into several bags, I think it is necessary to ensure the given detection algorithm produces very small percentage of false alarms on average so that when it does detect things of small size we can rule out the false alarm scenarios with higher confidence level."
- "Still exploring the options."
- "Matching passenger data with typical baggage."
- "Ticket-to-destination data mining."
- "Risk based screening."
- "With the trend toward displaced threats I see little to no good applications for big data in aviation security."
- "Using big data to assist in other law enforcement activities such as

narcotics smuggling."

- "Don't know."
- "To address the issue of broken down threats (shot gunning)."
- "Passenger screening with data provided at ticket purchase and prior to arriving at the airport to better define risk associated with each passenger."
- "A knowledge about possible threats could be detected if proper algorithms are developed."
- "Passenger identification in real time using facial recognition or some other form of optical or biometric ID."
- "Non-foundational improvements."
- "Not exactly my field, but improved ATR—looking for airport-wide patterns. Is a distraction being staged? Are there holes in coverage? Anything really unusual happening?"
- "Expanding trusted traveler and conceptually 'trusted cargo' platforms."
- "Coming from a human factors side, I think we could do more with human interaction and training for intervention."
- "Many applications, from adaptive threat detection, passenger vetting, and passenger/bag correlation."
- "Many applications, so long as data from the tickets (airlines) can be shared with data from our machines."
- "Neural Networks, adaptive filters, support vector machines mainly. Principal Component Analysis or Partial Least Squares—Discriminant analysis are good but not necessarily applicable to the constraints of time for Aviation Security."
- "Staffing model improvement, risk analysis."
- "Removing False Alarms."

Question 5: What should be done to protect soft targets (e.g., baggage claim, check-in, rail stations and other transit venues)?

Respondents: 27

Skipped: 34

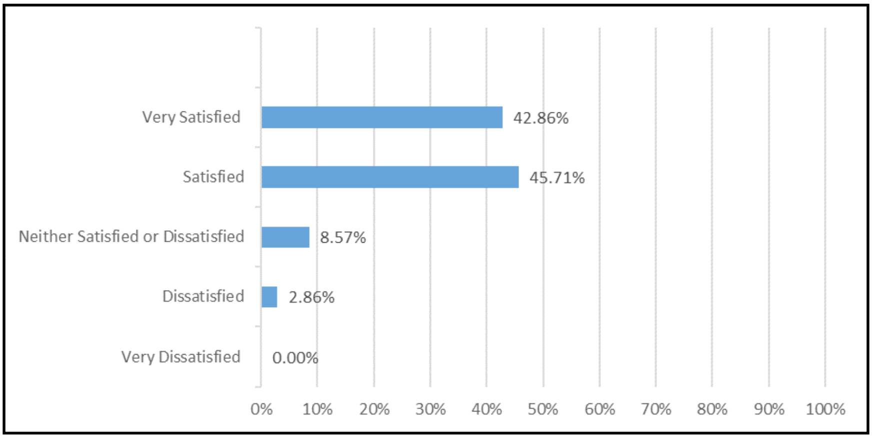
Individual responses:

- "Obviously, security sensing must be moved closer to the entry point and pinch-points must be reduced or eliminated. Distributed and remote sensing could be beneficial."
- "Facial recognition and behavioral detection."
- "Assuming these sites are arranged in a way that the entry is through some portal. The use of hidden sensors prior to entry plus fast THZ."
- "Random challenge questioning."
- "Change in policy/defined handoffs."
- "Surveillance expansion of known/trusted traveler programs intelligence gathering and risk assessments."
- "Eliminate large groups of waiting people through workflow improvements and expand the borders of transportation security."
- "More video & stationary distributed stand-off sensors."
- "I think the first step is spreading the knowledge. People should also help in the process. I think in big crowds and public spaces, surveillance cameras provide more information than any other threat detection method. I think surveillance cameras' streams should be reviewed by a machine and for finding a potential anomaly behavior using deep learning and ML algorithms and timing information. Is there any pattern during the last 24 hours in these detected anomalies to rule out false alarms? Human operators might ignore small incidences but if there is a logical pattern the computer might be able to detect it."
- "Place standoff bomb detectors without the location."
- "Extend the perimeter with more checkpoints."
- "Try to reduce busy periods with scheduling."
- "New technologies are needed that allow real time surreptitious surveillance of unstructured crowds."
- "More research investment into real time standoff detection tied to video

analytics people tracking."

- "Given the nature of the threat, not clear more is needed."
- "Some form of screening could be useful, such as screening people and their belongings undivested and uninterrupted for bigger threats with standoff threat detection or detuned metal detection. Another checkpoint is not the answer—it just moves the soft target."
- "Deployment of methods (software) and hardware for tracking behavior and events for early detection of suspicious activities to alarm the corresponding authorities."
- "Systems that detect mass casualty threats stationed before checkpoint security areas ideally right as you walk into an airport, train station, etc."
- "Greater overt surveillance."
- "Low-cost walk through detectors - have psychological deterrence effect even if don't do a whole lot."
- "Let's get one venue right before we expand to others."
- "I think we need to understand that problems have a better chance of success if they come from low probability areas to high probability attack areas. It sounds simple, but the fact is, the Greensboro, NC train station goes direct to DC, but the evaluation of passengers, cargo, etc. is vastly different starting south and headed north than the opposite. I get we want to avoid standardized procedures, but we have to be critical about reasonable floors of standards that can be achieved with resources on hand."
- "Reduce bottlenecks, holistic security postures."
- "Airports should not allow people without a valid ticket to enter the airports."
- "Merge different technologies together regardless of the manufacturer and see which combination works best. X-ray and CT might not be doable for soft targets, the first for safety reasons and the latter for the protection of multiple targets."
- "Outward facing security technologies, seamless people screening."
- "New remote sensor development."

Question 6: How satisfied were you with the topics and focus of the ADSA15 presentations and discussion?



Respondents: 35

Skipped: 26

Individual responses:

- "For good or bad, industry is not always motivated by altruism. Without a paying customer it is hard to champion new features or improvements in existing products or even new products and technologies. It was very good that the TSA attended, but there was not the level of direction or commitment that would have made a difference. The discussions with "representatives" of passengers, industry, and regulators was not especially meaningful nor did it add new perspectives. I was not sure what the point of the war games exercise was. The memorial to Dr. Bijjani was a very good idea. It reminded us on whose shoulders we stand."
- "Some topics generated more discussion than others and thought more information from TSA and issues they are trying to address would be helpful in determining the direction for the discussions. It might also be useful to have some other government agencies participate with areas they are trying to address."
- "Excellent mix of topics and presenters."
- "Good information but way too many speakers and not enough discussion/breakout sessions."

- "High level review and analysis of technological, administrative, and business issues."
- "There should be more time provided for discussions and questions on each presentation."
- "I would like to see more check point talks and interaction between industry, government and the airlines."
- "With the exceptions of the panel discussion I found ADSA15 to be stale with too much time spent covering the same old X-ray and millimeter wave technologies. Going forward there should be a better mix of subject matter including presentations of technologies that address emerging threat scenarios."
- "I liked the short 20 min talks and the diversity in topics. Would be great to see more international perspectives on the security issues."
- "It was my first visit to an ADSA workshop and the diversity of topics ensured that most elements of the checkpoint were addressed, allowing holistic thinking and discussions during the event."
- "I enjoyed the talks, exchanged ideas, learned and provided a lot of comments and recommendations."
- "Informative discussions with industry and government partners, although still need airline participation and passenger representation."
- "Would prefer more focus on software; integration, bid data, machine learning algorithms."
- "It was my first ADSA, so I didn't have a lot of set expectations, but I really found the approach fascinating and completely different from what we normally do. Speaking personally and only from my individual perspective, I think TSA has a huge blind spot by not differentiating industry from academia. That was so informative and helpful for understanding how decisions are made."
- "I found the following talks to be *not* interesting: EU Supported Security Research Activities, Estimation and Detection Information Tradeoff for X-Ray System Optimization (EDIT Curves), Safety Act, Compton scatter imaging, M&S/HD Animation Focus on data analytics and multi-sensor fusion is very important."
- "Photoacoustic Spectroscopy needs a bit more groundwork as to results for standoff detection. I did not see the robustness for the analysis in the results. I was glad to see TSA actively participating but I believe academia professors should also be present to address each of the results for companies."

Question 7: Do you have any recommendations for future ADSA workshop topics?

Respondents: 24

Skipped: 37

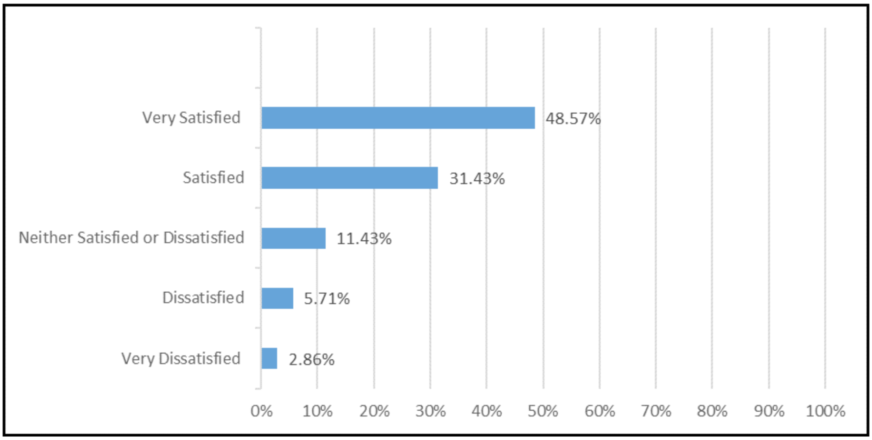
Individual responses:

- “Potential security solutions for mass transit and multimodal areas, for example combination of passengers using ports, trains and airports. Sensor integration and how to manage and best use the data and determine risk from passenger.”
- “Add trace detection and screening aspects of airport’s perimeter.”
- “More gaming and interactive sessions.”
- “Interaction between detection standards/performance and screening workflow.”
- “Continue to bring outside industries in to apply COTS solutions to security sphere.”
- “Need to include presentations and involvement of both Airlines and Airport Authorities (key stakeholders currently not involved, and abstaining from interaction).”
- “More multi-sensor fusion.”
- “I think the quality of talks are getting improved and inviting people from big companies working on machine learning and knowing about their approaches to their own problems is a good approach.”
- “DICOS 2A Implementation and TSA/DHS construction of an image data base for ATR development.”
- “I would like to see more check point talks and interaction between industry, government and the airlines.”
- “1. Hyperspectral imaging. 2. Man-portable sensors for displaced threat detection. 3. Likely future threat scenarios.”
- “More passenger experience factual data, more cargo attendance and their problems. Also would be good to walk through a fictional checkpoint so that all understand that fixing 1 problem may create another down the line. The end goal should be to fix the start to finish (entry to exit) of the checkpoint.”
- “Include more discussion of terrorist perspectives and more cost-benefit

assessments of proposed changes and added technologies."

- "More of the same please! I particularly enjoyed the discussion and participation elements, it is a useful format."
- "Continue to have these workshops."
- "To include works on tracking events, and adaptive methods for threat evaluation."
- "Get the airlines in so we can get their perspective of checkpoint security."
- "Nontechnical discussion on common goals and means of measuring achievement."
- "Software; integration, bid data, machine learning algorithms."
- "Not sure if ADSA specific, but I think we need an inter-DHS center conference where we come together for the singular purpose of collaborating and sharing results."
- "More multi-modal fusion, thinking outside the box for holistic security."
- "Really need to delve into how we can make certification less rigid to foster better innovation. It was touched upon, but we need a workshop just on this."
- "The protection of soft targets, open venues and railways adjacent to key airports. Students should be encouraged to present as they have in this workshop. More participation from Academia might work best to bridge the gap."
- "More Big Data Approaches."

Question 8: How satisfied are you with the format of the ADSA workshops?



Respondents: 35

Skipped: 26

Individual responses:

- “The idea of ‘last slide first’ is intriguing. It might be helpful if all speakers started with ‘after this presentation you will know more about X’ and ‘why learning about X is beneficial to the ADSA context.’”
- “The generation of questions based on the direction provided for the briefings seemed to work well. Carl does a great job at this and keeping the discussions on topic and capturing the essence of the topic for actions or future discussions at the next meeting.”
- “Facilitation and time management could be better.”
- “Too many speakers/presentations. More discussion and less static listening.”
- “Sometimes too rushed... some subjects had less relevance, however they helped with thinking outside the box (innovation).”
- “Maybe should try have specific sessions instead of one general session.”
- “I thought that this conference was a bit off base from the mission.”
- “The format is OK. The topics and technologies discussed need to be expanded.”

- “Maybe have runners with the microphones so that all discussions and questions can be heard.”
- “Good, robust discussion was very useful.”
- “The discussions are very useful in two directions.”
- “I would have appreciated more times to talk to people—schedule seemed pretty packed. More coffee breaks? The ‘war games’ idea was cool. Maybe small-group activities that get people talking as part of the program?”
- “I found that many of the speakers were cut off just as they were addressing interesting problems that are relevant to this space (for instance, fusion presented by Google, video processing by Professor Saligrama). But CT and baggage screening talks were allowed to go too long. Additionally I found that by interrupting the speaker early, much of the audience was left out of the loop. How are the questions relevant given that the speaker hasn’t even presented anything yet? I think the speakers should be allowed to present what they have spent time preparing, and that a longer panel discussion can be used to allow more question-based discussion. It would be helpful if the second day was classified so that real information could be shared.”
- “The schedule was overfilled. The most important part of any conference is the time between talks where connections are made and more detailed questions can be answered. There was hardly any time for these discussions. The format should also be changed to allow for a little more time for presenters to get into their talks before questions are allowed. The idea of workshop, not conference is nice, but if the presenters are given no time to introduce the problem on which they are working, it is difficult for the majority of the audience that is being newly informed on the topic to follow the discussion. It would be nice to see a more normal presentation, but require the presenter to stop at three points for questions instead of just having questions in the end, like at a conference, or free-for-all questions throughout as is the current format.”
- “The logistics were great. The food was good and the schedule was catching up. The first day was way too long though.”

Question 9: What did you like and dislike about this workshop?

Respondents: 26

Skipped: 35

Individual responses:

- "Liked the discussions. Some areas seemed to be more R&D for R&D and not focused on addressing real issues from an operational perspective."
- "I liked to be updated about bulk detection emerging technologies and meet people working in this field."
- "Enjoyed the game."
- "Facilitation and time management could be better. The interactive format is very good."
- "The discussion-based format is much better than uninterrupted talks at typical conferences."
- "Like: location, venue, time for informal networking is very important. Dislike: rushed."
- "Too much of a focus on trying to shape group behavior in the beginning ('I'm not leaving until I get enough questions') which resulted in us being well behind schedule very early."
- "This was the best workshop so far. Technical content and the venue were better."
- "It has located in a better location and the refreshments have improved."
- "I love the interaction with industrial and governmental peers. More time devoted to open discussion."
- "I like that the speakers are asked to give us the bottom line slide first, but don't like the lack of technical depth in most presentations. I am also not a big fan of the workshop becoming an echo chamber with the same group of people giving basically the same presentations."
- "I like the format but as with most ADSAs we get behind schedule and talks and interesting discussions are cut short."
- "Liked the diversity of topics. Disliked what I perceived as the lack of understanding of the full market problem and a focus to fix pieces of the problem."
- "Generally, I learned a lot."

- “I liked the discussion and diversity of topics and presenters. Day 1 was a bit long though.”
- “Some talks are too vague.”
- “It was nicely catered and the location was new and nice. While the formal exchange of ideas is great in developing ideas, at times questions got off topic and the moderators should have stepped in sooner. Another issue was the amount of people in the room asking questions differently. Some people would stand while others used the microphone it should have been explained better how people should ask questions at the beginning of the workshop.”
- “May be worthwhile considering different tracks, if participation grows too large.”
- “Always like meeting people! Some good technical talks. Would have liked more time for networking, without having to bail out on speakers....but still, very worthwhile.”
- “I would prefer if presentations could be provided in advance to focus on greater interaction by presenter and audience. It is a shame to waste the talent pool provided by the audience.”
- “I felt ill equipped to answer technical questions- and i’m not sure how I could better communicate that to the audience.”
- “I liked the presentations from other fields. While the panel discussion was interesting, I question the usefulness of discussing what we ‘think’ the passengers or threats are thinking/doing.”
- “Really liked the format and quick presentations and interaction. Disliked the interactive game.”
- “The content was great. The format was bad. See the previous answers.”
- “I disliked the long first day. I really liked the encouragement to participate and ask questions. I also liked the ending presentation because TSA addressed what they did not see and what they really wanted.”
- “The panel was interesting, possibly more of that. Good back and forth dialogue between presenters and audience, good mix of industry Long days and therefore easy to lose concentration during 2nd half of the day.”

Question 10: What other comments do you have on the workshop?

Respondents: 14

Skipped: 47

Individual responses:

- "Might be useful to address both the detection as well as the operational issues from a systems perspective. Well conducted meeting and very well attended by variety of stakeholders."
- "None, great experience!"
- "Thank you. Well done."
- "Thank you."
- "If possible private discussion areas to discuss and to go into greater detail on some of the topics presented."
- "I would like to see more check point talks and interaction between industry, government and the airlines."
- "Bringing in economics and economic analysis more might be useful."
- "Find hotels closer to the venue, please. Finding taxi to reach the conference is challenging sometimes."
- "Overall the conference was great, looking forward to next year."
- "Very informative, thank you."
- "Always worthwhile."
- "Thanks to Melanie and Carl!"
- "Great initiative for academia."

14. Appendix: Acronyms

TERM	DEFINITION
2D	Two-dimensional
3D	Three-dimensional
AATR	Adaptive automated threat recognition
ACC	Airports Consultants Council
ACI	Airports Council International
AD-102	Acquisition Management Directive 102. Also referred to MD-102 at TSA. http://www.dhs.gov/sites/default/files/publications/102-01_Acquisition_Management_Directive_Rev02.pdf
ADSA	Advanced Development for Security Applications (name of workshops at ALERT)
ADSA01	First ADSA workshop held in April 2009 on the check-point application
ADSA02	Second ADSA workshop held in October 2009 on the grand challenge for CT segmentation
ADSA03	Third ADSA workshop held in April 2010 on AIT
ADSA04	Fourth ADSA workshop held in October 2010 on advanced reconstruction algorithms for CT-based scanners
ADSA05	Fifth ADSA workshop held in May 2011 on fusing orthogonal technologies
ADSA06	Sixth ADSA workshop held in November 2011 on the development of fused explosive detection equipment with specific application to advanced imaging technology
ADSA07	Seventh ADSA workshop held in May 2012 on reconstruction algorithms for CT-based explosive detection equipment
ADSA08	Eighth ADSA workshop held in October 2012 on ATR algorithms
ADSA09	Ninth ADSA workshop held in October 2013 on new methods for explosive detection
ADSA10	Tenth ADSA workshop held in May 2014 on air cargo inspection
ADSA11	Eleventh ADSA workshop held in November 2014 on air cargo inspection
ADSA12	Twelfth ADSA workshop held in May 2015 on explosive detection at the checkpoint
ADSA13	Thirteenth ADSA workshop held in October 2015 on explosive detection at the checkpoint

TERM	DEFINITION
ADSA14	Fourteenth ADSA workshop held in May 2016 on developing and deploying technologies for fused systems
ADSA15	Fifteenth ADSA workshop to be held in November 2016 on next generation screening technologies and processes for the checkpoint
ADSA16	Sixteenth ADSA workshop to be held in May 2017 on addressing the requirements for different stakeholders in transportation security.
AIT	Advanced imaging technology. Technology for locating objects of interest on passengers. WBI is a deprecated synonym.
ALARA	As low as reasonably achievable
ALERT	Awareness and Localization of Explosives-Related Threats, A Department of Homeland Security Center of Excellence at NEU.
AMU	Atomic mass unit
APEX	DHS name for projects of primary importance. In this report, it refers to the APEX checkpoint program, which is also known as Screening at Speed (SaS)
API	Application programming interface
ARPA	Advanced Research Projects Agency
ASL	TSA Advanced Screening Lane
ASP	Airport security plan
ASTM	American Society for Testing and Materials
AT	Advanced Technology; a TSA term for X-ray equipment deployed at the checkpoint for screening cabin baggage and divested items
ATD	Automated threat detection; a synonym of ATR
ATR	Automated threat recognition; a synonym of ATD
AUC	Area under the curve
BAA	Broad agency announcement; a DHS and TSA term for a request for proposals
BDO	Behavior Detection Officer
BHS	Baggage handling system
BLS	Bottled liquid scanner
CAPPS	Computer-Assisted Passenger Prescreening System. https://en.wikipedia.org/wiki/Computer-Assisted_Passenger_Prescreening_System
CAT	Credential authentication technology
CASRA	Center for Adaptive Security Research and Applications
CAXI	Coded aperture X-ray screening

TERM	DEFINITION
CBP	Customs and Border Protection, DHS. http://www.cbp.gov/
CBRA	Checked baggage resolution area. Level 3 screening: Open the bag
CERT	Certification test performed by TSL for checked baggage systems (EDS)
CGUI	Common graphical user interface
COE	Center of Excellence; a DHS designation
CONOP	Concept of operations
CPU	Central processing unit
CREATE	A DHS COE at the University of Southern California
CT	Computed tomography
CTX	A model of checked baggage scanner produced by Invision
CUDA	A parallel computing platform and application programming interface (API) model created by NVIDIA
CZT	Cadmium zinc telluride. https://en.wikipedia.org/wiki/Cadmium_zinc_telluride
DARMS	Dynamic Aviation Risk-Management System
DAU	Defense Acquisition University
DHS	Department of Homeland Security
DHS S&T	Science & Technology Directorate, DHS
DICOM	Digital imaging and communications in medicine. A communication and image format standard for medical imaging equipment.
DICOS	Digital imaging and communications for security; a standard for sharing data and results from transportation security equipment
DNDO	Domestic Nuclear Detection Office, DHS
DOT	Department of Transportation
DT&E	Developmental test and evaluation
ECAC	European Civil Aviation Conference
EDS	Explosive detection system; a TSA term for systems to detect explosives in checked baggage.
EMD	Enhanced metal detector
ETD	Explosive trace detection
ETP	Explosives trace portal
EXD	Explosive Division, DHS/S&T
FA	False alarm
FAMS	Federal Air Marshall Service

TERM	DEFINITION
FAR	False alarm rate
FBI	Federal Bureau of Investigations
FOC	Full operational capability
GAO	Government Accountability Office
GUI	Graphical user interface
HME	Homemade explosive
HP	Hydrogen peroxide
HVAC	Heating, ventilation, and air conditioning
HW	Hardware
IATA	International Air Transport Association
IED	Improvised explosive device
IMS	Ion mobility spectrometry
IOS	Operating system used for mobile devices manufactured by Apple Inc.
IP	Intellectual property
IPT	Integrated product team
IR	Infrared
IRD	Interface requirements document
ITF	Innovation Task Force, TSA
IV&V	Independent validation and verification
JPEG	Joint photographic experts group
LiDAR	Light Detection and Ranging. https://en.wikipedia.org/wiki/Lidar
LLNL	Lawrence Livermore National Laboratory
MDI	Morpho Detection
MMW	Millimeter wave imaging
MRI	Magnetic resonance imaging
MS	Mass spectroscopy
NEMA	National Electrical Manufacturers Association. http://www.nema.org/
NEU	Northeastern University
NGA	National Geospatial Intelligence Agency
NMR	Nuclear magnetic resonance
NSF	National Science Foundation
NQR	Nuclear quadrupole resonance
OCR	Optical character recognition

TERM	DEFINITION
OCRA	Office of Risk and Capability Management
OEM	Original equipment manufacturer
OIA	Office of Intelligence and Analysis, TSA
OMB	Office of Management and Budget
OS	Operating system
OSARP	On screen alarm resolution protocol/process
OSC	Office of Security Capabilities, TSA
OSPIE	Office of Security Policy and Industry Engagement, TSA
OSO	Office of Security Operations, TSA
OSR	On screen resolution
OT&E	Operational test and evaluation
OTAP	Open Threat Assessment Platform. A project conducted by Sandia National Laboratory for TSA.
OUP	Office of University Programs, DHS. http://www.dhs.gov/science-and-technology/office-university-programs
PC	Personal computer
PCB	Printed circuit board
PD	Probability of detection
PFA	Probability of false alarm
PI	Principal investigator
PNR	Passenger name record. https://en.wikipedia.org/wiki/Passenger_name_record
PPV	Positive predictive value
Pre-check	A TSA program to increase the screening speed for certain passengers
QCL IR	Quantum cascade laser infrared
QR	Quadrupole resonance
QUAL	Qualification test performed at the TSL to enable equipment to be listed on a qualified products list
R&D	Research and development
RBS	Risk-based screening
RFI	Request for information
RFP	Request for proposal
RFST	Random finite sets trackers

TERM	DEFINITION
ROC	Receiver operating characteristic. https://en.wikipedia.org/wiki/Receiver_operating_characteristic
S&T	Science and Technology Directorate, DHS
SaS	Screening at speed
SME	Subject matter expert
SBIR	Small Business Innovation Research. https://www.sbir.gov/
SOAP	Simple object access protocol. https://en.wikipedia.org/wiki/SOAP
SOP	Standard operating procedure
SPOT	Screening of passengers by observation techniques
SRI	Stanford Research Institute
SSI	Sensitive security information
STIP	Security Technology Integrated Program
T&E	Test and evaluation
TBD	To be determined
TCO	Total cost of ownership
TDC	Ticket and document checker
THz	Tera-hertz inspection
TIP	Threat Image Projection
Trace	Synonym of ETD
TRAP	TSA Requirements Analysis Platform
TRL	Technology readiness level. https://en.wikipedia.org/wiki/Technology_readiness_level
TRS	Tray return system
TSA	Transportation security administration
TSE	TSA Security Equipment
TSIF	TSA Systems Integration Facility. A TSA testing facility in Arlington, VA
TSL	Transportation Security Lab, Atlantic City, NJ
TSO	Transportation security officer; scanner operator
TSWG	Technical Support Working Group
UAV	Unmanned aerial vehicle
UI	User interface
USB	Universal serial bus
WTMD	Walk-through metal detector

TERM	DEFINITION
XBS	X-ray back scatter
XRD	X-ray diffraction
Zeff	Effect atomic number

15. Appendix: Minutes

The ADSA15 minutes were edited for purposes of clarity. All errors in the minutes are due to the editors of this report and not due to the speakers themselves.

15.1 Key

The following fields indicate the flow of conversation as it took place during the question and answer portion of each presentation.

- Q: Question
- C: Comments from the Audience
- S: S&T Statement
- TSA: TSA Statement
- ALERT: ALERT Statement
- A: Presenter Answer

15.2 Day 1 Minutes: November 15, 2016

I. INTRODUCTION

Topic: Welcoming Remarks

Speakers: Michael Silevitch (ALERT, Northeastern University), Nadine Aubry (College of Engineering, Northeastern University), Laura Parker (DHS)

Discussion of the evolution and impact of ADSA, including perspectives from NEU and S&T.

ALERT: ADSA has grown nearly fivefold from the first workshop. If you solve someone's problem, they will come to you. We want to hear what problems you've solved and engage in a conversation. There are many areas that have problems that still need to be solved. Since the last ADSA, we now have the problem of long wait times.

Topic: Setting the Stage

Title: Workshop Objectives

Speaker: Carl Crawford

Discussion regarding the scope and challenge for aviation security and industry engagement, and of recent developments.

ALERT: We need to focus on displacement phenomenon. No silver bullet, phenomenal detection, no false alarms, immediate deployment, and amazing throughput. We will need to aggregate, fuse, etc. to solve the problem. Don't look at technology as a silver bullet. Look at how it can work into the problem. Forage other fields. Protecting aviation means protecting soft targets. Displacement.

A: Building upon other people's work. Apply the scientific method to the work for further advancements.

C: Very interesting. Long wait times experienced in the U.S. in the summer changed something—it enabled the U.S. via the TSA Innovation Task Force (ITF) and the airlines to incorporate the automated screening lanes. I believe that it resolves the problem. It comes out of automotive automation (e.g. Singapore). In Singapore, robots hand trays to passengers.

C: Airlines are the driving force behind these changes. Are we missing something by not having airline people here at these workshops?

A: It's very difficult to get them to attend. We have a panel discussion to share their viewpoint.

TSA: There is a different approach to how we deal with airlines.

A: Safety is the #1 priority; getting planes off the ground is #2.

C: The process for getting products into the marketplace has slowed down. What once was a three separate processes route has grown to eight processes, and it seems to be growing to twelve processes.

A: We will deal with it in the Adaptive Automated Threat Recognition (AATR) project. Deployment may have 30 processes. We have a Government Accountability Office (GAO) report that says it's almost infinite.

S: There are so many different technologies. We need help to bring it all together. It fails because you can't bring it all together.

A: Organizationally or technologically?

S: Technologically.

A: I would think organizationally, also.

TSA: People can go online and check in. People don't want to pay for baggage. They have one carry-on bag, and the airline takes the bag at the gate for free. Now they go directly through security to the gate. How do we manage peak times when there are 4-5 planes all loading at one time? They skip the gate.

C: There are competing goals for the various stakeholders, resulting in tension between the need to have more integrated environments as we move forward, but cyber are a real competition for this.

TSA: Yes. Cyber-security impacted our ability to deploy. It's a delay. We have to retrofit for things that haven't been designed with that mindset. It's clumsy.

C: Standalones are focused but can't do it all in the focus area.

C: Also, we need to consider how to operate in a degraded state when the integration is less than expected (e.g. when the network fails).

TSA: Cyber is one of the key items that we need to address. During the initial cyber issue in June, we had to discontinue the Security Technology Integrated Program (STIP).

C: Does the shoe scanner need to know about everything?

A: The answer might be yes. We have some briefs that address that.

ALERT: Pre-check has modified behavior. For example, passengers are arriving at the airport later. We aren't using this increase in information about the traveler to force more managed inclusion. We want to hear more from the government on displacement. Who is taking the lead on deploying new technology—Department of Transportation (DOT), airport operators, airlines, or TSA?

TSA: Wait for the System Architecture Activities talk.

TSA: How will you integrate privacy into CCTV at the checkpoint?

II. AVIATION CHECKPOINT OF THE FUTURE – PERSPECTIVE

Topic: Systems Architecture Activities

Title: Office of Security Capabilities System Architecture

Speaker: Keith Goll

Discussion of TSA's focus on Systems Architecture, and TSA management of Acquisitions.

TSA has moved away from technical conferences, so the ADSA15 Workshop is *a very good venue to get discussions going. TSA is reorganizing the Office of Security Capabilities (OSC) as of December 5, 2016. There will be no OSC any longer. TSA has asked the Defense Acquisition University (DAU) to look at how TSA does acquisitions. TSA has heard from industry that the process is too slow. As the process matures, oversight matures, and things take longer. Responsible for purchasing, deploying and maintaining the equipment. Reorganizing into three groups: Acquisition, Program Office, Requirements.*

TSA deployed technology beginning in 2003 and this equipment has held up pretty well. Some of the publicity is undeserved. TSA is trying to have a more systematic view—integrated, interoperable, and modularized.

Change the model of proprietary designs. Upgrades are costly. Lack of aggregation makes it difficult to exchange information.

Can we aggregate at a system level? This involves real-time threat information and sharing, so we can make risk-based decisions across the enterprise. Regarding pre-check, we can do so much more if we have access to the data and quick access to it.

Q: It takes a long time to get through certification and to the field. If you open it up, now you have four different software companies that can run. Does it mean you now have four times as long to get through the process? If not, how will TSA manage this?

A: As we move to open architecture, we know that processes will have to evolve and change. We want to stand up industry working groups to get that piece right. Our processes right now are very prescriptive and based on how things are today, so it’s going to have to evolve.

Q: In relation to your description of disaggregation, the TSA Advanced Screening Lane (ASL) will become relatively ubiquitous. You have disaggregated the work of the sensor, moving data from the sensor to the search desk. The algorithm exists on the system, not on the box. Is this so you can certify the algorithm on a simulator rather than on a box? Why not run the algorithm off the box as well?

A: I agree. We want to build an architecture that allows this.

ALERT: Is TSA looking to certify algorithms separate from a box?

A: It’s on the roadmap that we are considering.

ALERT: What about academia? Do you have a scientific advisory board structure? How do you pull in ideas?

A: We use the work industry very broadly. Sometimes we are talking about airlines; sometimes, airports; and sometimes vendors. We aren't excluding academia.

Q: How do you motivate inventors? Let's go back to 2000. Suppose Doug Boyd didn't have the desire to do something new, it never would have happened. It seems that the innovation comes from people who are crazy enough to do something that has not yet been done or specified. That is missing from this approach.

A: TSA is interested in setting up models that allow new innovative approaches. We've been hearing that it's hard to get ideas in front of TSA. We have to set up a model that allows that to happen.

Q: Are you going to have a technical component in the TSA? Technical capability that was obvious in TSA is no longer obvious.

A: As part of the new Office of Risk and Capability Assessment (ORCA), we are trying to rebuild that technical capability. S&T is a good partner..

Q: As you start to look at risk-based screening based on different algorithms, what gets certified? How will you scale-up with respect to infrastructure?

S: Hackathon culture is an emerging business approach. We hope to launch something like that here at ALERT.

Q: How do you merge technologies or architectures? I believe it is much easier to merge the output data and correlate the responses from the system. You might think it takes more time, but it does not. Big data and data mining—couple them.

C: We have a talk tomorrow that talks about taking algorithms out the box and testing them.

TSA: We have two projects looking at this: TSA Requirements Analysis Platform (TRAP) and Open Threat Assessment Platform (OTAP).

TSA: When we hired MITRE, we asked them to map out the end-state. Where do you want to go? Put together a workshop to map out what the passenger journey looks like and what capabilities we wanted from keyboard to gate. We don't talk about the detection capability—that's a given. We need to detect all threats at the highest level. Throughout, the thing that stands out is identity management. You see surveillance extending beyond the checkpoint. We don't own information outside of that. If the airport has a CCTV feed, we want that, because we want to use that to make risk-based decisions; however, there are privacy regulations and ownership issues involved. We need some sort of analytic cloud. We are developing MissionNet. Take all the TSA Security Equipment (TSE) and build a separate dirty cloud for cyber and clean it before it transfers onto TSANet. Protecting soft targets is the airport's responsibility through the airport security plan. How do we work more closely with the airport? This is going to entail a change of roles and responsibilities. As for security capabilities, it's what we need, not what we necessarily have today. Are there definitions for the identified capabilities? If someone wants to invent, how are the details obtained? How do we get ideas for the whole curb to gate journey? We need to prioritize what we should focus on first.

C: It is interesting to see identity management. Airports Council International (ACI) also identified identity management as a key thread. Airports today, manage identities of their employees through their airport security plan (ASP).

TSA: We have been looking at how Customs and Border Protection (CBP) does this.

C: Prescreening requires non-physical aspects (big data analytics). TSA's Office Intelligence and Analysis (OI&A) has responsibility there, but they seem to be super insular and less interested. They are not dedicated to build. You know what your challenges are. They don't know what questions to ask. That is the highest leverage piece to this whole thing.

TSA: I don't know the answer to that question. The Summer of 2015 crisis (failure at checkpoints). TSA doesn't have an overarching system architecture to bring the whole thing together. Threat detection using the equipment in the airport. No one responsible for the whole journey. The role of system architect is going to grow to show how all these pieces fit together. How each responsible entity with TSA is going to have to do their part. It needs to be cohesive.

C: OI&A should also be here listening.

Q: Have you looked at individual airports purchasing and operating their own equipment vs. TSA's style one-size-fits-all approach? This allows individual airports to adjust things.

C: In general, looking at different models; looking at different equipment, but also different models for acquiring, deploying, and operating.

C: OI&A is traditionally insular. When they saw the European Civil Aviation Conference (ECAC), to feed back into their own processes, their eyes opened up. It will inspire them to come forward and improve themselves.

Topic/Title: TSA Innovation Task Force

Speaker: Mara Winn

Discussion of the Innovation Task Force and how the environment continues to evolve.

How airlines are now feeding data to TSA. For example, if there is a free seat, they will drop their price to fill the seat. TSA has to change their process to get the passengers through. How do you take advantage of what your partners and stakeholder partners are doing? It requires interconnectivity to know when a person is entering the airport. If the airline knows that the passenger is at the checkpoint, they can hold that flight 30 seconds…

Q: The scariest part of the airport is the queue. What is the answer?

A: Get rid of the queue. Jet Blue got rid of their check-in system that was operating as a queuing system, not it is kiosk only. Airlines are very scared of another Brussels attack, so they are getting involved earlier on. People standing in the queue are lower risk because of earlier reviews. We need to provide basic training to airport personnel. The Starbucks person has responsibilities for monitoring.

ALERT: Where in the process does TSA identify the passenger?

A: When you hit the ticket document checker. When they make the reservation, the data enters Secure Flight (and the airline feeds that data to TSA). That is how we know whether you are a selectee, pre-check, or normal passenger.

ALERT: If you do know that information, do you know that I fly once a month?

A: I don't know enough about that.

Q: What is TSA doing to be able to look at social media, Google, or Facebook—in order to do a much better of job of making the data more accurate?

A: That aspect has come up. This is why we need them (Google, Facebook, IBM, etc.) to be here.

A: Early stage demonstrations do not have to be perfect. If it's perfect, it's too late in the game. We find issues at Operational Test and Evaluation (OT&E). It is too late to find out that your operators can't use it. It is too late to find out TSA has bad requirements. Not writing them well enough to communicate what the need is and making sure that everything is testable, so that they operator who is doing that job day-in and day-out can use it on the floor and make critical decisions. How can ITF take reasonable risk to see that happens?

Insular environment—it may not be sustainable, but can I try new procedures that will drive those future decisions? ITF is only 10 months old. A lot of the things that we want to do are just getting off the ground. Innovation site is not an Advanced Screening Lane (ASL). ASL is one solution that was demonstrated at one site. The whole point of the innovation site is demonstrating many solutions. If you are already in a S&T activity, Innovation can bring you onboard so you can see what happens in the field. We can do technology demonstrations. It's more an issue of mindset, rather than policy. The TSA Office of Security Policy and Industry Engagement (OSPIE) is looking into biometric bag drops in Minneapolis.

C: Development of new technology. Small companies are the ones who are innovating. Classification of information. Getting information to these small companies. They don't have clearances. This is a major bottleneck. You can't give them feedback because you are unwilling to tell them.

A: I don't have a good answer. Lack of a contractual connection to TSA. ITF does not do development through broad agency announcements (BAA), but it has to be ready for deployment (it can have a lousy user interface since it is not being deployed broadly at this point).

C: It assumes you get one.

Q: You mentioned Probability of False Alarm (PFA). What other measures, or metrics are you looking at? Simulants?

A: It depends on what the solution proposer is looking for. If it's a system that can be put in series vs. the program of record decision.

Q: How do you assess detection performance in the field?

A: You could run explosives. Work with the proposer. What do you want to learn? You can learn detection in a lab, but if you want to know how the transportation security officer (TSO) operates…

Q: In your attempt to bring computed tomography (CT) into the checkpoint, how are you changing the TSO's thinking about it? They want to run the CT system like the advanced technology (AT) system?

A: We are in the process of working with different vendors to work through that. The TSO is not going to dictate how the system should operate. If you focus on training: how we approach the TSOs; how do they function; what feedback do they get from the system itself or from the people around them; then we can take that information back to learn how the system can be deployed effectively.

C: It looks like you are planning to take inputs from Amsterdam's Schiphol and other international airports.

A: Yes. We each have different focuses. In some areas, they are ahead and we can learn from some of that. Airports in Europe are managed differently. We are concerned with 440+ airports, while they are focused on a single large airport. But what can we take away and adapt? Getting the lessons learned documented, so that it can be disseminated.

Q: Does this result in consistent testing?

A: That is a separate topic with different threats and different concerns.

C: We supply equipment to the airlines, ultimately. They are at ACI, and future passenger experience, but not here. Delta just invested $50M for bag tracking.

A: I believe that they do care about security. They have very little knowledge about detection. You would be amazed about what they don't know. They don't understand detection technologies in the least. There is a lot that has to be done to make it a checkpoint suitable system. They thought you could snap your fingers and get detection of liquids in bags immediately. They recognize the advantage of facilitating TSA advancement in the area and their customers will benefit. Part of their business is liability. You can tap into that. You have to take a different approach of explaining it to them. There is a significant appetitive for taking advantage of that and we are trying to take advantage of that while gas prices are low.

Topic/Title: TSA Requirements Analysis Platform (TRAP)

Speaker: John Morgan

Discussion of the TRAP and how TSA intends to use it.

A: Is this concept sound or workable? Maybe if we modify it a bit.

Q: I have a small company. Some of our technology has a technology readiness level (TRL) of 2-3. How do I get in the radar of getting into this process?

A: From an infrastructure process, we are now ready after a year of building. For the contract vehicles, I defer to TSA.

ALERT: Is TRAP a software product? The answers have to come from the experts. It is not clear how the experts plug into TRAP.

C: It's a simulation platform that can plug in real algorithms and hardware. The engine runs projected passengers and models performance of each element to get a better feel for the overall system. Look at an actual checkpoint environment so you get a feel for what those interfaces are and how you ultimately fit them into the screening architecture.

C: The key is the feedback loop. Mara mentioned they are fairly new; this is fairly new. Conveying information about gaps; guiding industry research and development (R&D); and tying into airports with real live demos to modify the virtual environment is key to tightening the whole process. If you work with industry to tie it all together in a very cohesive and cost effective way that is key. TRAP will benefit.

Q: I'm a vendor. How do we work with TRAP?

A: There is a contractual element. Technically. TSA provided access to in-the-loop items (viewing station, algorithm) for working with vendors. Inputs and outputs. How do we close the gap? Software interface.

Q: Does ACME Security call you?

A. ACME Security calls TSA. TSA tells General Dynamics (GD) to put this into the hopper.

Q: You put together a nice demo. What do you want people to know?

A: Exercise concepts in a pure demonstration. Exercise technically how to plug it together. What happens when you put this stuff all together? Biometrics with facial recognition at the ticket and document checker (TDC) to inform downstream equipment. What it took technically to put it all together.

Q: Can you speak to integration lessons learned?

A: The idea of TRAP as an early integration and idea foundry has been validated in the demonstration. TRAP started to work with the data models and ideas to determine what the solution architectures can be to pull this off.

Topic/Title: UK Perspective on Checkpoint Screening

Speaker: Ben Jones

Discussion of how the UK views screening at the checkpoint. Topics addressed include:

- *Differentiated screening using passenger information to activate different* *screening algorithms.*

- *Centralized image processing at five UK airports*
- *Move to Threat Image Projection (TIP).*
- *Explosive detection system (EDS) for cabin baggage.*
- *Remote Screening.*
- *Competing concerns about the threat environment, asset replacement cycles, increasing passenger volumes, policies and regulations, operational processes, technologies.*
- *Commercial Drivers: Older airports may want to upgrade equipment. Newer airports may not. May only want algorithmic upgrade.*
- *Managing the potential divergence in equipment and processes.*

Q: Complete TIP for EDS too?

A: Yes, and we have to look to see if it will set off the alarm.

Q: Centralized image processing. You don't do that now?

TSA: Yes, we do this for checked baggage, but we are looking to do this for checkpoint too. We want to create an On-Screen Alarm Resolution Protocol (OSARP)-like environment just like the UK. Due to network; remote screening.

Q: How do you intend to achieve that outcome when some feature X is not mandated? Please explain the flexibility EU airports have.

Q: How are you dealing with shot-gunning? Disassemble threat, and built-in redundancy. Different passengers. Weapons embargo from Russia. In children's toys. Maybe you get a frame or a receiver, and cover in a welder's alloy (melt with a hair dryer).

A: UK home office program. Parcels in the post.

C: This happened in Brussels and Paris.

Q: Is a gun on an airplane a crime or terrorism?

A: Our job is to protect the airplane and the people on it. We established a cabin baggage working group. Shrink the screening area. Applying EU policies.

Q: European experience—people just showing up?

A: Baseline of screening. We don't want to go below that for anyone. For threats, we might go higher than that.

TSA: How do you go higher?

A: This isn't an area that we've done much in yet. We mandate 25% through advanced imaging technology (AIT) if they must be screened, or a higher setting.

TSA: We have people looking at Facebook and other things.

A: I can't comment on what our intelligence agencies are doing in this space.

Q: What is the state of weapons detection?

A: Automated gun detection is the aspiration for cabin baggage. We are looking at the current state of the art in academia and industry. Not a commercial driver from the operators.

Topic: EU Supported Security Research Activities

Title: EU Security Research

Speaker: Paulo Salieri

Discussion of EU Security Research Activities, funding, and opportunity. Open challenge led and mission driven approach. Create social trust in research-based security policies. Reduce the barrier to the cross-border dissemination of research outcomes. 8% budget funds R&D. Collaboration among practitioners, academia, and industry. Much of the landscape had been set already, so it was difficult to shift over the next year.

C: A lot of work is organized around the Horizon 2020 program. How can entities based in the U.S. that do not have European representation participate? This needs international cooperation.

A: Horizon 2020 is the name of the 7-year research program. Israel, Switzerland [*some discussion*], Turkey, and Norway contribute. They are countries that are participating, so they are considered members. They are welcome to join, but they don't receive funding. If their contribution is important without their presence, then they can get funding. Reciprocity is important. In the past we have had US entities, such as Georgia Tech, participate.

Q: Can you talk about the how?

A: We invite entities to group together. It is a requirement that they are from different nations. For example, police with the university with industry.

Q: How much money is available for homeland security research? Here we have the National Science Foundation (NSF), but that is general funding, not homeland security focused. How much is available in Europe for homeland security funding?

A: 1% of GNP. 2% in research. 8% in innovation. Most countries don't have a security research program. Funds that are mobilized for civilian security is 3% of the R&D budget. This represents 50% of what is spent in the European Union. 1.7B euros over 7 years—that is about 250M euros/year. We don't have a division between fundamental research and applied research. We have to use the monies through an instrument of collaborative engagements. There is value in creating a community. The International Air Transport Association (IATA) is participating with Rapiscan and Morpho and some university. Expedite (Shannon airport) is participating with TSA. One for EU and one for TSA screening—being fused. Heathrow and Schiphol are participating. There are 300 projects and 1500 participating entities. 1.35B euros from the EU. 50% of total European civil security R&D. The Commission Security Research Program is recognized as the central actor and federator in security research in the EU.

Panel Discussion: Perspectives on Checkpoint Security – Airline, Vendor, Passenger, Terrorist

Speakers: Matthew Merzbacher (Vendor, Passenger), Harry Martz (Passenger), Jimmy Oxley (Terrorist)

Panel discussion of the various perspectives, objectives, and pain points. The Airline perspective is based on informal discussion and TV ads (safety is a priority, sells seats; schedule is secondary).

C: Invest in passenger experience, not security.

TSA: I don't think they understand the full extent of detection technology as TSA and the people in this room do.

Terrorist: I don't see how security sells seats. I look at schedules as a passenger.

C: The Airline group is actively engaged in trying to water down regulation. Global airlines are actively trying to water down regulations, so that they don't get in the way. Airports are not interested in security, other than they have a liability.

Passenger: I want to go from point A to point B safely, but I want to just walk onto the plane. I don't want to divest anything.

ALERT: Good luck. Look at the current situation. It's the balance between security and expediency. No pat downs, no wait times is the checkpoint of the future.

Q: Would you prefer that the other 150 on your flight are not screened?

<u>Passenger:</u> What does it take to be safe?

ALERT: What information are you willing to give us to qualify that you are safe? If other passengers are willing to give information…

A: I work at Lawrence Livermore National Laboratory (LLNL). It's in the security vetting forms. Lots of information. And the U.S. Government's Office of Personnel Management (OPM) lost that. You have some people who don't want to give that information.

ALERT: I think that is obfuscation. That was given to a very limited distribution. Would that information have to be given to a whole chain of command? Airports, etc.

A: I don't think we should have to requalify for our clearances. It should put us in pre-screen. It depends on how much time has passed since the last terrorist event to determine how much people are willing to put up with. I did a survey of my class.

<u>Passenger:</u> I want predictability and consistency. It could be consistent for 5 minutes, but then there is a choice between high standard deviation vs. low deviation. There needs to be better instructions for newbies. "Do I take off my shoes, or do I keep them on?" There needs to be signage and concept of operations (CONOPS) improvements for helping people get through the process as quickly, efficiently, and effectively as possible. As far as less experienced passengers go, they want openness. It drove my mother-in-law nuts as to why she was being patted down. It wasn't explained at all. She wanted to know "Why did they do this to me? Why did they do that?"

Q: I represent a company that creates a composite Hardened Universal Load Device (HULD). Explosions did not penetrate the casing. Why won't you buy my containers?

A: They weigh more and cost more.

C: We should bring in an insurance person.

A: We also heard that a forklift broke it and it could not be repaired. Forklifts are part of the environment.

C: I agree that consistency is important. Self-segregation is important and airlines are the masters. (e.g. price, status, premium experiences). Are we willing to provide more information if that is needed, and as passengers, can we get a more consistent experience?

C: If you view pre-check as an experiment vs. a policy, then yes it took a little longer. But there is a class of passengers who are willing. When they opened the new bay bridge I argued that they should keep the old bridge open, and charge less.

<u>Vendor:</u> Security is a given need, so I didn't mention it. My corporate overlords want a consistent revenue stream. Opportunities to see what happen, try and fail. We need more open dialogue between regulators and solution providers to be able to figure out the requirements and solutions together. We tend not to provide the best solutions when we aren't consulted. I don't believe the one-size-fits-all model can work in the long run.

C: In the open dialogue, do you include access to data, such as false alarm rates and scan data?

<u>Vendor:</u> Information is king. I haven't seen anyone do worse with more data.

<u>Terrorist:</u> Here are major terrorist attacks. These are the materials that I will attack with. 2 weeks in the camps. Initialing reliably is a big deal, so I'm looking at TATP. If I can get military explosives, then so be it, but you have learned to detect military explosives. Low vapor pressure, but I tend to scatter material. So, we don't have to look for these. I don't need much material if I'm attaching a transportation mode (airline or otherwise). There is an increase in vehicle assaults for gatherings of people. If you push it out before you get to the checkpoint. Any time you end up with a line of people… Shopping malls.

C: Some airports have adopted random screening at the gate.

<u>Terrorist:</u> Terrorists will wear their bombs for days and get comfortable. For example, the "Shoe Bomber" at number 2—he explained his time in the camps and his experience.

C: If you've seen one airport you've seen one airport. This is done intentionally.

Q: Do you receive training on what you do once you get through the airplane doors? Or on packaging?

Terrorist: Nervousness is not true of the trained terrorist, but may be more true of the lone actor.

Q: Do you use real credentials or false credentials?

Terrorist: Normally real, but false is an option depending on sophistication.

Q: Would you open the most secure door (cockpit), or not?

Terrorist: I might look at the bathroom. As a passenger, I am waiting for them to put timers on bathroom visits. As a woman or a mother, you need to spend time in the bathroom.

Q: If the airplane is filled with your friends, do they need screening? Facebook friends? Second tier? This group?

Passenger: Yes. No.

Q: How do terrorists feel about travelling through EU airports? There is less technology.

Terrorist: Frankfurt and Geneva had more space and better queuing.

Q: Informed by regulations as they are affected by the airport lobbying group, it's a different regime. Are you cognizant of that? Are the risks the same?

TSA: Tolerance of the passenger decreases the further away from an incident. How do you keep their tolerances high without having a terrorist incident?

A: Public events of catching someone. At a high school, they sent out fake information.

C: My 14-year-old commented on how much friendlier the airport in Australia was there.

Q: How did you feel about the Inspector General's report? The performance was substandard.

A: Why are they even doing it if it doesn't work? It leads to passenger frustration.

Q: Do vendors agree?

[*General agreement among vendors.*]

Q: Would you go through a regular checkpoint, or a pre-check lane?

Terrorist: I would go through a regular checkpoint lane. I haven't seen people slip in to pre-check. Maybe it's possible, but I haven't seen it.

III. VENUE PROTECTION

Topic: Insights for Mobile Radiation Detector Adoption

Title: Understanding the Adoption Process of National Security Technology: An Integration of Diffusion of Innovations and Volitional Behavior Theories

Speakers: Michael Egnoto

Discussion of the lessons learned regarding the deployment, application, and adoption of a mobile radiation detector through direct public uptake. An overview by the DHS START Center of Excellence: An approach to engaging the public in soft target protection through semi-passive crowd sourcing of sensor data and deployment of National Security Technologies (NST).

Q: Are the portable radiation detectors (PRD) based on counts or spectroscopic?

A: There were three tests. We weren't allowed to know what materials by Advanced Research Projects Agency (ARPA), but it was successful. Under $1K.

C: Half the population would carry items to protect them. Have them alert the wearer before triggering a general alert. It is an avenue to keep their family safer than someone down the street.

A: People didn't want payment. Higher rates of defection. Motivations to engage with this technology. Bring something home that empowered them and the environment around them. Displacement is easy. We are behind in all transportation modalities. We are engaging with the public to share that load.

ALERT: Why don't we have a nationwide program to train dogs?

A: It's an awful idea.

Q: How do you integrate them?

A: Hardest thing is to get them charged. Reminder texts help out. Construction of support messages to keep the public engaged long term. Detectors haven't existed long enough. It supplements the functionality of a needed device (e.g. sleeve for a cell phone). There is push back in form factor from younger people. We don't need everyone in the general population. The majority of people only take a few thousand steps per day. Most are generally stationary with set schedules. Tight traveler paths. Then we looked at police. Gadget insolvency.

How can we start collapsing these technologies?

Q: Aren't tight patterns enough?

A: Peak hour traffic, or all the time. Couriers are ideal. Semi structured routes. A lot of foot traffic. Police. Public transportation. Busses are slow, constantly stopping. Can plan a distributed network that's up all the time.

Q: What about mail carriers? They have a lot of coverage; they are on every street.

Q: If you see something, say something. You have to go after the human factors. No one wants to pay for it, because you can't put it in a parade. I have X items. Training is perishable and dependent on low turnover.

Q: What about putting it onto vehicles?

A: We want to put it on a few university bus routes.

Q: What about the low positive predictive value?

A: Our sponsor wasn't interested in exploring that.

Q: What about the holster? What do you do when it does go off?

A: We wanted to tether it to cell phones. Send a text message. The sponsors declined to allow this. The wearers want advanced alerts, but never got them. Integrate into everyday routines. Radios have a better chance of staying charged and active (vs. cellphones).

Q: Did you look at political culture from the people you were surveying?

A: It didn't break down on left and right. It broke down on trust in government. Tapping into patriotism helped. The ignorance on how these devices work – RN detectors will give exposure. The general public does not know how to think about these items. We have an opportunity to frame the argument, so we are mindful of screw-ups.

Topic: The Importance of Meta-Data

Title: Does Content Matter?

Speaker: Malcolm Slaney

Discussion of content, similarity, context, connectivity, and early vs. late fusion. Examples: Netflix, music, tagging images, and web links. Image features only *result in poor performance. Context matters. It is better than captions, and filenames.*

Q: On what information did you make the web graph?

A: The links are all available.

Q: Did the temporal order matter?

A: No.

Q: Should we turn the sensors off and just follow the links?

A: The image tells us something. Recognizing context from images is really hard. It's a complicated world. People can do it sometimes, but it's harder for computers to do it. You get better results when you can say where the information came from. Every time you make a decision, you lose information.

Topic/Title: Adaptive Learning, Venue Protection and Experience at the Rio 2016 Olympics

Speaker: Lisa Sagi-Dolev

Discussion of intelligent systems – when a machine needs to make a decision. No two venues are the same. Adaptive ATR is important. All of that has to be taken into account.

Q: How do you get threat data?

A: We start off in-house. We have an in-house library. We have a partnership with Stanford Research Institute (SRI) that has a range. We do a sanity check in the field. We put the threats in, not just in terms of false alarm which is the biggest concern, but also detection. We test each explosive. Please make a decision for your balance. Give up some types of guns, so it doesn't alarm on selfie sticks.

Q: What is the most significant barrier to this approach?

Q: What features does your system use to differentiate between liquids and threats?

A: Iterative dual energy X-ray, and rotating the bag.

Q: What features do you use in the images?

A: Over 200 features, machine learning based, deep learning, fuse different types of information, auxiliary information (size, weight, etc.). I am not going to discuss the parameters. We were able to bring the ceiling down to the level that they wanted to open bags within 4 iterations. We perform a sanity check.

Q: Is this in discussions to select a receiver operating characteristic (ROC) curve, or adapting where along the ROC curve?

A: The ROC curves move. We receive data from those venues. We see which are similar. We merge the data. We test it virtually, and then physically (the sanity check). We were at the Olympics. Our main objective was that everyone was happy, and the customer experience. The system never saw Olympic medals before. And it was being detected as weapons. There were no false alarms with 1 to 5 umbrellas, but at 7, there was a false alarm.

Q: Is there a feedback loop?

A: Yes. The guard can then state whether it is a real alarm or a false alarm.

Q: How do you certify something like this in the operational space?

A: How do you test this when it is evolving all the time? When it is regulated. Answer. We help them. We come from this field. We have the experience. We create threat books. We work with local police and local security. What is the most prevalent and dangerous? We provide them with a result of what we can do for you. Here are the tradeoffs that you are going to make, and you choose to make it. A significant barrier is the network.

Topic: Scope, the Technical Challenges, and the Progress in Building Cognitive Computers

Title: Cognitive Computing – Progress & Challenges

Speaker: David Nahamoo

Discussion of cognitive computing.

Q: People are willing to submit themselves to the visibility that it should be. If we are going after terrorists, why would they be willing to submit themselves?

A: Do I trust this person? We all have a lot of time. People are willing to spend 30 minutes at home to fill in questions from an automated system, so then the doctor can focus. The interactivity is important.

Q: What if you could acquire all of the biometrics and biomarkers surreptitiously and the passenger doesn't know? There are privacy issues, but technologically?

A: Blood gives the highest information; saliva and sweat goes to the next level. Your precision will change. If you can use it. The least intrusive is the most valuable.

Q: You get human feedback to describe the features. Was the prior model adaptive?

A: Adaptation for any task always helps. Supervised learning helps. We aren't that far down that I can give you the full answer yet. 4000 images. Linguistic interpretation of the images. Helped the deep learning on the visual information. Text was used as a regularizer for the images (don't go there). The training was helped and informed with the linguistic information.

Q: How long is the training?

A: It can take many days. It depends on how much training data you have.

Topic: Data Analytics in Medicine and Possible Application to Aviation Security

Title: AI and Analytics in Healthcare

Speaker: Homer Pien

Discussion of how data analytics is best applied and the pitfalls and lessons learned from its application in medicine. It is possible to draw an infinite number of erroneous correlations (correlation is not causation). There is a class that you should never treat. Under what cases do you intervene, and how do you intervene? Risk stratification.

Q: How do you save them money?

A: You anticipate what things you need to focus on to prevent readmissions.

Q: How are you building the classifiers?

A: We have the historical data. We know what patients have been released and readmitted.

Q: Where are the levers?

A: How do you provide security at a reasonable cost that the general public is satisfied?

Q: What is the fundamental difference between the medical application and the security application?

A: Cancer cells are incredibly intelligent. For every system, there is a counter-measure and a counter-counter-measure, but from the data science perspective, that may not be relevant.

Q: What about the capatated case in medicine. Shutting it off. Is there a parallel in security?

A: For an industry, they will spend $1B for a drug that they get. On the device side, it is a capatative model. On the security site, it is a capatative model. It is hard for a vendor to invest since they don't know how well it will perform or whether it will be purchased. Capatative capitates innovation.

Q: Medical data has outcomes, and mortality data. How many of what types of incidents have happened? Isn't' there an assumption that there are data sets?

A: It's very expensive to do double-blind prospective control studies. What is the burden of proof that you are willing to act on some evidence? Philips has 1.5M+ devices. I can pull in structured data, and unstructured data. DHS is somewhat different. I don't know what type of data you can pull in.

IV. VENDOR SYSTEMS

Topic/Title: Tribute to Richard Bijjani

Speaker: Michael Ellenbogan

A tribute to Richard Bijjani.

Topic/Title: Evolv's Products for the Checkpoint

Speaker: Michael Ellenbogan

A discussion of mass casualty screening with the Evolv Edge and Mosaic IQ platform. We are too closed an industry; now moving quickly to open standards environments. Incorporate COTS sensors to make a smarter system.

High throughput, false alarm rate. Focus on larger threats. If there are a lot of false alarms, forget about it. If you create new lines, forget about it.

Apply random screening as needed. Move it to a different location. Very few applications are ready to step up to 100% screening. Apply phenomenology based Automated Threat/Target Detection (ATD).

Q: Backpacks?

A: Backpacks we can carry through. Bigger suitcases have to be screened separately.

Q: What about under the arm?

A: This is a mass casualty sensor.

Q: Who is setting the detection requirements specifications for your customers?

A: We have set them. Aviation industry has bright line tests. Bad news—bright line tests. We have feedback from others what constitutes a mass casualty threat. How do we do it automatically? This is what the system does; this is what it doesn't do. We are happy to work with them to adjust sensitivity. We want to find long guns but not handguns. Needs human judgement, sustainability, and scalability.

Topic/Title: Analogic ConneCT Checkpoint CT System

Speaker: Steve Urchuk

A discussion of checkpoint CT screening of divested items with Analogic's ConneCT. Lowest cost of ownership is critical. Minimal components with highly integrated design. Open systems architecture. Proprietary solution is not always the best. We think CT technology is at the foundation of the next generation checkpoint. Starting and stopping causes issues. CT provides more information.

Q: Weapons?

A: Baseline is detection of solids and liquids.

A: None are certified to the new standard.

Q: Operator assist?

A: What do you present to the operator? How do you train them?

Q: Checked baggage CONOPS adopted at the checkpoint?

A: At the moment, but without clarity on how this will proceed. We envision getting the checkpoint to a whole baggage model. There is a sequence of steps. We think that CT is the best enabler to get us to the end state.

Q: To remove objects, you remove it. To insert it, what do you do? Do you use shape? Where do you take the objects from to insert?

A: We have an objects database. We work with different regulators who have objects that they want to present. It's a 3D insertion. You have to put it in the bag, not outside the bag. It's stressful when doing yourself. A large percentage of screeners were able to find these objects.

Q: Which algorithms?

A: Solids and liquids for now. 1 year from now we will have LAGS Category 3 detection.

Q: How do you avoid stopping and starting?

A: You have to be able to stop.

Topic/Title: IDSS Detect 1000 Advanced Checkpoint Scanner

Speaker: Patricia Krall

Discussion of IDSS Detect 1000 CT scanner and CT at the checkpoint. Quality of information and data drives performance. If it is insufficient to segment the bag, you cannot determine mass and therefore, determine what is or is not a threat.

Q: As CT has come down in price size, where is TSA on this at the checkpoint?

TSA: I think TSA sees CT as a very promising technology. The platform provides more opportunity for future capabilities, which is clearly very promising. TSA hasn't made its final decision. TSA is doing technology demonstrations actively working with vendors to see where it goes in an operational environment, because the checkpoint is a different environment.

TSA: 2020 is the schedule for recap of the checkpoint X-rays. Proven out through the ITF to inform the requirements that goes into the next procurement. If we put it into the ITF and it performs spectacularly, TSA may need to do something sooner.

TSA: We have one checkpoint design guide, regarding airport size environment. It may influence how we select and deploy.

C: In the AT field, we want to take the operator out of it, but if you bring in CT, you are now talking about bringing the operator back in.

TSA: Yes, ultimately, the goal is to minimize the operator, but until we can get there, we want to give them the best tools to make better decisions.

Q: Would TSA have the appetite for an AT if it had these capabilities with the operator in the loop?

TSA: Absolutely.

Q: Infrastructure. AT has certain power; footprint. Will you invest in infrastructure upgrade?

TSA: We want to add in more flexibility as we move to CT. We might not put CT everywhere; we probably can't afford it due to structural limitations. Moving away from that one-size-fits-all.

TSA: We are trying to do a better job as airports are doing construction, to advise them of potential infrastructure needs. Are we at 30%, 60% 90%...? They don't want their floors as Swiss cheese. E.g. Bring in power from above. Possibly new floor tech that supports mobile agile designs.

Topic/Title: X-Ray Diffraction Imaging – Achievements and Challenges

Speaker: Matthew Merzbacher

Discussion of X-ray diffraction imaging and new systems based on this technology. New prototype installed at the DHS Transportation Security Laboratory for evaluation, with additional models to follow.

Q: How well does it work?

A: Works successfully in the field.

Q: Do you get the same performance in the field as the previous certified X-ray diffraction system?

A: The new system is fast.

Q: Secondary search, or is it fast enough to be a primary screening device?

A: Checkpoint 10cm / second.

Q: Weapons?

A: Comes with pre-scanners as well. High-resolution.

Topic/Title: Coherent X-Ray Scatter (CXS) for Material Discrimination at a Checkpoint

Speaker: Dan Strellis

Discussion of screening approach that applies coded aperture with coherent X-ray scatter (CXS). Collecting energy sensitive information, depending on where *the energy is presented as a pattern on the detector. Depending on enough reconstruction, you can calculate the spatial parameters. Need to do a lot of data collection, what the signatures are on the X-ray diffraction.*

Still need: High-flux compact air-cooled X-ray sources, efficient 2D detector arrays, GPUs following published roadmap, competitive cost structure.

Q: Is it cost competitive?

A: No, if you look at 620DV and CT that is forthcoming. It can fit in the middle ground, but right now the cost is too high.

Q: What is the region of responsibility in spectrum space?

A: In the end, it's if you detect it or not. We don't have to qualify if our momentum transfer function is accurate or not.

C: Duke University published papers that said that the spectrum is not isotropic.

A: In some areas, it's fine, in others it's not so fine, but it's not horrific. CT has windows too.

Q: It looks like the coded aperture X-ray imaging (CAXI) is being used on all items, or is it queued?

A: Dual energy transmission image to find out where the bag is located, so we use that to prompt which voxels to reconstruct.

Q: Multiple sets of 2D coded apertures – detector pairs?

A: Yes.

Topic/Title: Fast and Reliable Bomb Threat Clearing of Civil Airplanes

Speaker: Mircea Tudor

Discussion of preventative screening of all aircraft entering or exiting service, and how to overcome the challenges of screening an airplane for threats. It is time consuming and expensive, and 20% of the structure is in areas that cannot be physically inspected (e.g. wings).

Q: How powerful is the source?

A: 320 KeV to 4 MeV depending on size of the aircraft.

Q: How fast?

A: Real time as plane goes through the scanning frame.

Q: Can you this equipment on the deicing equipment?

A: No, but only because deicing is done with passengers on board.

V. BEHAVIORAL DETECTION (LYING) AND DETERRENCE

Topic/Title: Transdermal Optical Imaging – A New Frontier of Threat & Deception Detection

Speaker: Kang Lee

Discussion of guilty knowledge detection and deterrence. Guilty knowledge is a test of recognition. Inexpensive; ability to use any camera (e.g. GoPro) for remote and covert physiological data capture: blood flow, emotional related facial clues, heart rate, blood pressure, and stress level (against adult norms).

Emotional status (emotional vs. neutral > 95% accuracy). Based on lab participants who are aware of the test. Emotional valence (positive vs. negative emotions: > 85% accuracy).

Q: What about kinesthetic techniques?

A: Watch the next talk.

Q: Do you see baseline changes between populations? Seasonal?

A: Special processing because of different skin tones; not necessary because we normalize against your skin tone. They want to use this technology to detect depression, so I can’t answer.

Q: How do you know that this is a lie?

A: We are detecting what you know, not deception. Guilty knowledge. Somehow sensitive to the question of bombs.

Q: What if I have a fear of terrorists, but I’m not a terrorist?

A: We can flag you because your response is different and then refer you to someone else to investigate if there is an issue.

Q: Have you done a comparison to polygraph tests? False alarms?

A: Yes, we are looking into this now.

C: Appears to be a reciprocal.

A: Subliminal and superliminal tests, results are flipped.

C: Seeing a picture of a bomb can elicit a reaction that has nothing to do with being a terrorist.

A: Could happen. We need to collect data. Drug smuggling or carrying cash is a high probability event.

ALERT: I think the bomb is too overt. If you show me a bomb, I will be nervous.

A: We aren't showing a picture. Just the word. We did a study to show names. If we show a picture that's gruesome, you might get a reaction from more of the general public. Recognition time is 20 milliseconds.

Topic: Next Generation Screening Starts with the Eyes

Title: EyeDetect – An Accurate, Non-Invasive Technology that Detects Lies by Analyzing Eye Behavior

Speaker: Mark Handler

Discussion of an alternate approach for automated guilty knowledge detection based on eye imaging. It consists of 310 questions, and takes 30 minutes.

Traditional testing for sensitivity of guilty knowledge – field test – has been about 50%. Lab data is good, but overlearning is an issue. 100-150 persons are polygraphed to select one individual to hire. Traditional testing is expensive and to hinge someone's job on something that we're not sure of is concerning.

Q: What about false positives and false negatives?

A: We don't have an inconclusive range. Sensitivity is 83, false negative is 17. False positives 12. Point estimates.

Q: Probability of detection of what?

A: Screening questions are different than diagnostics tests. Talking to TSA's general counsel. Take it on the road. Use it as a deterrent. Prisons also.

Q: Is it impacted by glaucoma or nystagmus?

A: Not affected, as long as the pupil is dilated. If there is a neurological issue where the pupil doesn't dilate as normal. Track the Simon says. Increase cognitive load.

Q: How do I correlate between someone who is lying and a terrorist? If the impact is on throughput at a security checkpoint, then what is the PD and PFA if you shorten it?

A: This is very hard. In field studies, there were very low base rate issues. We make the assumption they haven't done this. On the positive sides, we do drugs. Or failed urine analyses (UAs), or admissions, or hair tests. Very detailed admissions. We use that to establish ground truth. On shortening it—that's going to be the challenge. Thinking about using this as a monitor for refuges.

Topic/Title: Deterrence – Is it Effective and How to Make It Better?

Speaker: Matthew Merzbacher

Discussion of the interplay between detection and deterrence, and the various types of deterrence. Ultimately it has to do with economics – that people are willing to continue to fly. Critical factors: manage culture; perform gaps analysis; do what you intend; and not more or less. Information needs to flow down. Performance flows up. Needs monitoring/auditing.

We do gap analysis and then walk away. We need to do continuous and everlasting gap analysis. Also, when anything changes, new gaps will open up, especially in open architectures.

Big challenges of innovation task force: How to try out the innovation, and why it won't play nice with existing systems. But may be worth it in the long run.

How much information is passed down to the front lines? Are they just practicing techniques and don't know why and where? If you know why, then you will do a better job.

Testing how the system works when you know how it works, or just try and break it.

Catch them when they are on the trial runs, so you will deter because it's too hard to do it.

TSA: Threat shifting? If I can't take down a plane, I'll blow people up in line. If I can't do that I'll pick another threat vector.

A: It's obvious that threat shifting is a tactical practice. Hamburg was flattened. The bombers would go off deep into Germany and if they couldn't accomplish their goal, they will do this instead. I have no answer. It's worth talking about. I would like to see it on the list of topics for some other speaker.

C: That is one of the things that is different between fraud and terrorism. You use that loophole as many times as you can until you get caught. In terrorism, it is one and done, so you need to shift more frequently. You talked about structured openness. I think it should be structured randomness.

A: I don’t think that randomness is bad. If you say “you were randomly selected,” that is okay, and even if we got an indication, that is okay. The PD is unknown. The most successful fraud agents have never been caught or detected.

Q: Can you talk about openness?

A: The more pokes you take, the better you can improve. We are often too careful about protecting sensitive information, instead we should be publishing for more scrutiny.

15.3 Day 2 Minutes: November 16, 2016

I. INTRODUCTION

Title: DICOS 2A Status

Speaker: Steve Skrzypkowiak

Status update and discussion of DICOS 2A, and call for participants. Announcement that the National Electrical Manufacturers Association (NEMA) has waived charges for participation in DICOS 2A.

Q: Have all of the contractors who produce images been invited to respond?

A: Yes.

II. AUTOMATED THREAT DETECTION AND INTEGRATED SYSTEMS

Topic/Title: Adaptive Automated Threat Recognition (AATR)

Speaker: Harry Martz

Discussion of a newly funded project for ALERT to develop algorithms that are dynamic and configurable to help mitigate the lag between initial algorithm development and field deployment to address emerging threats and threat configurations. Instead of certifying per explosive and per machine, can we do it faster? Discussion of a computer readable detection requirement specification, and continuous training.

Q: What data will you use? DICOS or a different common format?

A: The Imatron medical scanner.

C: It takes a long time.

C: It doesn't take that long.

A: Once a threat is added to TSA's threat list, people have to make these materials to test with. They are dangerous. You have to iterate with different threat containers, and run it through different scanners. It's costly, and takes a long time. Instead of certifying each system, certify the process. If we need to get something out quick, it can happen overnight or within a day.

Q: Each of these processes will look at a derivative. You will get a different result on a different scanner, because of the way they reconstruct and filter.

A: We are looking at a system independent feature space. Z-effective space and density space. We've demonstrated it on a lab system and shown confidence. We're working with vendors to discuss.

C: There is no homogenous algorithm across the different vendors. Each vendor will have a different set of features, not necessarily a subset or superset, so trying to provide the feature set of a specific explosive to vendors won't provide consistent performance across each system. You could allow vendors to have a plugin that they would provide.

A: Let's talk offline. I'd like to understand more. It will only be as good as the features that we know you are using. It comes down to these are the features that we are using that they tell you about.

C: You need to consider system geometries. Systems have unique geometries. We may have to have a library of AATRs that are paired against geometry classes. It maps nicely to open system architecture.

A: If we get a call from TSA, we have to detect explosive X. I imagine that performance will be poor. But quickly we can get this out in the field to buy time. We have this list of X number of explosives. You change the weighting of the explosives, then you run your explosives in bags; then you derive features; and then you update the algorithm.

C: I'm not sure this is the right problem. I believe vendors have the ability to develop AATR within their own groups. When the discussions took place previously with TSA on how to implement, they were having problems understanding how they would test, qualify, and deploy.

A: Policy is hard to change. Lisa Dolev [Qylar] is working in the field where there's no specs, or tradeoffs. TSA has to start to make their own decisions.

Topic: Accelerating Certification Testing by Creating an "Instrument Mode" Construct and by Avoiding Lorenz Attractors

Title: Accelerating AIT Certification Tests

Speaker: Lee Spanier

Discussion of schedule drivers for test and evaluation (T&E) activities. T&E is intended to challenge the device under test to a wide array of use cases and environmental factors. Presented the concept of vendors embedding an instrument mode in devices, so that more data can be gleaned per test event, and thereby provide confidence that the data needed by T&E can be obtained while reducing the number of targeted test events.

Example of current timelines: 30-45 mock passengers. Evaluation against existing requirements: 4.5 ~1 month; evaluation against new requirements: 7.5 +/1 month.

Schedule Drivers:

- *Target Development and Validation (Simulants, Phantoms, Threats)*
- *Comprehensive Target Detection Test*

Tools for Acceleration:

- *Test Mode – Save images in very high fidelity.*
- *Image Quality Standards (ANSI N42.59) – speed up approvals of engineering changes & regression test.*
- *Instrument Mode – Design in. Harvest and productize. Deliver continuous information.*
- *Body Phantoms. Repeatability and reliability.*

Q: Why are image quality standards needed? Images are not displayed for AIT due to privacy concerns.

A: Because the algorithms use the image.

Q: If you are going to bring us into your process, it's not discrete. How can you use this for testing if it might be variable?

A: Look at key parameters. Plenty of examples of how this is done: State vehicle inspections. Test access. Printed circuit board (PCB) in circuit test. If I have just 0 or 1, my test is very inefficient. Some areas are stable; tolerant. Other areas have weak detection; high variance. Create a heat map. Some areas have chaotic behavior. As we move to more machine learning. These spots are under sampled, underdeveloped. Starts to look like an attractor.

C: This looks like a great idea. Identify degrees of freedom of some variables that impact detection and false alarm rates.

A: Thank you.

ALERT: These singularities. Have you tried them on live targets?

A: Yes, on people and on body targets.

C: The set of samples is infinite and impossible to collect.

A: It is hard, at least for the time scales that we are talking about.

C: There are simulated methods that you can use which will let you estimate infinity.

A: I don't propose to do a full factorial test. We have customers in the GAO and we have to work to achieve those targets. I can't deliver +-10%.

Q: You have a comprehensive spec that discusses body types, materials and sizes. As a vendor we design to this multifactorial space. When you start looking at precise scenarios that goes beyond the spec. How do you derive action out of those? There is too much variability but you pass the overall spec. What is the end goal?

A: Instrument mode will find its way into AIT field requirement specifications.

Q: Is this supposed to reduce the overall test time?

A: Yes.

Q: Do you know how much?

A: No.

Topic/Title: Zero-Shot Learning

Speaker: Venkatesh Saligrama

Comparison between traditional learning techniques and the need for a different approach when faced with insufficient training data for new classes of targets. Discussion of an approach to predicting classifiers for new classes: cross apply the latent structural thematic properties of known classes as context in order *to identify windows for new target classes. Applicable to homemade explosives (variability, new materials) and video forensics (suspicious activity detection).*

[*Due to time constraints, interested parties were invited to follow up with the presenter directly*].

Topic: HME Simulant Development and Validation

Title: Simulant Verification and Validation

Speaker: Robert Klueg

Discussion of how simulants can be applied as surrogates with confidence. S&T has funded a project to document Independent Validation and Verification (IV&V) for simulants.

We can use simulants, but we need to be able to verify that we can detect the real thing. We don't know your feature sets.

Can we give you images of real and simulant; and if you can't tell the difference. Can you provide feedback where it doesn't match without identifying the feature?

Can you bin your machine learning features into larger bins so that you can provide input to the government? Particle size, etc…

C: You are dealing with a problem further down the process tree than you need to, and you are making it more difficult for yourself than you need to. When you are talking about image sets, you aren't dealing with items derived by a vendor. The machine is making a measurement. If you give the characterization of the material as a measurement, you have a cross cutting piece of information that all vendors could give you back.

A: Yes, we want to provide. We run into trouble when we talk about texture. If we were able to produce a simulant that mimicked the elemental composition and the mass, would that be enough?

Q: The properties of the real material…then they can take that data and derive their own features from it.

C: Emerging tech needs more specific information. E.g. Quadrupole resonance. There are no simulants. What do you do about that?

A: Molecular spectral specific is tough. We are starting with X-ray and look for a process that is portable to as many modalities as possible. We have a team that is looking at processes for other modalities. Perhaps we need to use simulated data, or change the diffraction data. It's on our timeline.

Q: Since HMEs are expensive and dangerous to synthesize and test, terrorist shouldn't use them?

A: Our adversaries are less risk averse than we are. We need something that is stable or robotics to use the real material. That may limit the range of test scenarios. Allows the government to compress that timeline.

Q: Why is defining texture so difficult?

A: The definition of texture varies by what gives you texture and how you measure it. Is there some higher level feature? Can we look at higher level features (particle size, average particle distribution, attenuation…) that we can then go down that path of matching the simulant to the explosive? What are our tolerances? How close do those need to be? The government can't give you thousands of images.

Q: Are you going to provide images of simulants along with explosives images?

A: You can do your own corner case collection.

Q: We did a lot of work with HMEs and developing simulants. The challenges is the feature set is broader than seen in homogenous explosives. E.g. Crystal size. Infinite number of variations. How do you deal with this?

A: We expect to define the simulants in the same way that the explosives are defined in the spec. Supplemented with detection windows that are based on specific formulations. Use this to bound that space.

Q: How long does it take to develop a simulant?

A: Weeks, if we have the spec, and confidence. Matching Z and electron density is done very quickly. Getting the particle and texture distribution to match takes 3 months.

C: To make a simulant that may be system specific.

A: We don't want to do Independent Validation and Verification (IV&V) for every algorithm change. That is why we want to look at global features that the vendors can then derive the features that they use for detection.

C: I like simulants, however my experience is that they don't simulate explosives very well. They are far easier to detect. When using simulants, one should under match, not overmatch, and be able to vary the simulants just to see if you are near a cliff (i.e. Is my detection dropping precipitously or degrading gracefully?).

A: So you want dials?

C. Yes.

Topic/Title: A Generalizable Radiography Algorithm Test Environment for NDE Applications

Speaker: Andrew Wantuch

Discussion of a fast, automated, open architecture test environment to test and compare performance of 3rd party algorithms, separate from the scanner, and with standardized metrics.

Q: How many images with ground truth do you need to build an effective algorithm?

A: We have 2000 images, some with targets and some without targets. Presently, it is for one type of explosive, and we will add more.

Q: Realistically, you need more than five, and it may not be truly representative of how a terrorist may be hiding it. It's taking more time than algorithm development.

A: We agree with you. We want these tools so that we can run parametric comparisons. We treat that as an open question.

C: We are finding that segmenting and labeling images to be very time consuming.

A: The extent that we can automate this stuff will help.

Q: Does this algorithm need to know the geometry of the system, or source placement?

A: This is a testing platform for exercising algorithms.

TSA: Who would we buy from? Would we buy each individual part? Would we go to a third party?

A: There are a lot of business model uncertainties. We don't know yet.

C: The objective is to establish a consortium to figure these things out.

Topic: Deep Learning Overview

Title: Deep Neural Nets (& Security) from ZIP codes to Autonomous Vehicles

Speaker: Matthew Merzbacher

Discussion of deep learning domains, implementations, and applicability to security.

A: There are several challenges including: Automated & Tunable. There is no transfer function, and no explanations or understanding of why. Small and thin features tend to be challenging.

Q: How difficult is it change the weights?

A: Too many weights becomes computationally impractical and results in over fit. It requires a lot of training data. You have the vanishing gradient problem. Because you are doing back propagation from the outputs back towards the front, you train the end effectively, but it's hard to push them to the front, and that is where the early decisions are being made. The answer is deep learning; abstract the layers, which may or may not match the brain.

Q: What is the required training data set for neural nets vs. others?

A: There is a lack of a clear explanation system.

Q: Can we look at stream of commerce and train on that?

A: Localization of false alarms. A salmon identifier just for us. This presents a testing conundrum. It is hard to sell regulators on "trust us." It needs to degrade gracefully.

Q: Are there studies that tell which classifiers are accurate and most suitable?

A: I don't know of any. There is a paper by Merzbacher and Gable that talks about learning and voting. Yes, there should be an appetite for this. How do we share the data with the general machine learning community?

Q: How do you prevent training on illegal features like shape?

A: The same way you stop your hand developed algorithms from training on illegal features. You have to try and validate that they aren't doing that. You can test for that. I come with test cases. That is not fair. Yes, of course it is fair. I'm the bad guy.

C: You really don't know how these work, so you can't know how to break it. You can try and inspect the features and attack the features.

Q: Recent work shows that they are very fragile. If you perturb it gently, it will misclassify.

A: Correct. It's not to detect explosives. It's to validate that items that are safe to get on the plane. If I don't know what this is, I can still alarm and push the problem to the next level.

Topic/Title: ALERT Review

Speakers: Laura Parker and Doug Bauer

Discussion of the review of the ALERT Center of Excellence, and capturing impact, success stories, and lessons learned.

C: The focus is on transition, unlike the National Science Foundation (NSF). It is to see how ALERT has impacted the community to support TSA's needs, such as security effectiveness (more threats, smaller sizes); and operating efficiency (throughput, automated screening – more efficient with the resources). Some of the activities of ALERT have contributed to that in describable ways. Customer satisfaction (Has the travelling public's process through the airport been made more congenial or problematic and what have we done to make it better than it otherwise would have been?) and cost (Have we reduced the cost to the government, traveling public or others?) are other factors. Please provide case studies, commentaries, and observations. We've had 15 ADSA Workshops. Where do we go from here? We are writing a report.

Q: Is the information supplied to you confidential? How will you handle information about vendors that people want to keep quiet?

A: Yes, it is confidential.

Topic/Title: Estimation and Detection Information Tradeoff for X-Ray System Optimization

Speaker: Johnathan Cushing

Discussion of EDIT Curves and Stochastic Bag Generation. Transportation Security Equipment (TSE) needs to both make a nice picture for the operator and also capture the core features properly. There is a tradeoff between detection and estimation metrics. Consideration of the environment to calibrate the scanner appropriately; based on optimization of the average cost function.

Q: What is the definition of detection and of estimation?

A: Left open to what the user wants to use. Detection is if you go by cost in a general term; probability of error. Estimation is how good you are at making a picture so that an operator can find a threat.

C: Detection is true positive. Estimation is quality of the image. I don't understand how you use the curve.

A: We find ourselves limited by the photon budget. Several different exposures will help detection; longer exposure will provide a better image. Multiple detectors for short exposures, long exposure for better reconstruction.

Q: What were the decision variables?

A: We have a few different ones.

Q: How did you do detection?

A: We did it on raw data space, not on images. Reconstruction cannot increase the information that your data has.

Q: How did your classifier work without features?

A: Divergence between two probability density functions—testing and training. Training for a threat being present, then a different set for training being absent, using a Bessel function approximation. You can use AUC (Area Under the Curve).

Q: What physical and electronic effects did you simulate for stochastic bag generation?

A: We just had absorption. Scatter was not ready yet. Just a proof of concept.

Q: Simulation is now going to the physical machine. Why?

A: Fixed machine. To determine how much angular adjustment you can do and get the same performance for CT.

Q: Vertical access is unclear in the EDIT curves plot.

A: Generated data to reconstruct what the density was for the object, and use the training data to reconstruct what the priors are.

C: Your data is always bounded.

Topic: Integration of Bottled Liquid Scanners and Electronic Scanners in the Innovation Lanes

Title: Checkpoint Technology Enabling Effective Screening of Bottles and Portable Electronics

Speakers: Pablo Prado and Tim Rayner

Discussion of how an integrator can successfully work with a system vendor to address the challenges of the deployment environment. As passenger numbers increase, facilitation becomes extremely important. Together, with the design of the machine to focus on security (i.e. detection), each system will need to be integrated into an automated integrated screening lane, almost ubiquitous at the large hubs. A standalone box doesn't really help, because it's more than just bin return—it needs to follow the full process for the passenger from divest to recomposure.

Perspectives:

- *Passengers don't want to stand in long lines and displacement is a concern.*
- *Airlines want passengers to get through the process and not delay the plane.*
- *TSA must manage rostering and staffing levels.*

Efficiencies are needed to help TSA cope with increasing from 240 to 720 images per hour per lane.

TSA: These figures are not TSA figures. TSA does not disclose the number of TSOs, or detailed statistics about the checkpoint per lane.

C: Interesting radio-frequency identification (RFID) on trays. Does it allow the security system to aggregate the passenger's multiple bins?

A: Yes, and also correlation with checked baggage.

TSA: Did you look at any other vendor?

A: Herbert and Scarabee, and Dynamics. ORS has only worked with MacDonald Humphries.

Q: Do you know down to the meter where the bins are?

A: Within a few inches, as the objective is to ensure that the tray is diverted properly.

RFID readers are at critical points, but not constant tracking. Gatwick added bodies – 8-10. They were not running lanes with 5 screeners.

TSA: TSOs per passenger is the metric going forward for cost benefit analysis.

Q: Are you aware of lanes that aren't just divest but also parallel recomposure?

A: Right now, the value is just to make the reclaim area as long as possible, rather than direct trays back to passenger stations.

Q: I went through Heathrow and they only have four stations. Have you done an analysis on the optimum number of stations? It was backed up, and alarm resolution was about 35-40 minutes.

A: Heathrow is unionized and Gatwick is not, so Heathrow limits the number of staff and Gatwick does not. Gatwick has employed remote screening. There is parallel divest in a non-remote environment helps but also contributes to issues as you are constrained by the single viewing station.

C: Part of the issue was all the stations were stopped.

A: The key is to evaluate each step in the process, so you can push the bottleneck away. That is the challenge.

TSA: The other key issue is the divestiture officer talking to one person right before they enter the X-ray. Broadcast, watching multiple people rather than one-on-one. How we train officers; how many we deploy; skillset training; and communication. If you don't communicate well, it will increase secondary searches. Are you going to talk about serial lanes, because they can also be automated?

A: We are highlighting a success story: Understand the elements of integration. The lack of space on the search station. The bottle liquid scanner (BLS) has been integrated into the MacDonald Humphries system. They have bins piled up because they didn't have space. Optimization of every step. Integrating alarm resolution and secondary search into the ASL is key. Need recognition that their devices will need to be integrated into an ASL, so make it so that it can be integrated. Don't fight the open architecture, or the OTAP, as it's inevitable. The box is just the sensor, it's just data following.

III. AIT ALGORITHMS

Topic: AIT Opportunities and Challenges

Title: Improved Millimeter-Wave Radar Concealed-Threat Person Scanning

Speaker: Carey Rappaport

Discussion of distinguishing concealed threat on the body and rejecting non-threats, and doing so on the move. Apply cross-sensor cooperative multistatic mm-wave radar and algorithms for exploiting depth information.

Q: Why wasn't it done before?

A: I don't know. But I have patents on it.

Q: Algorithmic or hardware.

A: The first is algorithmic, the second is hardware.

Q: We saw a screening at speed type solution, how is this different?

A: You mean the Evolve? We are looking for things on the order of centimeters.

Q: Have you thought of some approaches to address naturally concealed areas (armpits)?

A: For line of sight systems, if you block the line of sight, then…Perhaps on a moving sidewalk, if you have people hold onto moving handrails.

Topic: Ray-Based Modeling for Material Characterization

Title: Ray-Based Model for Material Characterization Using Mm-Wave Scanner

Speakers: Mahdiar Sadeghi, Elizabeth Wig, Carey Rappaport

Discussion of accurate characterization of anomalies detected in mm-wave to rule out explosives and reduce false alarms. Apply a ray-based model for material characterization using mm-wave; fast and non-iterative. Characterize material properties (thickness, dielectric constant) of potential threat materials.

Q: If this is installed, how much will this cost?

Q: This is a ray-based algorithm. Are you getting amplitude?

A: Yes, we are getting varying amplitude, vary, we normalize them to 100, because we were comparing it to the actual scan. It depends on the angle that someone is standing at which is out of the control of the algorithm, which makes it difficult to analyze. There is also the reflection coefficient which changes the amplitude.

Q: Is your algorithm robust to the cost where you may have a rough surface and your foci might be weaker?

A: We considered a flat surface.

Q: You have a standing wave. You have some width of your response. Is it the envelope of the standing wave or just one modulation?

A: These are the response at each standing wave. The total response is the incident ± the scatter. You just subtract the incident.

IV. TRADE-OFFS AND SOLUTIONS

Topic: Safety Act - Specifics for Small Businesses and Academicians

Title: The SAFETY Act and Business - Protecting You and Informing Your Customers

Speaker: David Paquette

Discussion of the SAFETY Act. The main purpose is liability risk mitigation, which caps liability in the case of third party claims to avoid discouraging innovation and deployment of anti-terrorism technology and systems. The SAFETY Act Office has partnered with government agencies (e.g. TSA, CBP, EPA).

Q: Do resellers qualify?

A: A reseller can receive the downstream effect if the supplier attains approval. However, if you value add onto that technology, but the product you are selling is an integrated solution, the downstream safety act protection does not apply, and you would need to lodge your own application for approval.

Q: Has the processing period sped up? What is the anticipated processing time to get to designation or certification?

A: 120 day deadline. We are on average 115-117 days. Block designation requirement is to process within 90 days.

Topic/Title: Trade-Offs to Increasing Security and Adding Checkpoints

Speaker: John Mueller

Discussion of how to measure and assess aviation security. How safe is safe enough, and how safe are we? Airline passengers are extremely safe from terrorism. There is a diminishing return from investments: Even if measures were cheap, and 100% successful, it would only make sense if the risk was 100x higher than it is today. How much should we be willing to pay for a reduction of risk for some where the probability is extremely low (e.g. The Federal Air Marshall program costs more than $1B/year if you include the cost of first class tickets).

Q: Slight improvement in risk reduction for 50% passengers in pre-check?

A: There are three assumptions: 1) 50% pre-check: How many passengers are terrorists?; 2) Assume 1/100 million. Number of airline passengers is 700 million, so we assume 7 terrorist attempts; and 3) Assume 25% likely to catch a terrorist and pre-check goes to 20%. Or assume 5% for regular, and then pre-check is worse, then it's a fraction of a percent decrease in performance.

Now there are more people who are skipping short hauls. 500 additional people are dying on the roads. If 50 people are back to flying, $7.5M per person results in additional return on investment.

Q: Does your work address the value of deterrence?

A: Yes, we try to estimate deterrence and disruption for each layer.

ALERT: How does this compare to other risks in society?

A: Americans' risk is 1 in 4 million for any kind of terrorist. Since 9/11, it is 1 in 80 million vs. 1 in 80 thousand for car crash death.

Q: Is there a price benefit? If the chance of being killed by a deer is higher, how much money can we save on death by deer instead?

A: Vanderbilt has done research on cost per saved life. Should we require people to have seatbelts in the back seats of cars? Back seats are relatively safe. If we put in seatbelts, how many lives will we likely save? Some may not wear them (and the cost of the security measure), but they only require them in new cars. The problem with retrofitting an older car is that it is very expensive. It's worth it in new cars, but not old cars. These are the decisions, since you don't have infinite money. It's incumbent upon public officials. Smoke detectors $100K/saved life.

Q: FAMS are being replaced with another countermeasure. A huge flaw, retrospectively, looking forward, if you made security disappear including the vetting process for immigrants. Would our chance remain 1 in 100 million? That is not a defensible position. Why would we assume that terrorists would not be successful if there are fewer barriers? This is not a frequentist problem. Your work does not take into account all of the quantifiable costs, but political leaders make decisions on public sentiment. People have fears of risk where they don't have control. They aren't making expected value calculations. From the perspective of policy makers, if people are more worried about terrorism, should we value it higher?

A: The issue is public safety. There has been a huge increase in homeland security, and it hasn't increased people's confidence. If you have a fear problem, then maybe you should get an army of shrinks.

Topic: Solving TSA's Problems Using an Exercise in War Gaming

Title: Improving Aviation Security Through Scenario-Based Gaming

Speakers: Graeme Goldsworthy, Diederik Stolk

Discussion of war gaming as an effective tool for risk management planning for TSA. Adversaries have the initiative. We are on the defensive. To be permanently on the defensive is debilitating for morale and expensive. War gaming is a tool to enable a more pro-active approach in defenders.

[*Live Demonstration: Group activity with scenarios. Attendees were broken up into groups and asked to address the scenarios.*]

A: What happened? A lot of dialogue, confusion, destruction, misinformation, and extraneous information. Many variables and many solutions. If you bring all the actors together in a modeling environment, you can get massive gains in a matter of day at low cost for simple scenarios. We use this for defense procurement. If we bring multiple stakeholders around the table and game it, we can identify trends, and learn to fail without costing anyone lives, or costing anyone money. TSA did not participate. Explain to TSA. Gaming allows you to identify things that you didn't think of. Allows you to get into the mindset of different stakeholders. Different actors that you didn't think of before. You cannot be on your own in this particular complex system.

C: I spent a considerable amount of time in war gaming. Nimitz. War gaming is quite useful in training, and helped in the Pacific, with the exception of Kamikazes. How do you leave room for the unanticipated, except the shared imperfect knowledge that we have today?

A: The way we do it is repeatable. The process has to be dynamic and repeatable.

V. EMERGING HARDWARE AND ALGORITHMS

Topic/Title: Photoacoustic Sensing of Explosives (PHASE)

Speaker: Robert Haupt

Discussion of approach for standoff characterization of explosives for close proximity applications with the potential to be extended to mobile aerial platforms. Applied UV interrogation vaporizes trace residue to generate an acoustic signal which can be detected through laser vibrometry and characterized.

Q: Can this cause detonation?

A: No.

Q: How much power?

A: Low.

Q: Have you tested this with artful concealment of explosives?

A: Even with a 5th generation transfer there will be residue.

Q: Scan rate? Field of view?

A: 3-4 mm spot size. Can use multiple spots individual beams.

Q: What are the distance for your results?

A: 1 meter away.

Q: How do you detect it? Receive side measurement of the Doppler shift?

A: We can put this on a static and moving platform. We use a laser Doppler vibrometer and an optical excitation source (deep UV pulsed laser 266 nm).

Q: 266 is not eye safe.

A: At the fluency level that we use (very low), it is. We have a path to work below the dose limits. There is absolutely no burning risk on the retina. It's a single pulse. The standard is 3mJ/cm2 per work day.

Q. What about the adhesion between molecule and surface?

A: It is an intrinsic property of the explosive. Release the stored energy into an acoustic wave.

Q: Do you see a potential application as an orthogonal with additional specificity to detect an area of interest and have another technology interrogate?

A: You can have a queued scan.

Q: What about one at the front end of a CT?

A: Yes, you can do that.

Q: What is the field of view?

A: You can have a very rapid scan. Multipixel scan. It will look instantaneous to the eye. It doesn't matter.

Q: This seems too good to be true.

A: This sounds like the perfect system. We believe we've come across the phenomenology that we can exploit. The question is once we go into the real world, how will it work?

A: We have a path towards eye and skin safety, but there is work to be done.

Q: Any other limitations? Other than safety?

A: Getting something that is consistently safe is our biggest challenge. There are certain diffusers. Rich in nitrogen, have to look in comparison to explosives.

Q: In terms of cost, do you have a projected cost for a 10m or a unmanned aerial vehicle (UAV)?

A: $20K to buy sources – $30-50K final cost.

Q: If you have a lot of explosive material in the soil, you will get a lot of false alarms.

A: There is a certain saturation point. At 100 nm the signals drop in amplitude. Mass is 1 micro-gram. High frequency, low acoustic clutter (below 20KHz). ½ MHz range. The background clutter has been quantified. There should be a discernable signal above background.

Topic/Title: Compton Scatter Imaging

Speaker: Eric Miller

Discussion of an approach for improving detection performance for severely limited view systems. Apply iterative reconstruction methods fusing traditional absorption data with Compton scatter photons. Improved imaging leads to improved material maps, which leads to improved detection. University has partnered with AS&E

Q: Are photon counts an issue?

A: Yes, as with all scatter detection systems.

Q: Are you mainly using dual energy?

A: We assume the detectors are energy resolved. Bins of 4KeV. It would be nice if the source were energy resolved as well.

Q: The straight ray has the Compton and photoelectric.

A: Propagate the scatter. We will have to see how much multiple scatter there is.

Q: How about attenuation too?

A: Attenuation is accounted for along those lines. If it is incredibly attenuating, there is only so much you can do, but I think it's being accounted for.

Q: What was the cost function that you've used?

A: It's a typical data mismatch terms with some regularizers. We assume the photoelectric is zero to begin with. We first recover density, and apply an edge preserving regularization scheme. We reconstruct from a gross scale to a fine scale.

Q: Did you apply any enhancement filtering?

A: No.

Q: How many energies?

A: 10 for the simulations. 100 for the Multix.

VI. VIDEO TRACKING OF PASSENGERS AND DIVESTED OBJECTS

Topic/Title: Attribute-Based Searching and 360° Surveillance Video

Speaker: Cindy Fang

Discussion of attribute based searching and 360-degree surveillance. Topics discussed include:

- *Developed 360-degree camera, seam calibration.*
- *For attribute based search, developed probabilistic image interpretation using the following functions: Person detection and gender classification; motion detection; Foreground modeling; Background subtraction and Break down into body zones.*
- *Capability to define parameters such as the color of a passenger's shirt, and it can search through all the video and find where they came from and where they went. A general search term will result in a lot of false alarms. If you down select from the search results to filter, it will re-perform a more restricted search. Data was hand truthed.*
- *Demonstration was installed as a chandelier fixture in the middle of Terminal A of Logan Airport (BOS) with perfect sight lines and unobstructed view. Lighting conditions, motion, different cameras, and reacquisition are all areas of research. Works better indoors where lighting is consistent.*

- *Example of Academia partnering with Industry to fulfill S&T sponsored projects.*

Q: Are there restrictions on distributing this data?

A: This is a public area, so we don't need consent from passengers.

Q: What feedback did you get from the FBI and DHS?

A: They were amazed by the image quality (back in the day).

C: This camera is 10 meters high.

A: Placement is key. Line of sight is very important.

Q: Cost per unit?

A: Trying to bring the cost down to $20K.

Q: Can you manage multiple feeds off the same camera?

A: We had 2 terminals. Live and looking back.

Q: Including the fisheye view?

A: Yes.

Q: Processing time?

A: Yes, fiber bundles. Compression is done on the server side.

Q: Cost?

A: You can imagine going for a 180° camera and sticking it on a wall to reduce cost.

Q: Storage, length of time, and how long are you taking it up?

A: 240 megapixels using JPEG-2000 10:1 compression ratio. 1TB. 8 frames per second.

Q: Have you thought about quickly screening through the data?

A: Different agencies have different needs.

Q: Is this a fisheye lens?

A: The fisheye is a stitched view. You can use a cylinder view.

Q: How did you calibrate?

A: Each camera overlaps by 100-200 pixels. Calibration is an offline task. Uses 6 points.

Q: Have you considered 2 systems, to capture views around a corner?

A: This is our first prototype. We are working with our commercialization partner to explore different view.

Q: Why not bring it down to 1 frame per second?

A: Operators are used to 30 frames a second.

Q: What are the holes?

A: Each is the lens of a standard camera. At the time there was not a 240 element focal plane. Academia is partnering with Industry to fulfill S&T sponsored projects.

Topic: CCTV+Video Analytics-Based Passenger Flow Management System

Title: Airports Optimized by CrowdVision - Video Based Pedestrian Analytics

Speaker: Shawn Dagg

Discussion of using CrowdVision's approach to using computer vision to do the counting including queues, occupancy, flows, density, asset utilization, and dwell times. Provides narrative through divest and recomposure. Can understand the whole process and optimize, including where TSOs are placed. Differentiates between people and wheelchairs, roller bags, etc… Uses COTS cameras and fisheye lenses.

Q: Are all head coverings white?

A: The algorithm takes into account hats, head coverings; anything that affects how the head and shoulders looks.

Q: Do you retain all of the video?

A: We use a fisheye, and once converted into metrics, we lose the video. We can keep a window of video for spot audits.

Q: Pan Tilt Zoom (PTZ)?

A: We cannot use PTZ, as we need a fixed view for our analytics. $400-500 range. The cost is negligible. Security doesn't like to share cameras. The higher quality, the better. We track vector (direction and velocity).

Q: Do you track and identify people if they leave the scene?

A: No.

Q: Is it just overlapping views?

A: Yes, we stitch them together into a single scene.

Q: Head and shoulders determination from a single camera or benefit from multiple cameras?

A: Only from a single camera. We are not stitching for display purposes, so it doesn't have to look as nice; just for tracking purposes. They have to be calibrated. Airports are a controlled environment. Lighting conditions (a lot of airports have natural light). We captured utilization to see how many divest stations there should be. 5 is optimal. Beyond 5, there are diminishing returns. 7 is too much. Each one is 1 meter, so move from the front to back. Efficiency at check in desk or kiosk.

Q: Did you measure the back end?

A: 25 meters. 80 feet.

Q: Do you count the TSO?

A: Yes, we can subtract that. Based on uniform.

Q: Is there a way to track the number of trays or bags per passenger as you change CONOPS?

A: That is a future development for us.

Q: Do you measure the effectiveness of TSOs in the airport?

A: We can measure the throughput down to a specific lane or step in the process. Pat-downs, secondary search, divest, and reclaim. When a lane is operating and not operating (start time, end time). It can be correlated to who is working in what lane.

TSA: Can you identify when one lane is more efficient than the other?

A: Yes, we generate automated alerts.

Topic: M&S/HD Animation (Ani-Sim) in Checkpoint Security Technology

Title: Using High Definition Animation in Modeling & Simulating Emerging Checkpoint Security Systems That May Require TSA Funding Support for Facility Modifications

Speaker: Rodger Dickey

Discussion of using high definition/high fidelity modeling techniques to capture, simulate, and project options and impacts.

Q: Are there proscriptive standards for what needs to be presented in the modeling and simulation results for TSA review of proposed screening deployment solutions?

A: Yes.

Q: Are there certified tools?

A: No.

Q: Is TSA willing to share more information?

A: Yes.

C: We need something like that for the checkpoint.

16. Appendix: Presentations

This section contains the slides presented by speakers at the workshop. The slides appear in the order that talks were given as shown on the agenda. Some of the presentation slides have been redacted to ensure their suitability for public distribution.

PDF versions of presentations can be found at the following link: https://myfiles.neu.edu/groups/ALERT/strategic_studies/ADSA15_Presentations

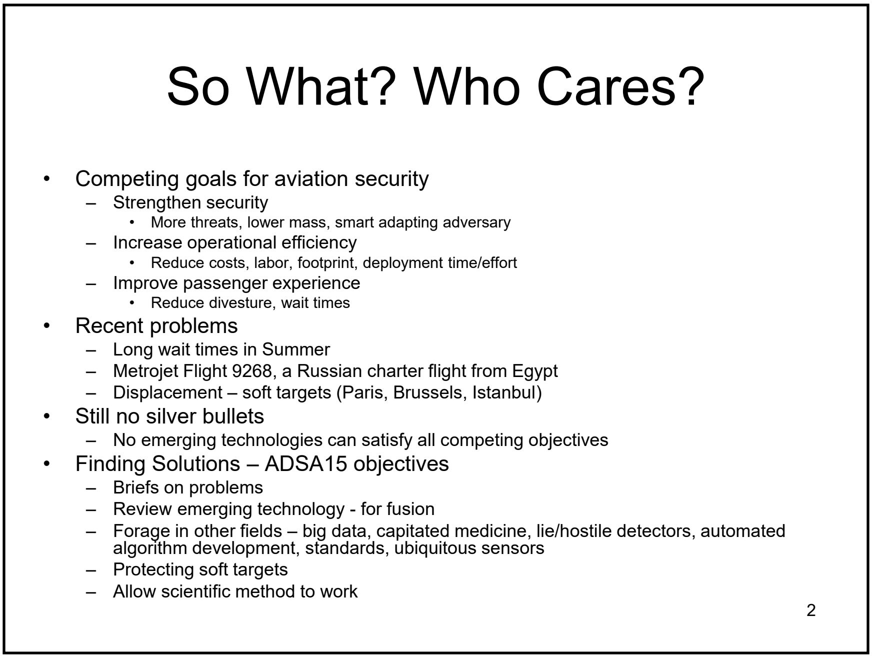
16.1 Carl Crawford: Workshop Objectives

Fifteenth Advanced Development for Security Applications
Workshop (ADSA15):

Next Generation Screening Technologies
and Processes for the Checkpoint

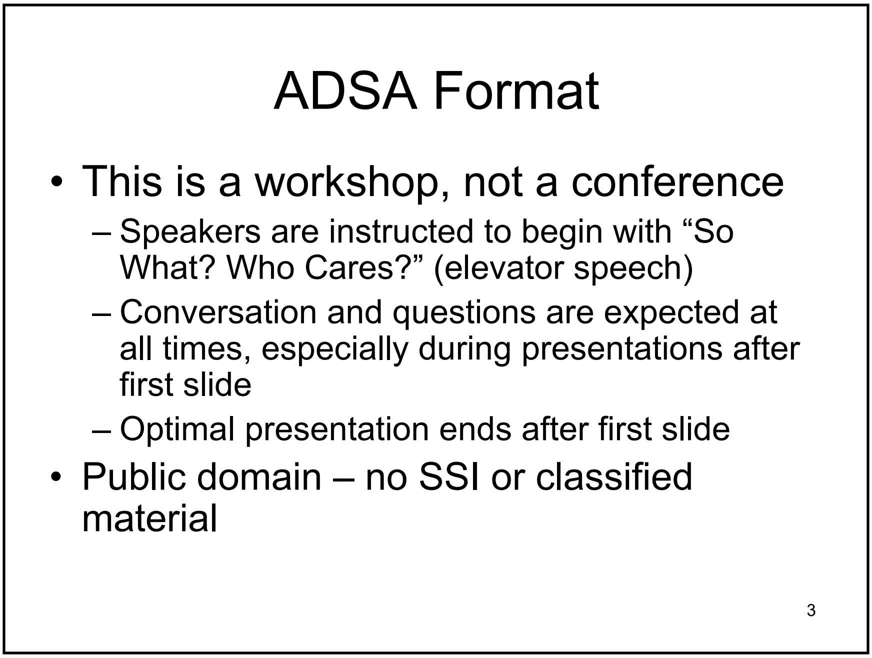
Workshop Objectives

Carl R. Crawford
Csuptwo, LLC



So What? Who Cares?

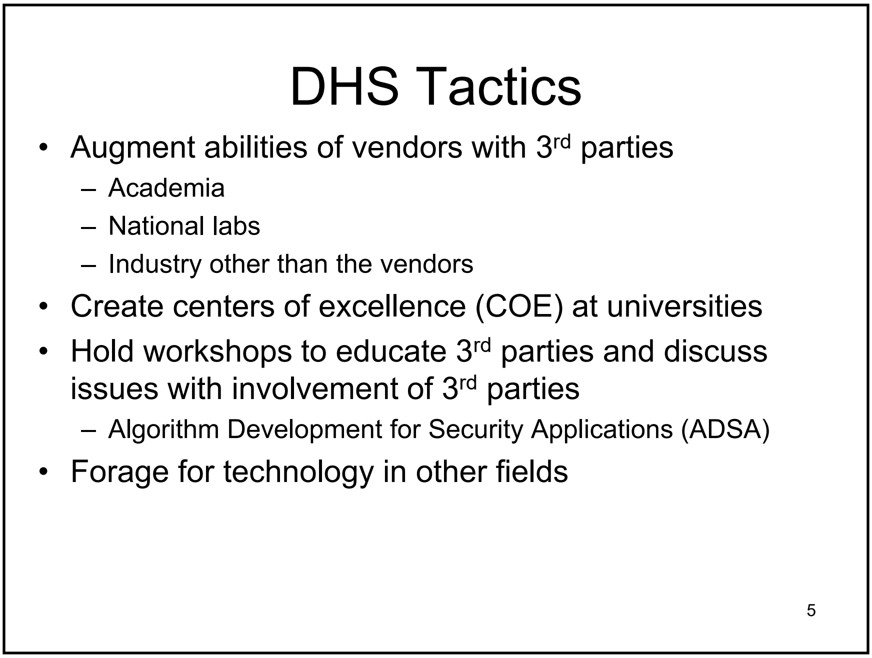
- Competing goals for aviation security
  - Strengthen security
    - More threats, lower mass, smart adapting adversary
  - Increase operational efficiency
    - Reduce costs, labor, footprint, deployment time/effort
  - Improve passenger experience
    - Reduce divesture, wait times
- Recent problems
  - Long wait times in Summer
  - Metrojet Flight 9268, a Russian charter flight from Egypt
  - Displacement – soft targets (Paris, Brussels, Istanbul)
- Still no silver bullets
  - No emerging technologies can satisfy all competing objectives
- Finding Solutions – ADSA15 objectives
  - Briefs on problems
  - Review emerging technology - for fusion
  - Forage in other fields – big data, capitated medicine, lie/hostile detectors, automated algorithm development, standards, ubiquitous sensors
  - Protecting soft targets
  - Allow scientific method to work



ADSA Format

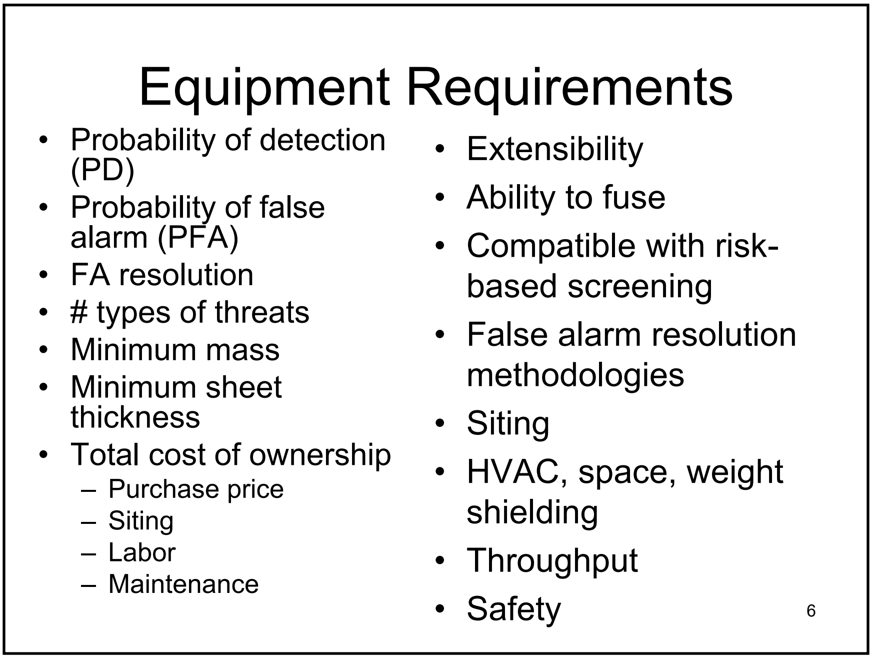
- This is a workshop, not a conference
  - Speakers are instructed to begin with "So What? Who Cares?" (elevator speech)
  - Conversation and questions are expected at all times, especially during presentations after first slide
  - Optimal presentation ends after first slide
- Public domain – no SSI or classified material

BACKUP SLIDES



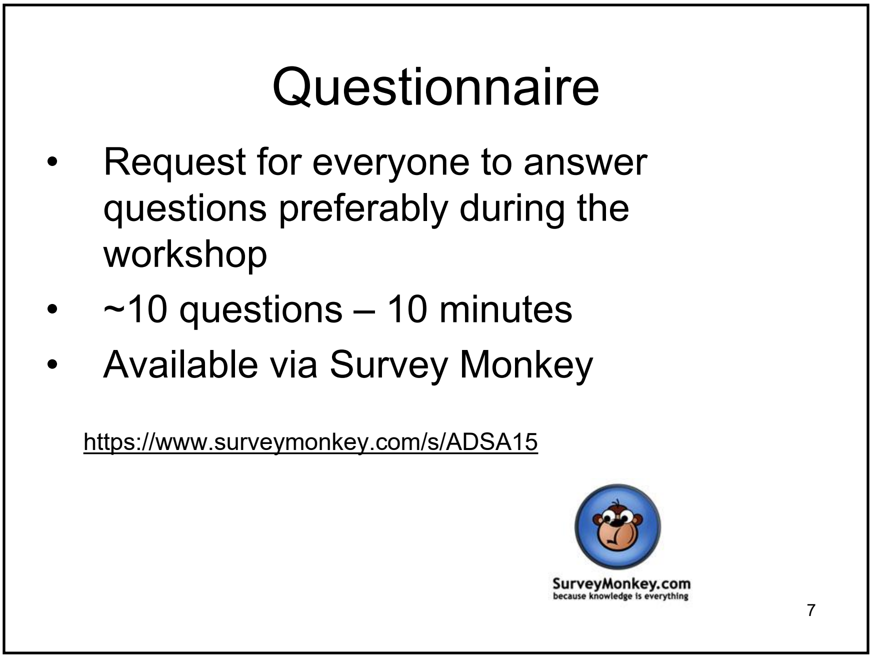
DHS Tactics

- Augment abilities of vendors with 3rd parties
  - Academia
  - National labs
  - Industry other than the vendors
- Create centers of excellence (COE) at universities
- Hold workshops to educate 3rd parties and discuss issues with involvement of 3rd parties
  - Algorithm Development for Security Applications (ADSA)
- Forage for technology in other fields



Equipment Requirements

- Probability of detection (PD)
- Probability of false alarm (PFA)
- FA resolution
- # types of threats
- Minimum mass
- Minimum sheet thickness
- Total cost of ownership
  - Purchase price
  - Siting
  - Labor
  - Maintenance
- Extensibility
- Ability to fuse
- Compatible with risk-based screening
- False alarm resolution methodologies
- Siting
- HVAC, space, weight shielding
- Throughput
- Safety

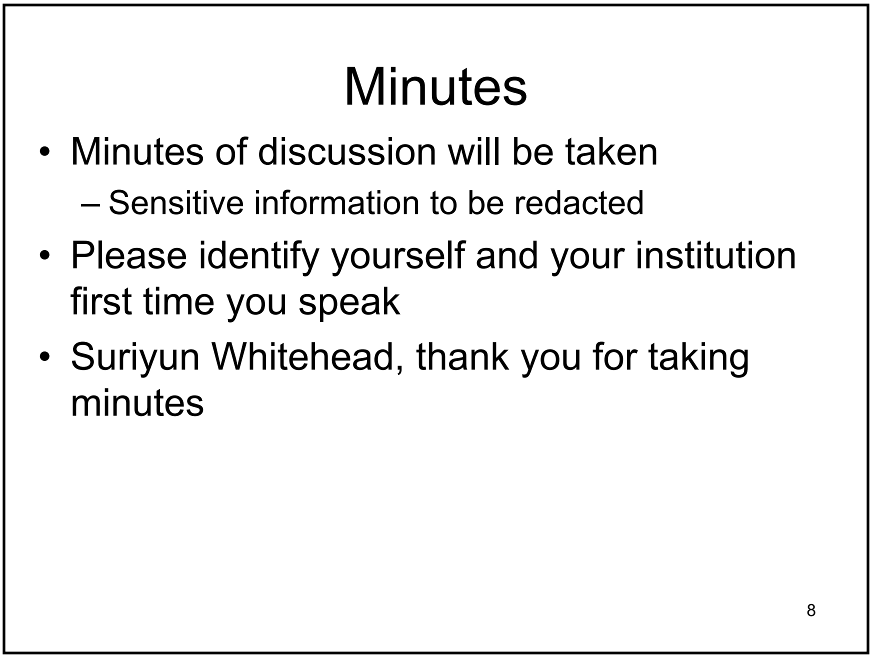


Questionnaire

- Request for everyone to answer questions preferably during the workshop
- ~10 questions – 10 minutes
- Available via Survey Monkey

https://www.surveymonkey.com/s/ADSA15

SurveyMonkey.com
because knowledge is everything



Minutes

- Minutes of discussion will be taken
  - Sensitive information to be redacted
- Please identify yourself and your institution first time you speak
- Suriyun Whitehead, thank you for taking minutes

Archival Materials

- Final reports and presentations from previous ADSAs
- Final reports from projects to CT-based EDS
    - – Segmentation
    - – Reconstruction
    - – ATR

https://myfiles.neu.edu/groups/ALERT/strategic_studies/

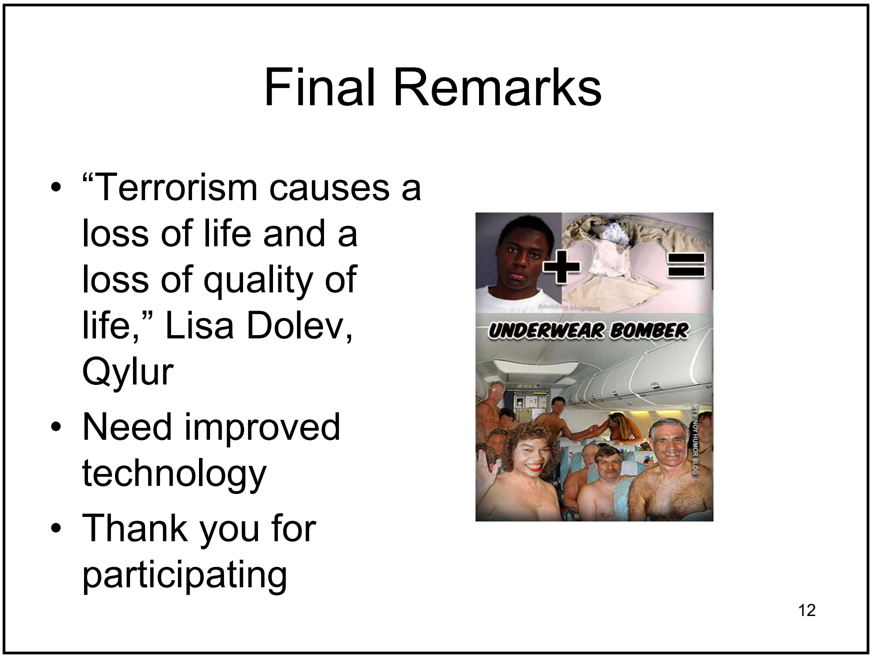
Acknowledgements

- Northeastern University (NEU)
- Awareness and Localization of Explosives-Related Threats (ALERT) DHS Center of Excellence
- Department of Homeland Security (DHS)
- Presenters
- Participants

Logistics

- Melanie Smith, lead
- Deanna Beirne
- Kristin Hicks
- Anne Magrath

Let them know if you need support during or after workshop.



Final Remarks

- “Terrorism causes a loss of life and a loss of quality of life,” Lisa Dolev, Qylur
- Need improved technology
- Thank you for participating

16.2 Keith Goll: Systems Architecture

Office of Security Capabilities
System Architecture

**Advanced Development
for Security Applications
(ADSA 15)**

★ ★ ★ ★ ★ ★

November 15, 2016
Keith Goll
Senior Technical Advisor
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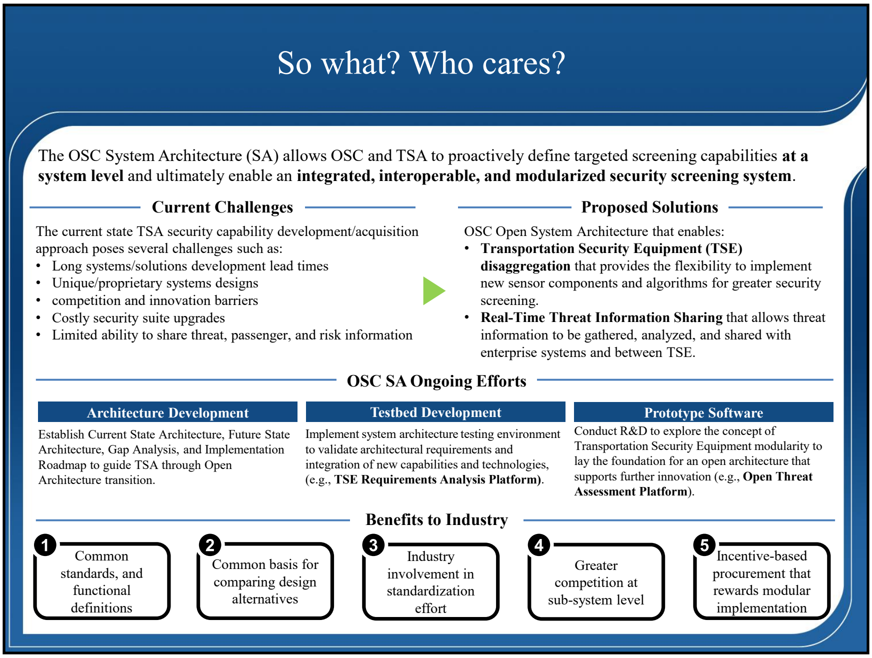
571-227-1035

Transportation
Security
Administration



So what? Who cares?

The OSC System Architecture (SA) allows OSC and TSA to proactively define targeted screening capabilities **at a system level** and ultimately enable an **integrated, interoperable, and modularized security screening system**.

Current Challenges

The current state TSA security capability development/acquisition approach poses several challenges such as:

- Long systems/solutions development lead times
- Unique/proprietary systems designs
- competition and innovation barriers
- Costly security suite upgrades
- Limited ability to share threat, passenger, and risk information

Proposed Solutions

OSC Open System Architecture that enables:

- **Transportation Security Equipment (TSE) disaggregation** that provides the flexibility to implement new sensor components and algorithms for greater security screening.
- **Real-Time Threat Information Sharing** that allows threat information to be gathered, analyzed, and shared with enterprise systems and between TSE.

OSC SA Ongoing Efforts

Architecture Development

Establish Current State Architecture, Future State Architecture, Gap Analysis, and Implementation Roadmap to guide TSA through Open Architecture transition.

Testbed Development

Implement system architecture testing environment to validate architectural requirements and integration of new capabilities and technologies, (e.g., **TSE Requirements Analysis Platform**).

Prototype Software

Conduct R&D to explore the concept of Transportation Security Equipment modularity to lay the foundation for an open architecture that supports further innovation (e.g., **Open Threat Assessment Platform**).

Benefits to Industry

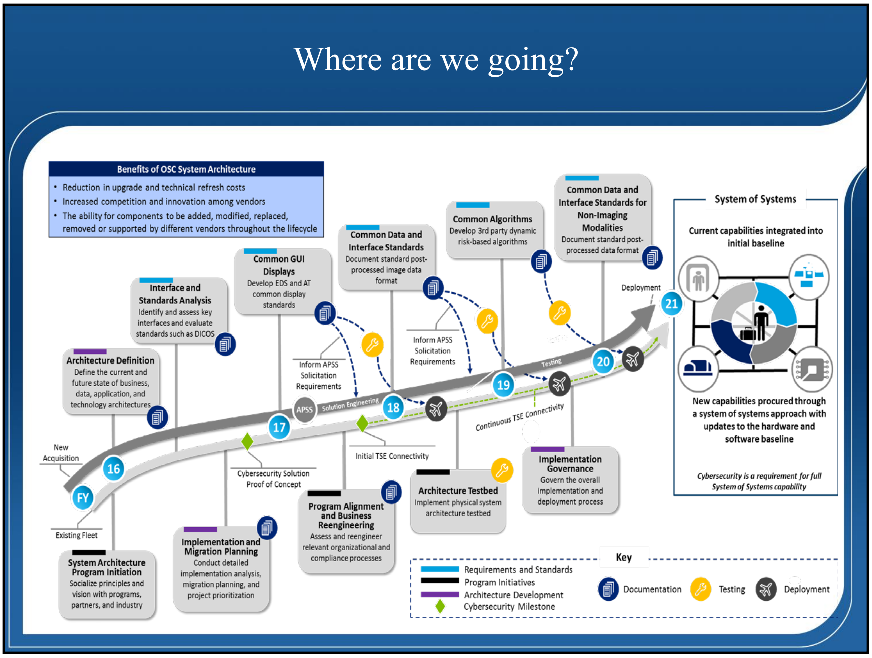
1. Common standards, and functional definitions
2. Common basis for comparing design alternatives
3. Industry involvement in standardization effort
4. Greater competition at sub-system level
5. Incentive-based procurement that rewards modular implementation

What’s our future vision for aviation security?

Leadership from across TSA held a strategy session **to inform cross-cutting initiatives, drive agency alignment, and guide future organizational investments.** The ‘passenger journey’ framed the conversation, with new, integrated capabilities being discussed as they apply throughout eight distinct security phases.

Passenger Journey Security Screening

	Security Phases	Security Capabilities
Pre-Screen	High-level vetting creates a basic risk profile when a passenger books a flight, creating risk-view of the airport population.	Identity Management, Surveillance
Perimeter	Screening takes place on a broad scale from the moment passengers and vehicles enter airport property.	Contactless Screening, Surveillance, Physical Security
Curb/Entry	Screening targets vehicles and passengers approaching the curb. Airport structures are protected from explosives and other threats.	Contactless Screening, External Partner Connectivity, Identity Management,
Check-in	Passenger risk identities are tied to bags and adversaries are prevented from bag separation.	Identity Management, Surveillance
Checked Baggage	Baggage is screened at the same level across airports. Positive bag ID means alarms in one area trigger screening at the other.	Identity Management, Surveillance
Checkpoint	Passengers wait in short or nonexistent lines for identity validation and screening. Technology standardization improve TSO effectiveness.	Data & Event Correlation, Identity Management, Incident Resolution, Standardization, Human Performance
Gate and Secure Area	Access to secure areas is restricted to individuals with valid credentials. Risk profiles, aggregate threat levels for flights, terminals, or airports.	Data & Event Correlation, Identity Management, Surveillance
Post Flight	Identity and risk profiles are anonymized for low-risk passengers to create data trends. Profiles for high-risk passengers feed future trips.	Identity Management



Where are we going?

Benefits of OSC System Architecture

- Reduction in upgrade and technical refresh costs
- Increased competition and innovation among vendors
- The ability for components to be added, modified, replaced, removed or supported by different vendors throughout the lifecycle

Architecture Definition
Define the current and future state of business, data, application, and technology architectures

Interface and Standards Analysis
Identify and assess key interfaces and evaluate standards such as DICOS

Common GUI Displays
Develop EDS and AT common display standards

Common Data and Interface Standards
Document standard post-processed image data format

Common Algorithms
Develop 3rd party dynamic risk-based algorithms

Common Data and Interface Standards for Non-Imaging Modalities
Document standard post-processed data format

System Architecture Program Initiation
Socialize principles and vision with programs, partners, and industry

Implementation and Migration Planning
Conduct detailed implementation analysis, migration planning, and project prioritization

Program Alignment and Business Reengineering
Assess and reengineer relevant organizational and compliance processes

Architecture Testbed
Implement physical system architecture testbed

Implementation Governance
Govern the overall implementation and deployment process

System of Systems

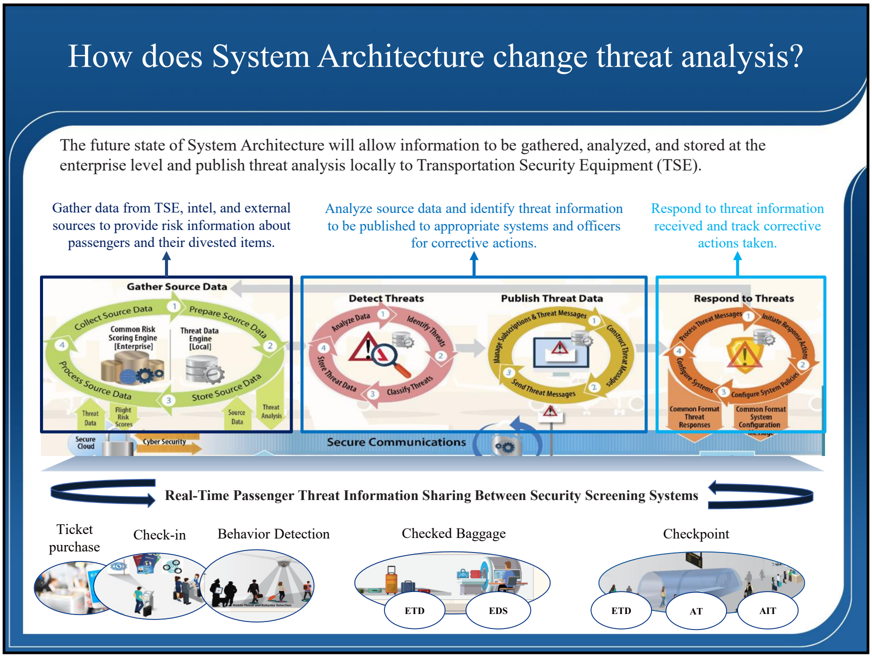
Current capabilities integrated into initial baseline

New capabilities procured through a system of systems approach with updates to the hardware and software baseline

Cybersecurity is a requirement for full System of Systems capability

Key

- ▬ Requirements and Standards
- ▬ Program Initiatives
- ▬ Architecture Development
- ◆ Cybersecurity Milestone
- ● Documentation
- ● Testing
- ● Deployment



How does System Architecture change threat analysis?

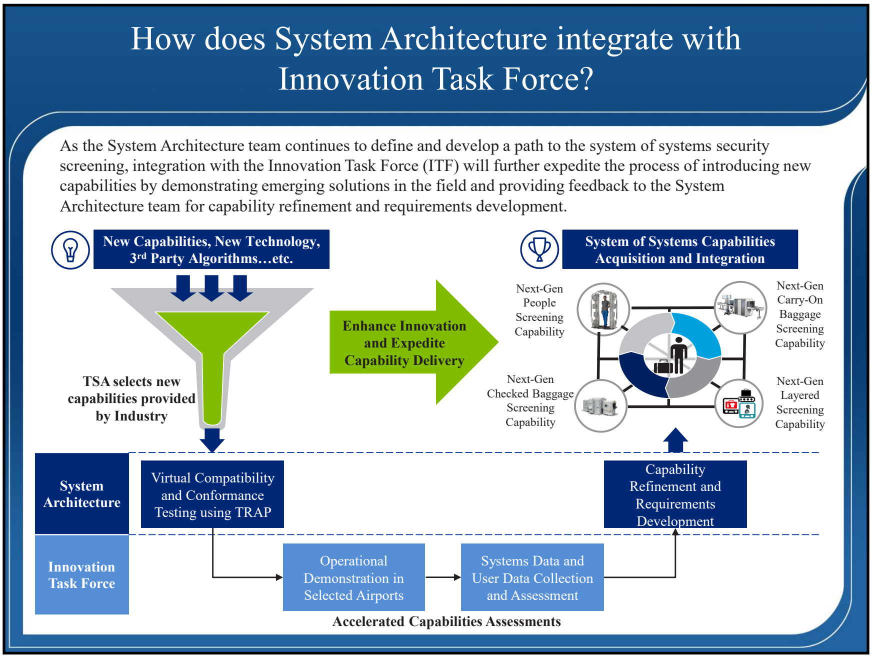
The future state of System Architecture will allow information to be gathered, analyzed, and stored at the enterprise level and publish threat analysis locally to Transportation Security Equipment (TSE).

Gather data from TSE, intel, and external sources to provide risk information about passengers and their divested items.

Analyze source data and identify threat information to be published to appropriate systems and officers for corrective actions.

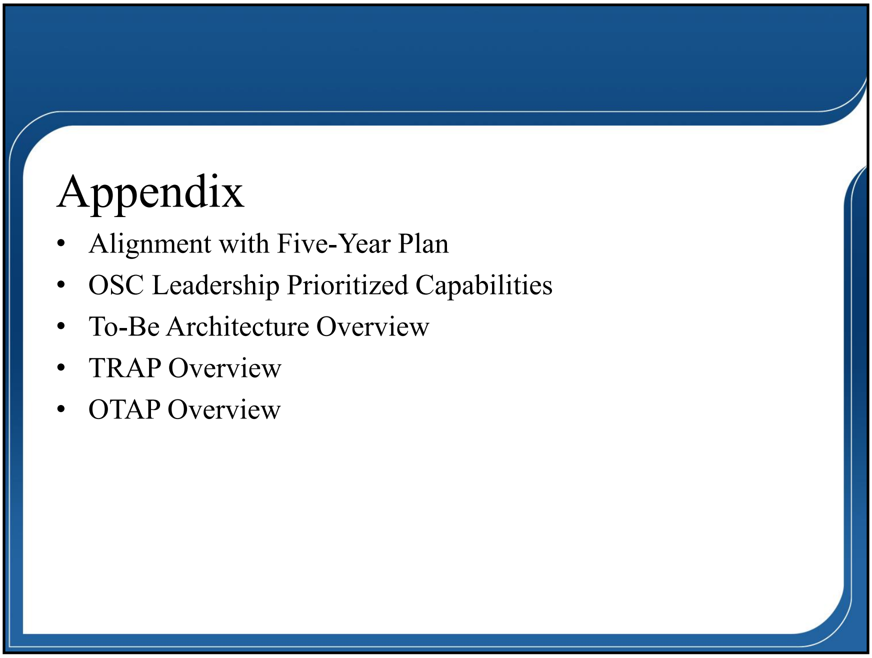
Respond to threat information received and track corrective actions taken.

Real-Time Passenger Threat Information Sharing Between Security Screening Systems



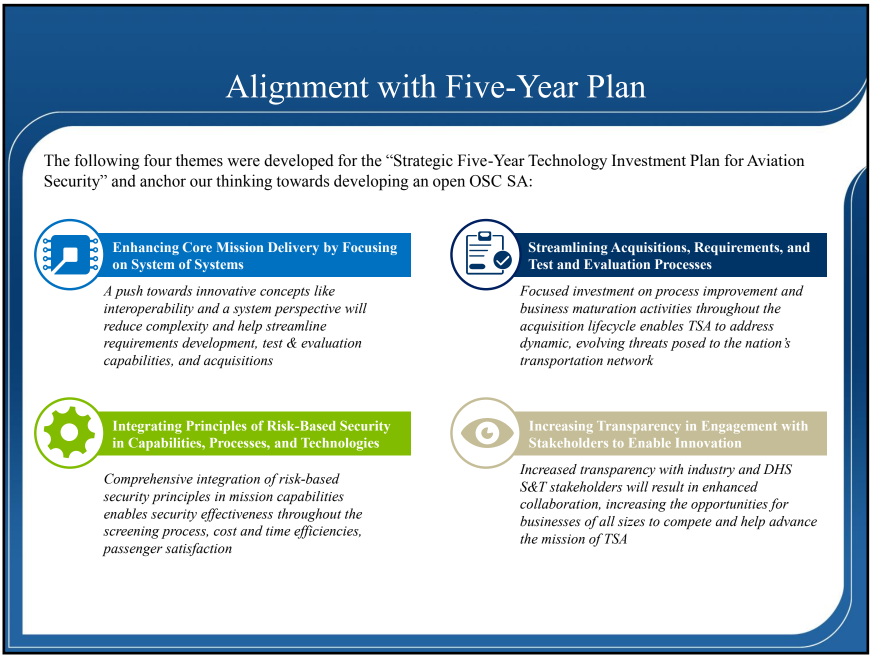
How does System Architecture integrate with Innovation Task Force?

As the System Architecture team continues to define and develop a path to the system of systems security screening, integration with the Innovation Task Force (ITF) will further expedite the process of introducing new capabilities by demonstrating emerging solutions in the field and providing feedback to the System Architecture team for capability refinement and requirements development.



Appendix

- Alignment with Five-Year Plan
- OSC Leadership Prioritized Capabilities
- To-Be Architecture Overview
- TRAP Overview
- OTAP Overview



Alignment with Five-Year Plan

The following four themes were developed for the “Strategic Five-Year Technology Investment Plan for Aviation Security” and anchor our thinking towards developing an open OSC SA:

Enhancing Core Mission Delivery by Focusing on System of Systems

A push towards innovative concepts like interoperability and a system perspective will reduce complexity and help streamline requirements development, test & evaluation capabilities, and acquisitions

Streamlining Acquisitions, Requirements, and Test and Evaluation Processes

Focused investment on process improvement and business maturation activities throughout the acquisition lifecycle enables TSA to address dynamic, evolving threats posed to the nation’s transportation network

Integrating Principles of Risk-Based Security in Capabilities, Processes, and Technologies

Comprehensive integration of risk-based security principles in mission capabilities enables security effectiveness throughout the screening process, cost and time efficiencies, passenger satisfaction

Increasing Transparency in Engagement with Stakeholders to Enable Innovation

Increased transparency with industry and DHS S&T stakeholders will result in enhanced collaboration, increasing the opportunities for businesses of all sizes to compete and help advance the mission of TSA

OSC Leadership Prioritized Capabilities

Security capabilities presented by participants have been grouped into ten capability categories and are listed in order of prioritization established during discussion.

1. Identity Management

Passengers are vetted at a high level so that verification is more accurate and risk levels are better understood in the aviation security system as a whole.
- Biometrics & Credentialing
- RBS
- Data Analytics

2. Integrated Network Architecture

An integrated network allows all TSEs and other technology devices to communicate seamlessly and supports data flow, allowing space for new capabilities and technology to be introduced.
- Dynamic Algorithms

3. Data and Event Correlation

Analytics and passenger data combined with real time events allow determination of an aggregate risk level for passengers / flights / airports.
- DARMS
- Predictive Forecasting

4. Contactless Screening

Measures taken to assess the threat of an attack from a distance allow for a more downplayed barrier to the secure area. Increased use of early, contactless screening improves security effectiveness while increasing throughput.
- Remote Screening
- Standoff Detection
- Vehicle Screening

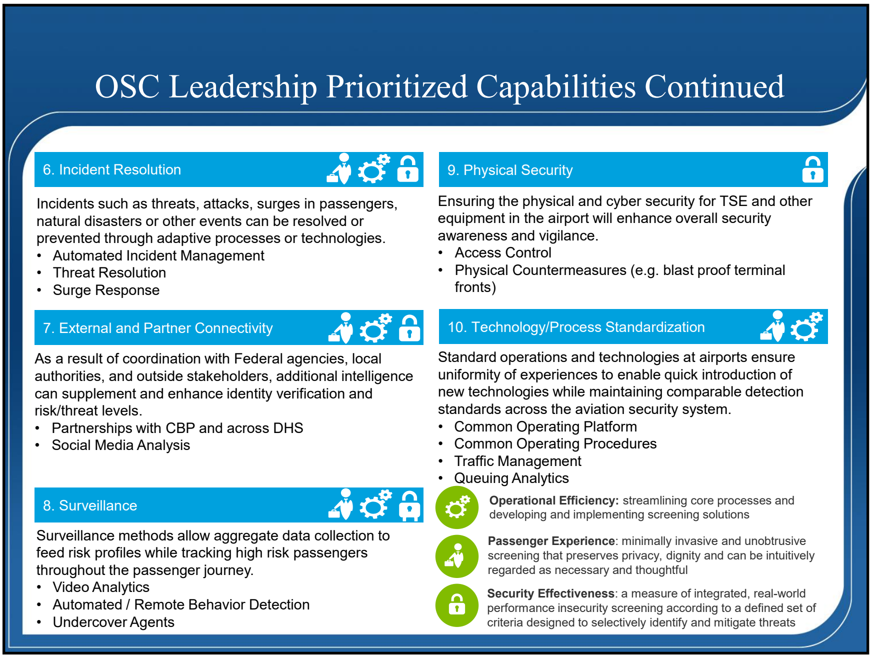
5. Human Performance

Transportation Security Officers (TSOs) are more effective due to technology and process improvements.
- TSO Enablers
- Common GUI

Operational Efficiency: streamlining core processes and developing and implementing screening solutions

Passenger Experience: minimally invasive and unobtrusive screening that preserves privacy, dignity and can be intuitively regarded as necessary and thoughtful

Security Effectiveness: a measure of integrated, real-world performance insecurity screening according to a defined set of criteria designed to selectively identify and mitigate threats



OSC Leadership Prioritized Capabilities Continued

6. Incident Resolution

Incidents such as threats, attacks, surges in passengers, natural disasters or other events can be resolved or prevented through adaptive processes or technologies.
- Automated Incident Management
- Threat Resolution
- Surge Response

7. External and Partner Connectivity

As a result of coordination with Federal agencies, local authorities, and outside stakeholders, additional intelligence can supplement and enhance identity verification and risk/threat levels.
- Partnerships with CBP and across DHS
- Social Media Analysis

8. Surveillance

Surveillance methods allow aggregate data collection to feed risk profiles while tracking high risk passengers throughout the passenger journey.
- Video Analytics
- Automated / Remote Behavior Detection
- Undercover Agents

9. Physical Security

Ensuring the physical and cyber security for TSE and other equipment in the airport will enhance overall security awareness and vigilance.
- Access Control
- Physical Countermeasures (e.g. blast proof terminal fronts)

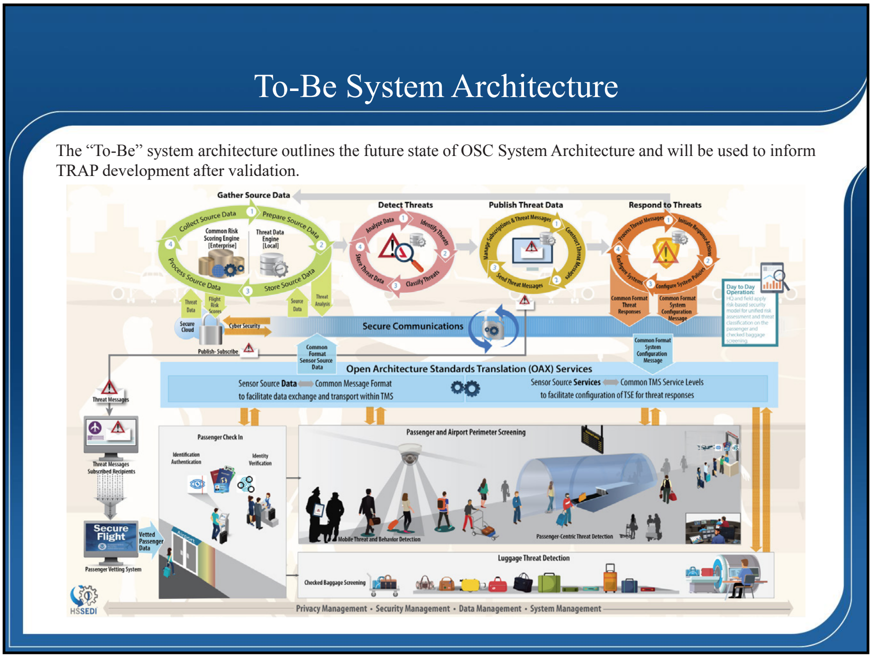
10. Technology/Process Standardization

Standard operations and technologies at airports ensure uniformity of experiences to enable quick introduction of new technologies while maintaining comparable detection standards across the aviation security system.
- Common Operating Platform
- Common Operating Procedures
- Traffic Management
- Queuing Analytics

Operational Efficiency: streamlining core processes and developing and implementing screening solutions

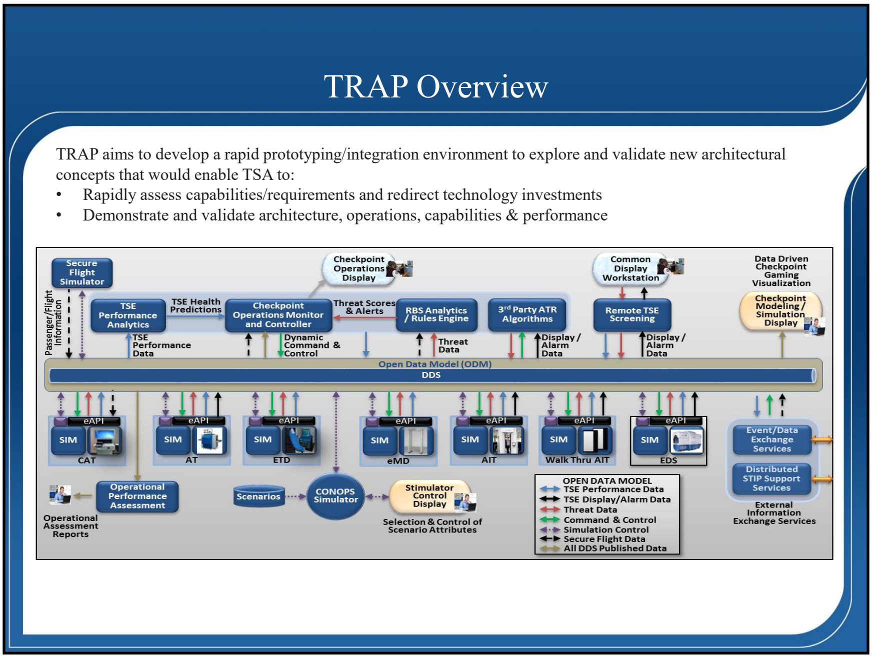
Passenger Experience: minimally invasive and unobtrusive screening that preserves privacy, dignity and can be intuitively regarded as necessary and thoughtful

Security Effectiveness: a measure of integrated, real-world performance insecurity screening according to a defined set of criteria designed to selectively identify and mitigate threats



To-Be System Architecture

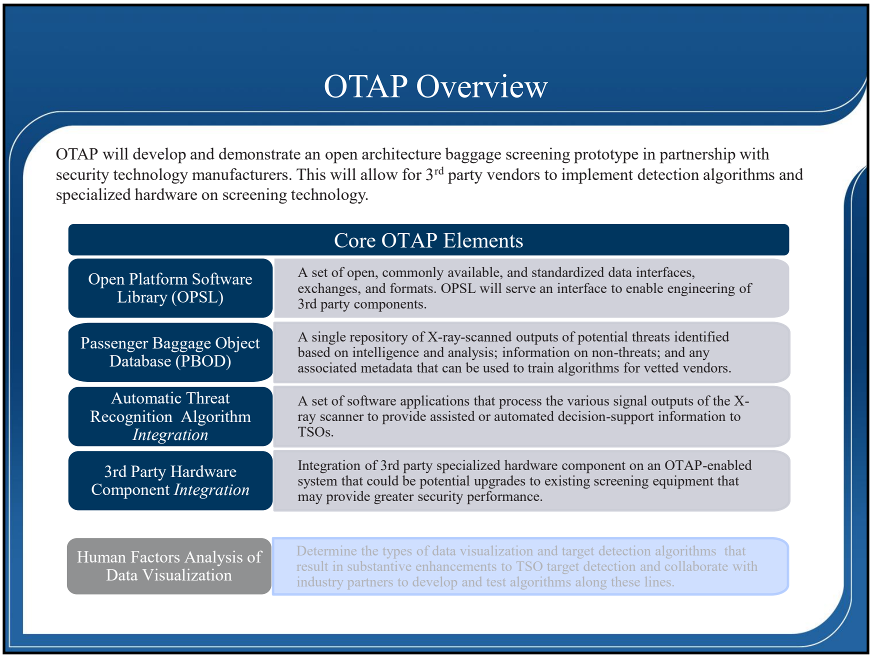
The "To-Be" system architecture outlines the future state of OSC System Architecture and will be used to inform TRAP development after validation.



TRAP Overview

TRAP aims to develop a rapid prototyping/integration environment to explore and validate new architectural concepts that would enable TSA to:

- Rapidly assess capabilities/requirements and redirect technology investments
- Demonstrate and validate architecture, operations, capabilities & performance



OTAP Overview

OTAP will develop and demonstrate an open architecture baggage screening prototype in partnership with security technology manufacturers. This will allow for 3rd party vendors to implement detection algorithms and specialized hardware on screening technology.

Core OTAP Elements	
Open Platform Software Library (OPSL)	A set of open, commonly available, and standardized data interfaces, exchanges, and formats. OPSL will serve an interface to enable engineering of 3rd party components.
Passenger Baggage Object Database (PBOD)	A single repository of X-ray-scanned outputs of potential threats identified based on intelligence and analysis; information on non-threats; and any associated metadata that can be used to train algorithms for vetted vendors.
Automatic Threat Recognition Algorithm *Integration*	A set of software applications that process the various signal outputs of the X-ray scanner to provide assisted or automated decision-support information to TSOs.
3rd Party Hardware Component *Integration*	Integration of 3rd party specialized hardware component on an OTAP-enabled system that could be potential upgrades to existing screening equipment that may provide greater security performance.

Human Factors Analysis of Data Visualization	Determine the types of data visualization and target detection algorithms that result in substantive enhancements to TSO target detection and collaborate with industry partners to develop and test algorithms along these lines.

16.3 Mara Winn: TSA Innovation Task Force

ALERT Conference

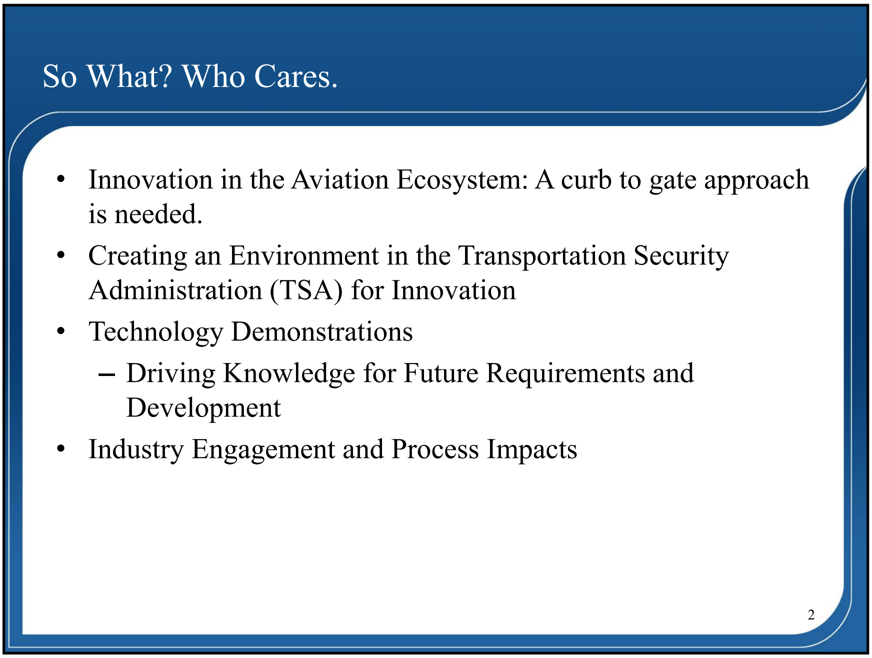
Office of Security Capabilities

Innovation Task Force

★ ★ ★ ★ ★ ★

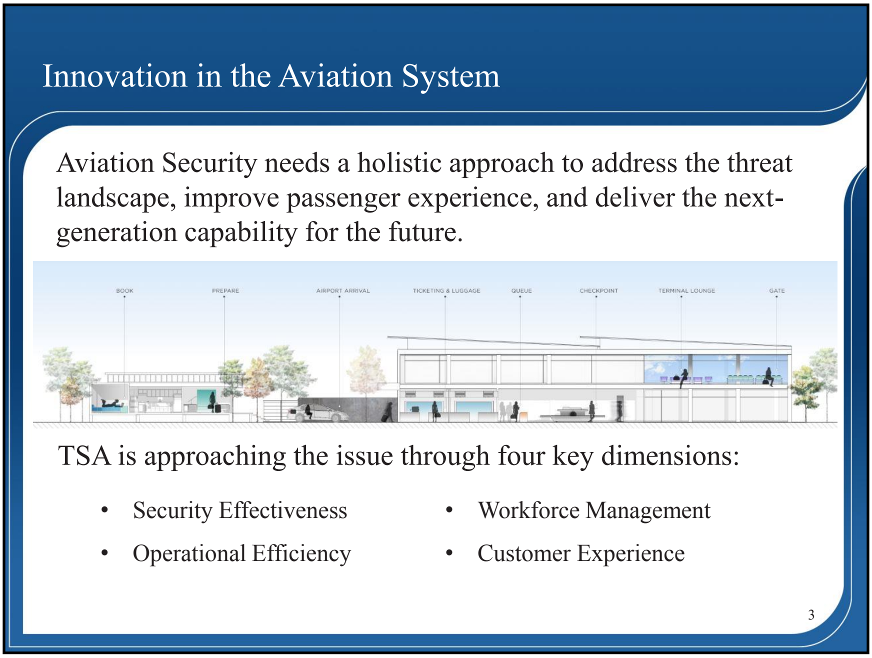
November 15, 2016

Transportation
Security
Administration



So What? Who Cares.

- Innovation in the Aviation Ecosystem: A curb to gate approach is needed.
- Creating an Environment in the Transportation Security Administration (TSA) for Innovation
- Technology Demonstrations
  - Driving Knowledge for Future Requirements and Development
- Industry Engagement and Process Impacts

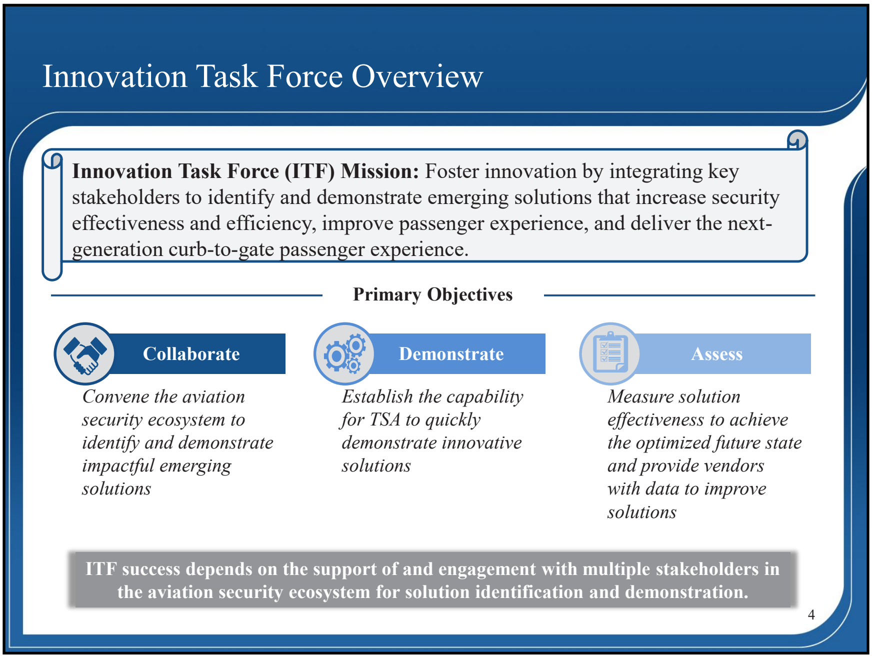


Innovation in the Aviation System

Aviation Security needs a holistic approach to address the threat landscape, improve passenger experience, and deliver the next-generation capability for the future.

TSA is approaching the issue through four key dimensions:

- Security Effectiveness
- Operational Efficiency
- Workforce Management
- Customer Experience



Innovation Task Force Overview

Innovation Task Force (ITF) Mission: Foster innovation by integrating key stakeholders to identify and demonstrate emerging solutions that increase security effectiveness and efficiency, improve passenger experience, and deliver the next-generation curb-to-gate passenger experience.

Primary Objectives

Collaborate

Convene the aviation security ecosystem to identify and demonstrate impactful emerging solutions

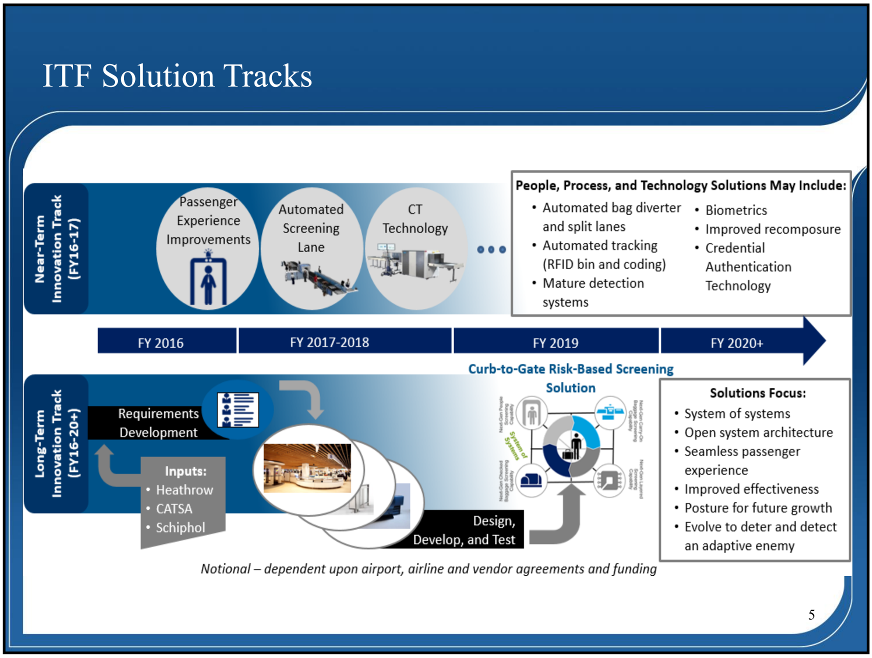
Demonstrate

Establish the capability for TSA to quickly demonstrate innovative solutions

Assess

Measure solution effectiveness to achieve the optimized future state and provide vendors with data to improve solutions

ITF success depends on the support of and engagement with multiple stakeholders in the aviation security ecosystem for solution identification and demonstration.



ITF Solution Tracks

Near-Term Innovation Track (FY16-17)

- Passenger Experience Improvements
- Automated Screening Lane
- CT Technology

People, Process, and Technology Solutions May Include:

- Automated bag diverter and split lanes
- Automated tracking (RFID bin and coding)
- Mature detection systems
- Biometrics
- Improved recomposure
- Credential Authentication Technology

FY 2016 | FY 2017-2018 | FY 2019 | FY 2020+

Long-Term Innovation Track (FY16-20+)

Requirements Development

Inputs:

- Heathrow
- CATSA
- Schiphol

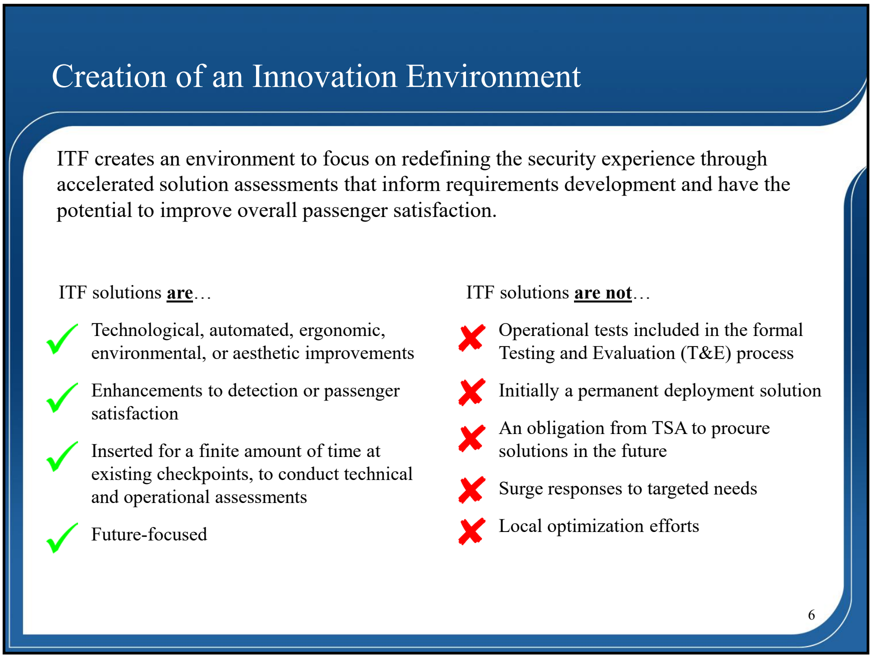
Design, Develop, and Test

Curb-to-Gate Risk-Based Screening Solution

Solutions Focus:

- System of systems
- Open system architecture
- Seamless passenger experience
- Improved effectiveness
- Posture for future growth
- Evolve to deter and detect an adaptive enemy

Notional – dependent upon airport, airline and vendor agreements and funding



Creation of an Innovation Environment

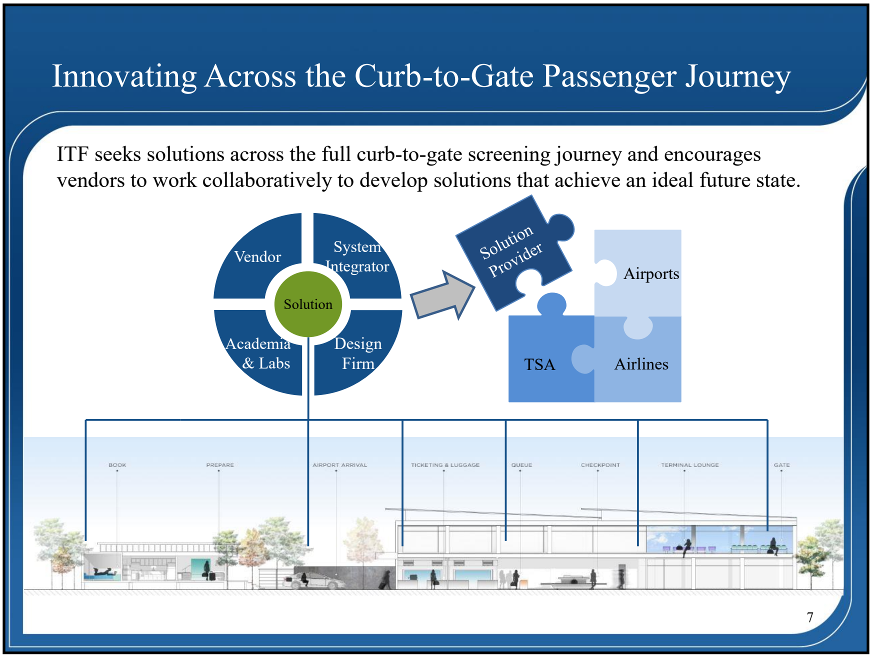
ITF creates an environment to focus on redefining the security experience through accelerated solution assessments that inform requirements development and have the potential to improve overall passenger satisfaction.

ITF solutions **are**…

- ✓ Technological, automated, ergonomic, environmental, or aesthetic improvements
- ✓ Enhancements to detection or passenger satisfaction
- ✓ Inserted for a finite amount of time at existing checkpoints, to conduct technical and operational assessments
- ✓ Future-focused

ITF solutions **are not**…

- ✗ Operational tests included in the formal Testing and Evaluation (T&E) process
- ✗ Initially a permanent deployment solution
- ✗ An obligation from TSA to procure solutions in the future
- ✗ Surge responses to targeted needs
- ✗ Local optimization efforts

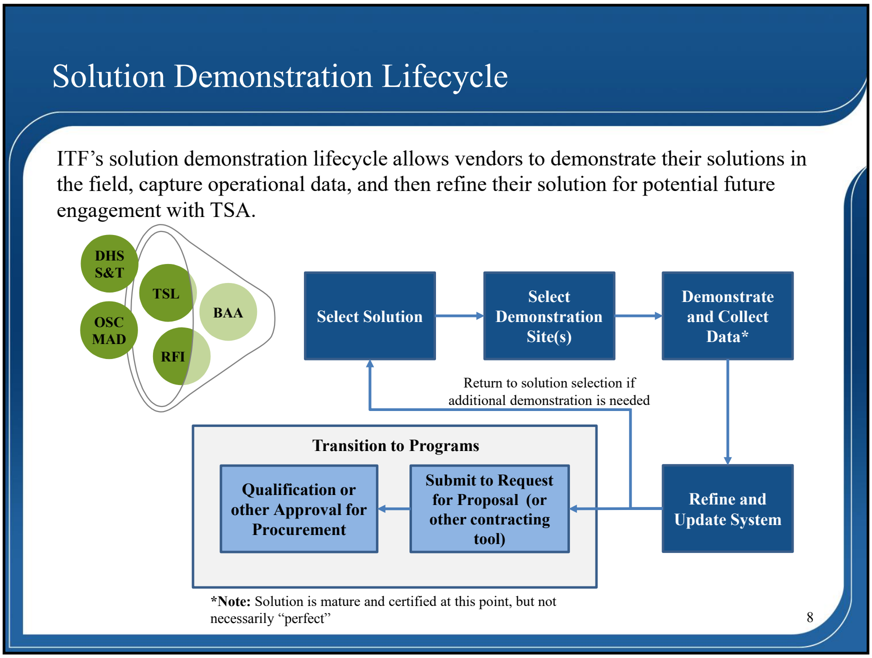


Innovating Across the Curb-to-Gate Passenger Journey

ITF seeks solutions across the full curb-to-gate screening journey and encourages vendors to work collaboratively to develop solutions that achieve an ideal future state.

Vendor
System Integrator
Solution
Academia & Labs
Design Firm

Solution Provider
Airports
TSA
Airlines



Solution Demonstration Lifecycle

ITF's solution demonstration lifecycle allows vendors to demonstrate their solutions in the field, capture operational data, and then refine their solution for potential future engagement with TSA.

DHS S&T
OSC MAD
TSL
BAA
RFI

Select Solution

Select Demonstration Site(s)

Demonstrate and Collect Data*

Refine and Update System

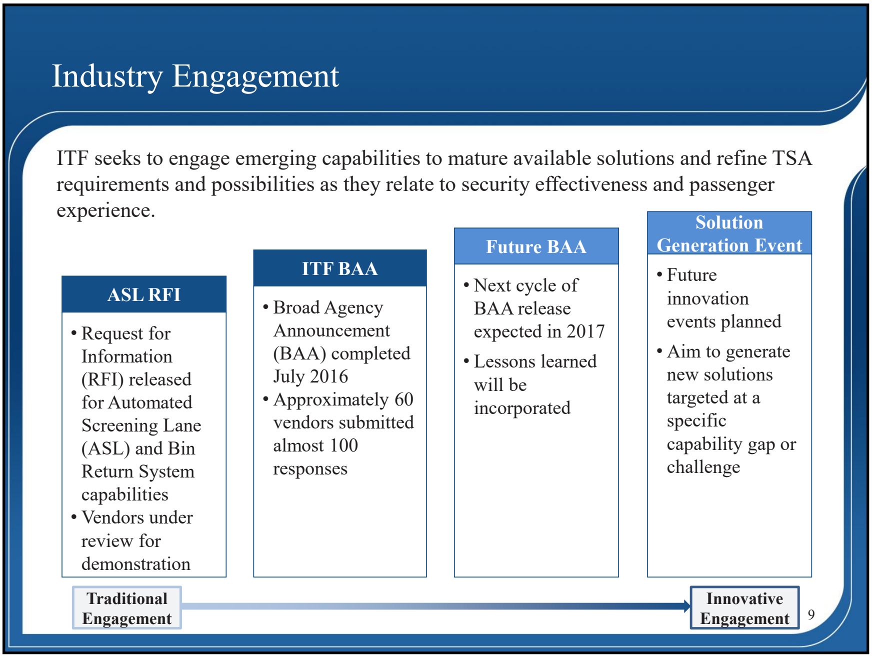
Return to solution selection if additional demonstration is needed

Transition to Programs

Submit to Request for Proposal (or other contracting tool)

Qualification or other Approval for Procurement

***Note:** Solution is mature and certified at this point, but not necessarily "perfect"



Industry Engagement

ITF seeks to engage emerging capabilities to mature available solutions and refine TSA requirements and possibilities as they relate to security effectiveness and passenger experience.

ASL RFI

- Request for Information (RFI) released for Automated Screening Lane (ASL) and Bin Return System capabilities
- Vendors under review for demonstration

ITF BAA

- Broad Agency Announcement (BAA) completed July 2016
- Approximately 60 vendors submitted almost 100 responses

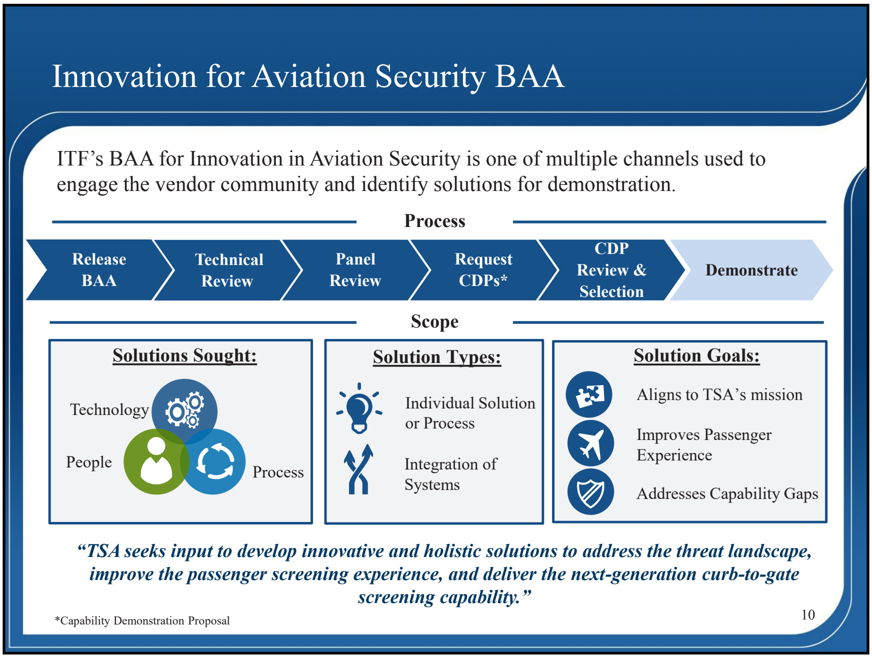
Future BAA

- Next cycle of BAA release expected in 2017
- Lessons learned will be incorporated

Solution Generation Event

- Future innovation events planned
- Aim to generate new solutions targeted at a specific capability gap or challenge

Traditional Engagement → **Innovative Engagement**



Innovation for Aviation Security BAA

ITF's BAA for Innovation in Aviation Security is one of multiple channels used to engage the vendor community and identify solutions for demonstration.

Process

Release BAA → Technical Review → Panel Review → Request CDPs* → CDP Review & Selection → Demonstrate

Scope

Solutions Sought:

Solution Types:

Individual Solution or Process

Integration of Systems

Solution Goals:

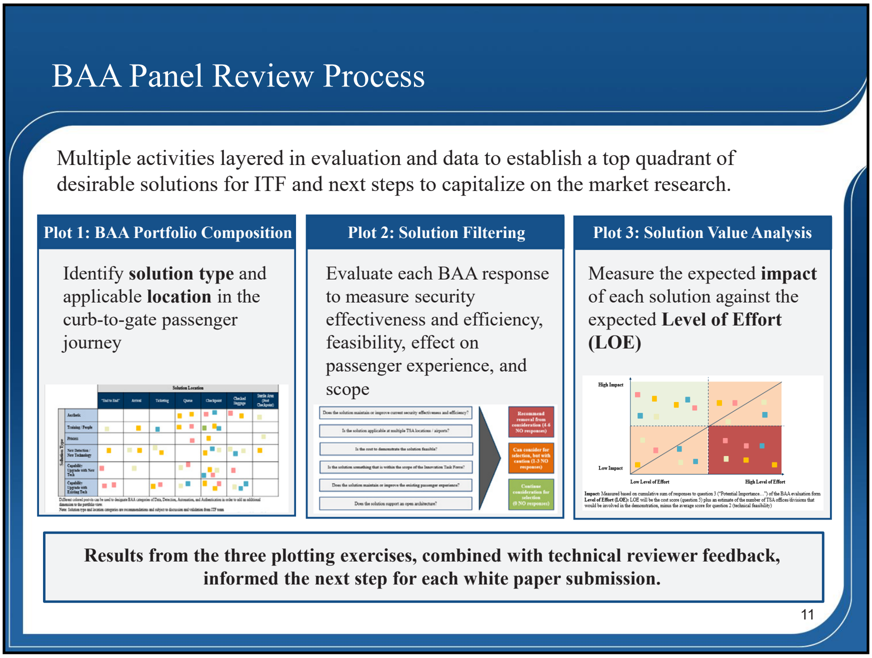
Aligns to TSA's mission

Improves Passenger Experience

Addresses Capability Gaps

"TSA seeks input to develop innovative and holistic solutions to address the threat landscape, improve the passenger screening experience, and deliver the next-generation curb-to-gate screening capability."

*Capability Demonstration Proposal



BAA Panel Review Process

Multiple activities layered in evaluation and data to establish a top quadrant of desirable solutions for ITF and next steps to capitalize on the market research.

Plot 1: BAA Portfolio Composition

Identify **solution type** and applicable **location** in the curb-to-gate passenger journey

Different colored post-its can be used to designate BAA categories of Data, Detection, Automation, and Authentication in order to add an additional dimension to the portfolio view.
Note: Solution type and location categories are recommendations and subject to discussion and validation from ITF team

Plot 2: Solution Filtering

Evaluate each BAA response to measure security effectiveness and efficiency, feasibility, effect on passenger experience, and scope

- Does the solution maintain or improve current security effectiveness and efficiency?
- Is the solution applicable at multiple TSA locations / airports?
- Is the cost to demonstrate the solution feasible?
- Is the solution something that is within the scope of the Innovation Task Force?
- Does the solution maintain or improve the existing passenger experience?
- Does the solution support an open architecture?

Recommend removal from consideration (4-6 NO responses)

Can consider for selection, but with caution (1-3 NO responses)

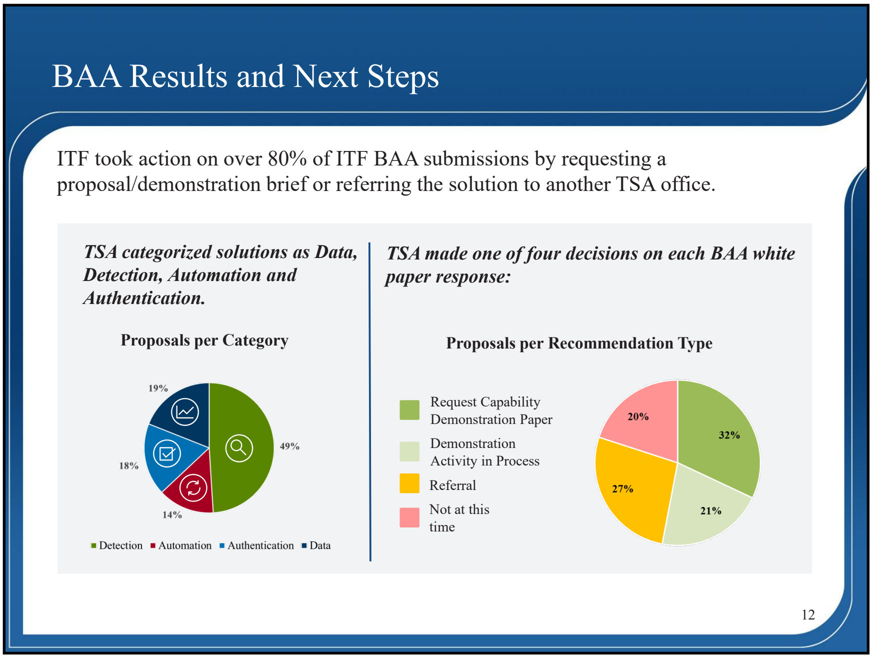
Continue consideration for selection (0 NO responses)

Plot 3: Solution Value Analysis

Measure the expected **impact** of each solution against the expected **Level of Effort (LOE)**

Impact: Measured based on cumulative sum of responses to question 3 ("Potential Importance…") of the BAA evaluation form
Level of Effort (LOE): LOE will be the cost score (question 5) plus an estimate of the number of TSA offices/divisions that would be involved in the demonstration, minus the average score for question 2 (technical feasibility)

Results from the three plotting exercises, combined with technical reviewer feedback, informed the next step for each white paper submission.



BAA Results and Next Steps

ITF took action on over 80% of ITF BAA submissions by requesting a proposal/demonstration brief or referring the solution to another TSA office.

TSA categorized solutions as Data, Detection, Automation and Authentication.

Proposals per Category

TSA made one of four decisions on each BAA white paper response:

Proposals per Recommendation Type

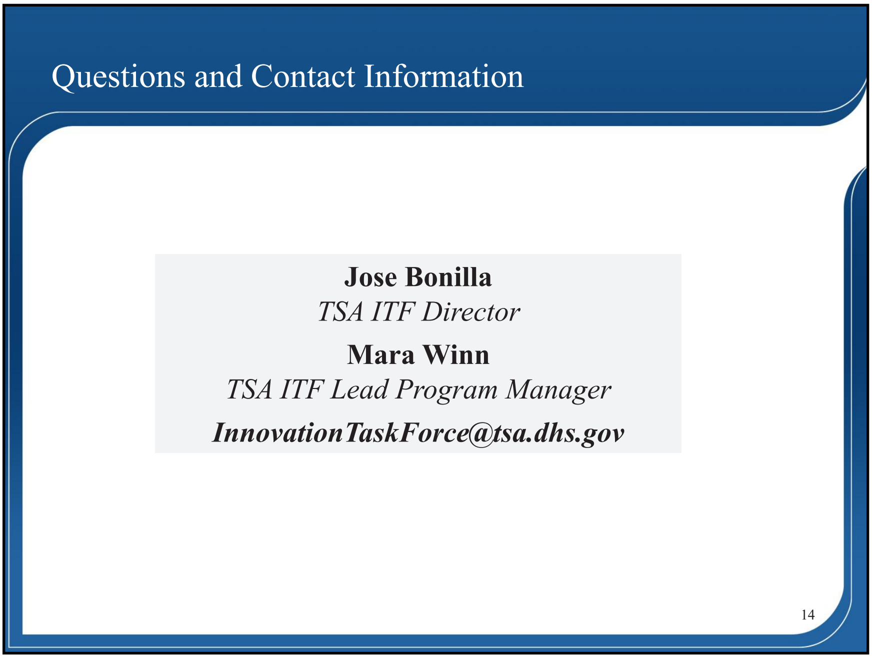
ITF Next Steps

ITF is focused on continuing ASL deployment activities, demonstrating Computed Tomography and other solutions from the BAA, and identifying new solutions from within TSA and across the industry.

1 ASL Deployments

2 Solution Selection and Demonstrations

3 Solution Identification



Questions and Contact Information

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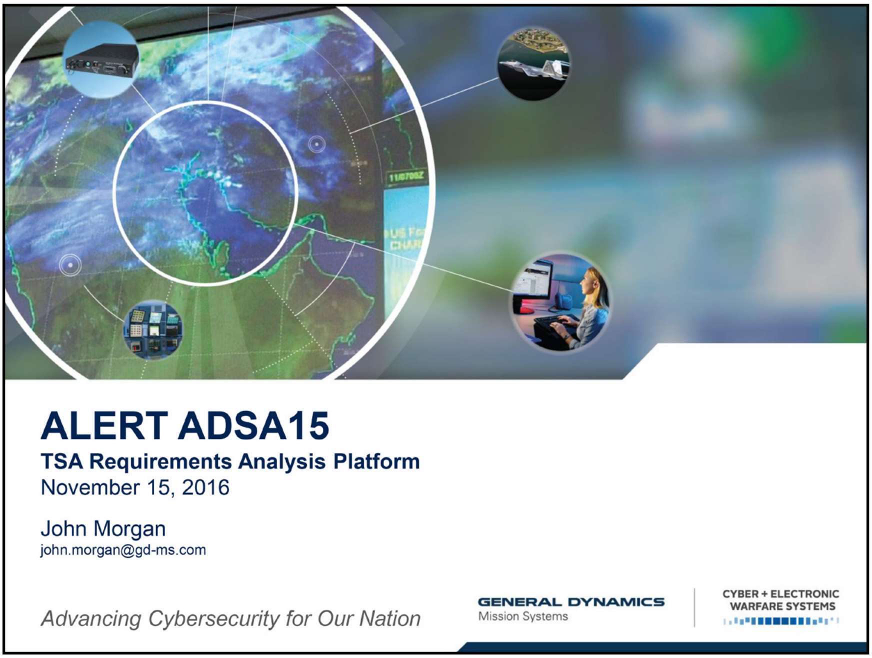
16.4 John Morgan: TSA Requirements Analysis Platform (TRAP)



ALERT ADSA15

TSA Requirements Analysis Platform

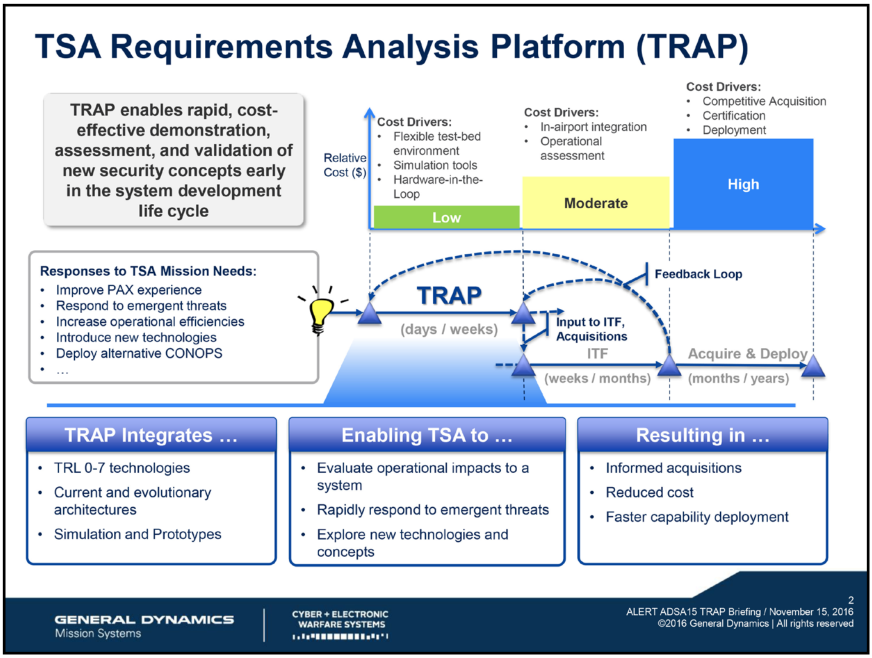
November 15, 2016

John Morgan
john.morgan@gd-ms.com

Advancing Cybersecurity for Our Nation

GENERAL DYNAMICS
Mission Systems

CYBER + ELECTRONIC
WARFARE SYSTEMS



TSA Requirements Analysis Platform (TRAP)

TRAP enables rapid, cost-effective demonstration, assessment, and validation of new security concepts early in the system development life cycle

Responses to TSA Mission Needs:
- Improve PAX experience
- Respond to emergent threats
- Increase operational efficiencies
- Introduce new technologies
- Deploy alternative CONOPS
- …

TRAP Integrates …
- TRL 0-7 technologies
- Current and evolutionary architectures
- Simulation and Prototypes

Enabling TSA to …
- Evaluate operational impacts to a system
- Rapidly respond to emergent threats
- Explore new technologies and concepts

Resulting in …
- Informed acquisitions
- Reduced cost
- Faster capability deployment

GENERAL DYNAMICS
Mission Systems

CYBER + ELECTRONIC
WARFARE SYSTEMS

2
ALERT ADSA15 TRAP Briefing / November 15, 2016
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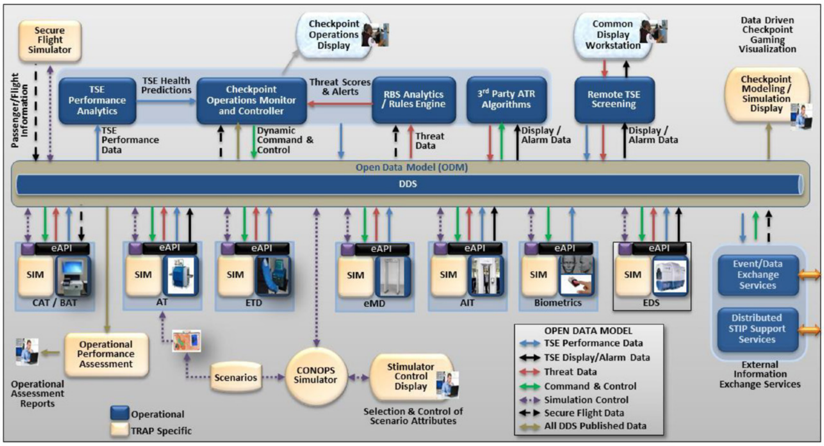
TRAP Functional Architecture



Secure Flight Simulator

Passenger/Flight Information

TSE Performance Analytics

TSE Health Predictions

Checkpoint Operations Monitor and Controller

Checkpoint Operations Display

Threat Scores & Alerts

RBS Analytics / Rules Engine

3rd Party ATR Algorithms

Common Display Workstation

Remote TSE Screening

Data Driven Checkpoint Gaming Visualization

Checkpoint Modeling / Simulation Display

TSE Performance Data

Dynamic Command & Control

Threat Data

Display / Alarm Data

Display / Alarm Data

Open Data Model (ODM)

DDS

eAPI SIM CAT / BAT

eAPI SIM AT

eAPI SIM ETD

eAPI SIM eMD

eAPI SIM AIT

eAPI SIM Biometrics

eAPI SIM EDS

Event/Data Exchange Services

Distributed STIP Support Services

External Information Exchange Services

Operational Performance Assessment

Operational Assessment Reports

Scenarios

CONOPS Simulator

Stimulator Control Display

Selection & Control of Scenario Attributes

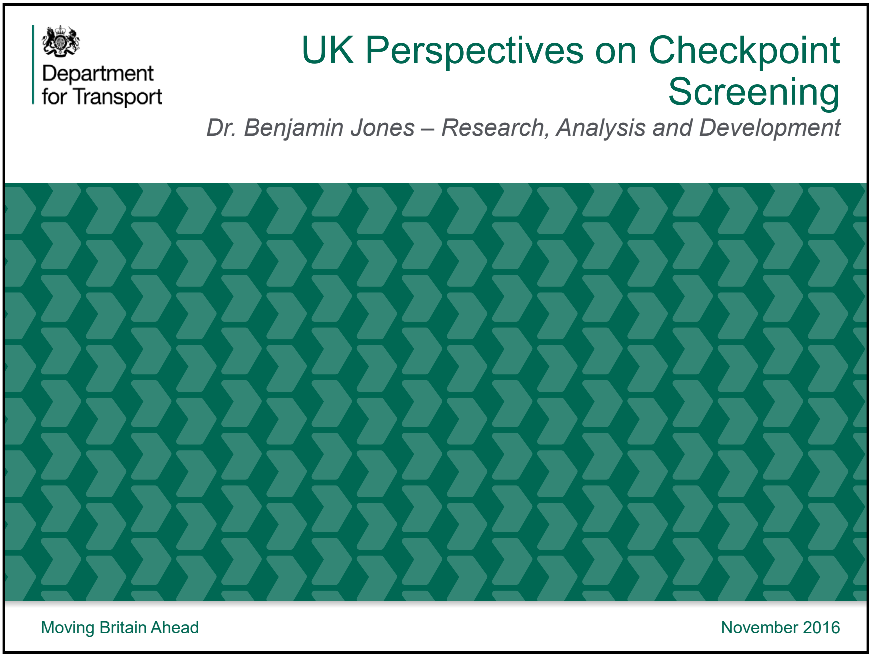
OPEN DATA MODEL
- TSE Performance Data
- TSE Display/Alarm Data
- Threat Data
- Command & Control
- Simulation Control
- Secure Flight Data
- All DDS Published Data

🟦 Operational
🟨 TRAP Specific

TRAP Use Cases

- Study architectural approaches to RBS
- Assess distributed computing architectural approaches
- Integrate 3rd party ATR algorithms in an OA analytics platform
- Evaluate applicability and effectiveness of standards throughout the architecture
- Prototype multimodal biometric authentication
- Incorporate more vendor HW/SW-in-the-loop capabilities
- Integrate, test, demonstrate next generation checkpoint technologies
- Evaluate CONOPS / SOPs
- ….

16.5 Ben Jones: UK Perspective on Checkpoint Screening



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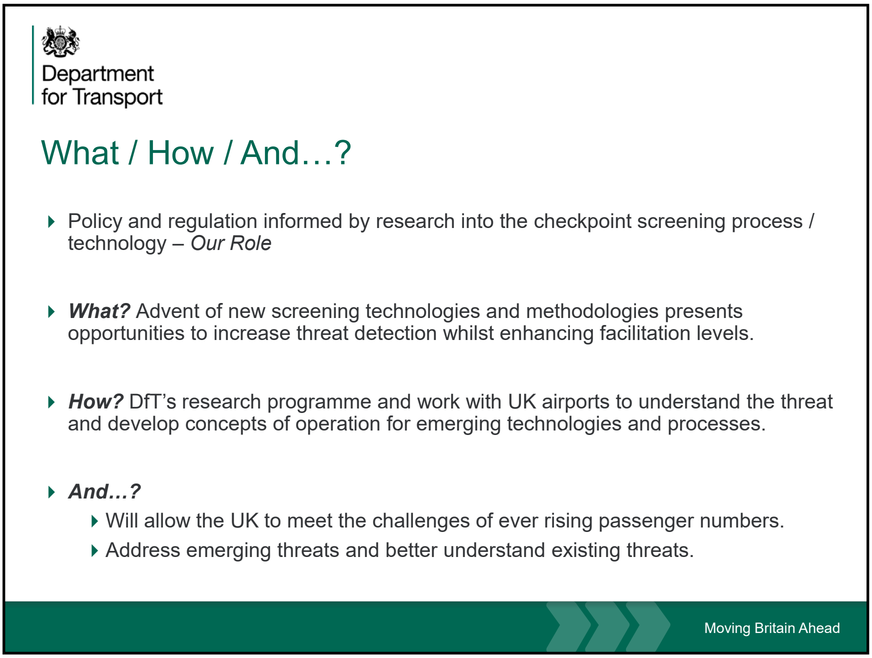
UK Perspectives on Checkpoint Screening

Dr. Benjamin Jones – Research, Analysis and Development

Moving Britain Ahead

November 2016



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What / How / And…?

- Policy and regulation informed by research into the checkpoint screening process / technology – *Our Role*
- ***What?*** Advent of new screening technologies and methodologies presents opportunities to increase threat detection whilst enhancing facilitation levels.
- ***How?*** DfT's research programme and work with UK airports to understand the threat and develop concepts of operation for emerging technologies and processes.
- ***And…?***
  - Will allow the UK to meet the challenges of ever rising passenger numbers.
  - Address emerging threats and better understand existing threats.

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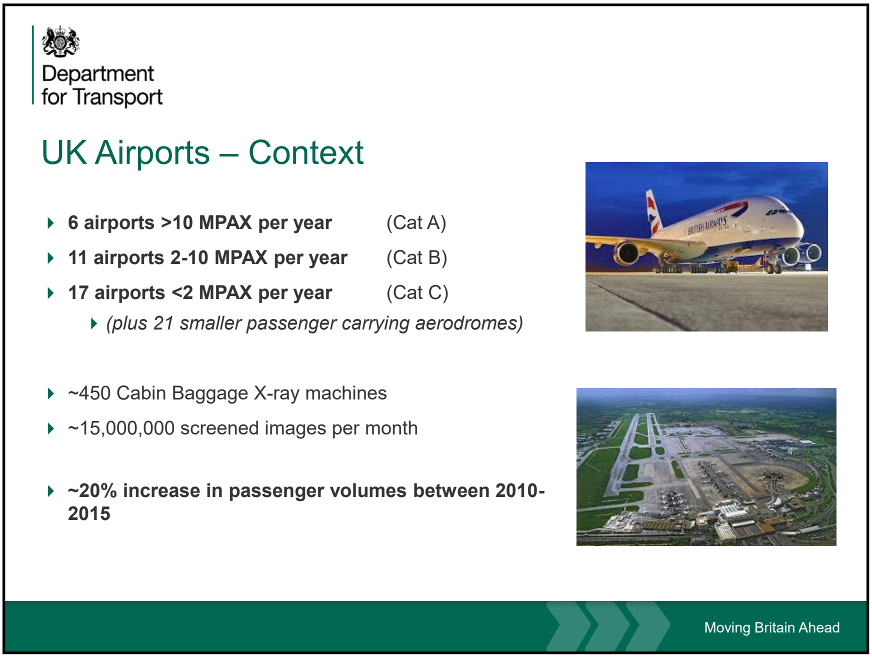

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UK Airports – Context

- **6 airports >10 MPAX per year** (Cat A)
- **11 airports 2-10 MPAX per year** (Cat B)
- **17 airports <2 MPAX per year** (Cat C)
    - *(plus 21 smaller passenger carrying aerodromes)*

- ~450 Cabin Baggage X-ray machines
- ~15,000,000 screened images per month

- **~20% increase in passenger volumes between 2010-2015**

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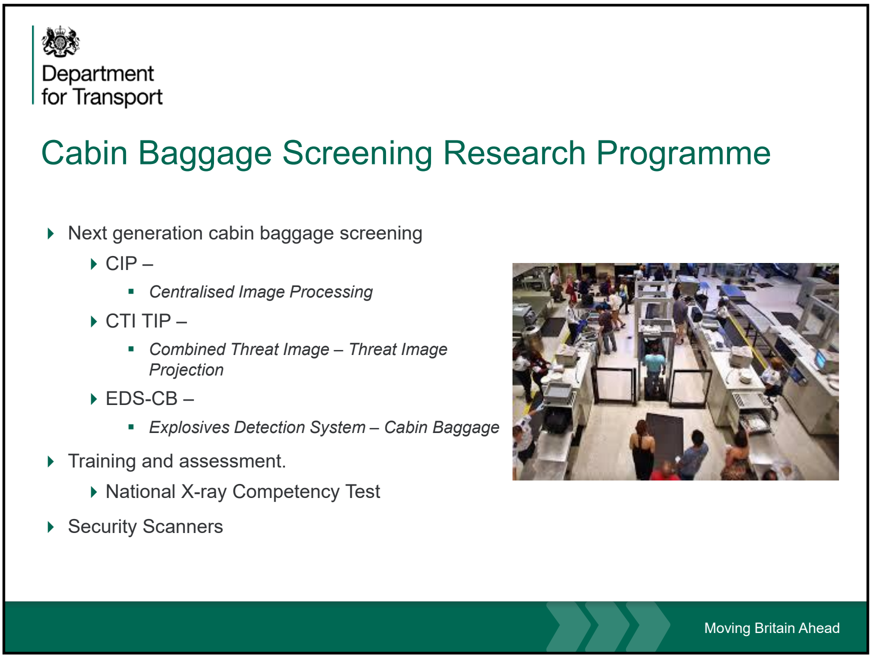

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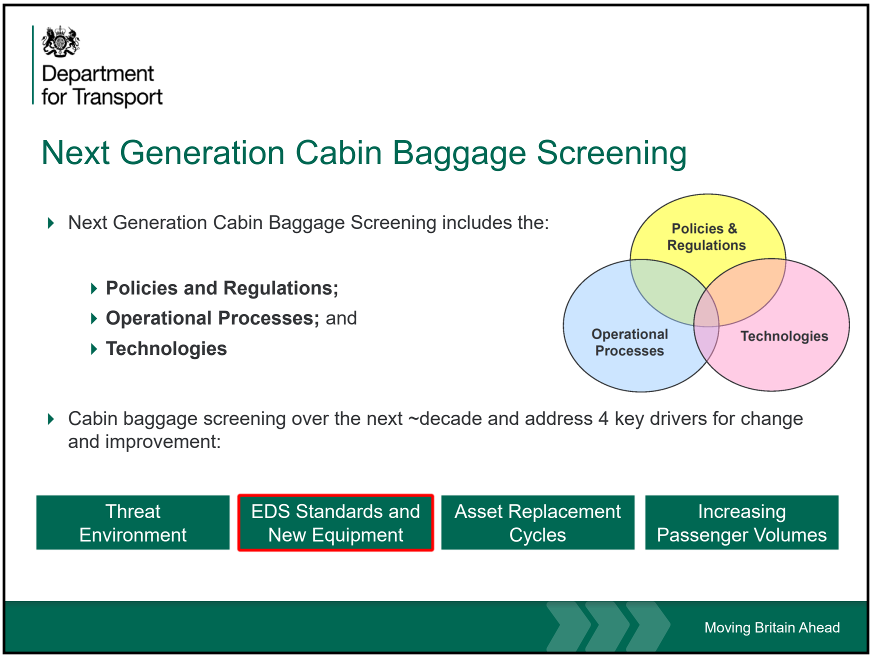
Cabin Baggage Screening Research Programme

- Next generation cabin baggage screening
    - CIP –
        - *Centralised Image Processing*
    - CTI TIP –
        - *Combined Threat Image – Threat Image Projection*
    - EDS-CB –
        - *Explosives Detection System – Cabin Baggage*
- Training and assessment.
    - National X-ray Competency Test
- Security Scanners

Moving Britain Ahead



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Next Generation Cabin Baggage Screening

- Next Generation Cabin Baggage Screening includes the:
  - **Policies and Regulations;**
  - **Operational Processes;** and
  - **Technologies**

- Cabin baggage screening over the next ~decade and address 4 key drivers for change and improvement:

Threat Environment

EDS Standards and New Equipment

Asset Replacement Cycles

Increasing Passenger Volumes

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Airport collaboration

- Established an Airports Cabin Baggage Working Group (CBWG) to:
  - Provide a forum to discuss issues around current and future cabin baggage screening arrangements.
  - Provide information and direction on the introduction of next generation cabin baggage screening equipment, such as EDS-CB.
  - Determine the need, or otherwise, for regulatory requirements and / or guidance on equipment operation and processes.

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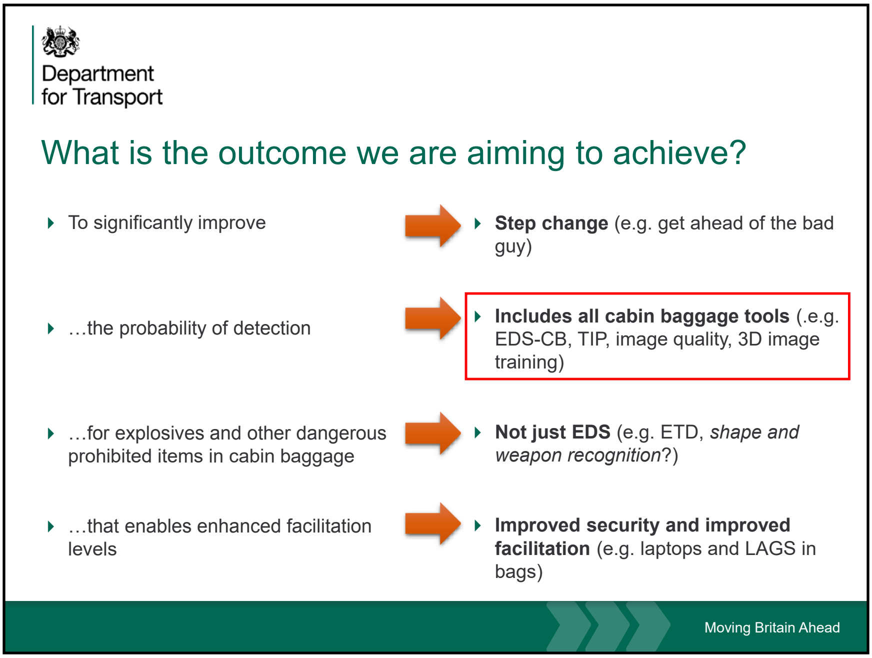

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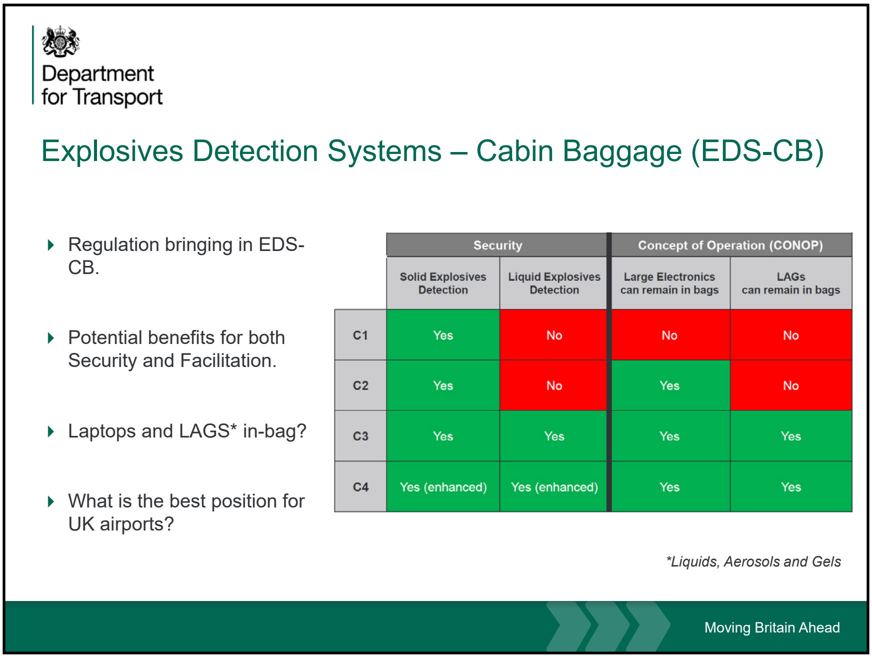
What is the outcome we are aiming to achieve?

- To significantly improve → **Step change** (e.g. get ahead of the bad guy)
- …the probability of detection → **Includes all cabin baggage tools** (.e.g. EDS-CB, TIP, image quality, 3D image training)
- …for explosives and other dangerous prohibited items in cabin baggage → **Not just EDS** (e.g. ETD, *shape and weapon recognition*?)
- …that enables enhanced facilitation levels → **Improved security and improved facilitation** (e.g. laptops and LAGS in bags)

Moving Britain Ahead



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Explosives Detection Systems – Cabin Baggage (EDS-CB)

- Regulation bringing in EDS-CB.
- Potential benefits for both Security and Facilitation.
- Laptops and LAGS* in-bag?
- What is the best position for UK airports?

	Security		Concept of Operation (CONOP)	
	Solid Explosives Detection	Liquid Explosives Detection	Large Electronics can remain in bags	LAGs can remain in bags
C1	Yes	No	No	No
C2	Yes	No	Yes	No
C3	Yes	Yes	Yes	Yes
C4	Yes (enhanced)	Yes (enhanced)	Yes	Yes

**Liquids, Aerosols and Gels*

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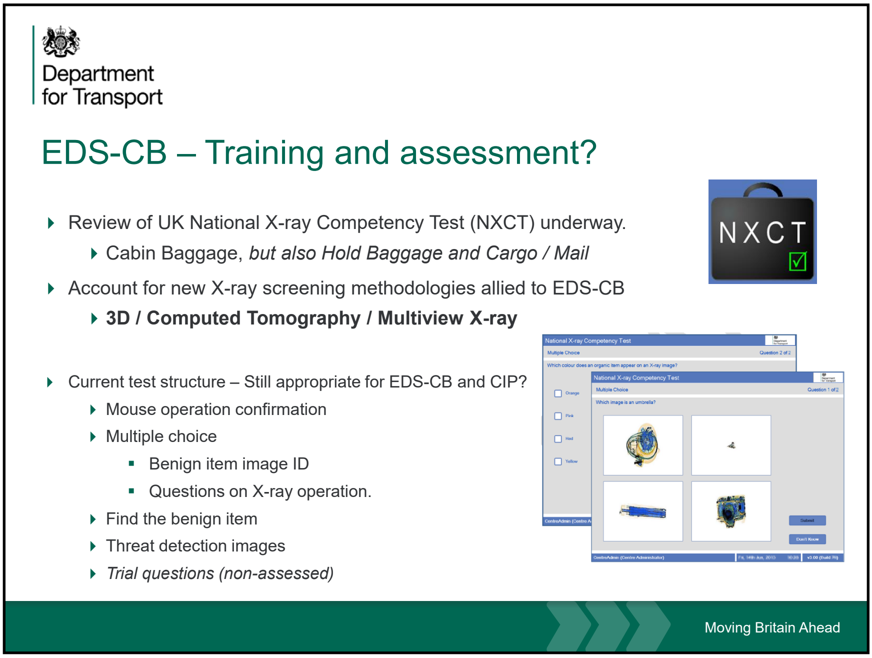

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EDS-CB – Training and assessment?

- Review of UK National X-ray Competency Test (NXCT) underway.
  - Cabin Baggage, *but also Hold Baggage and Cargo / Mail*
- Account for new X-ray screening methodologies allied to EDS-CB
  - **3D / Computed Tomography / Multiview X-ray**
- Current test structure – Still appropriate for EDS-CB and CIP?
  - Mouse operation confirmation
  - Multiple choice
    - Benign item image ID
    - Questions on X-ray operation.
  - Find the benign item
  - Threat detection images
  - *Trial questions (non-assessed)*

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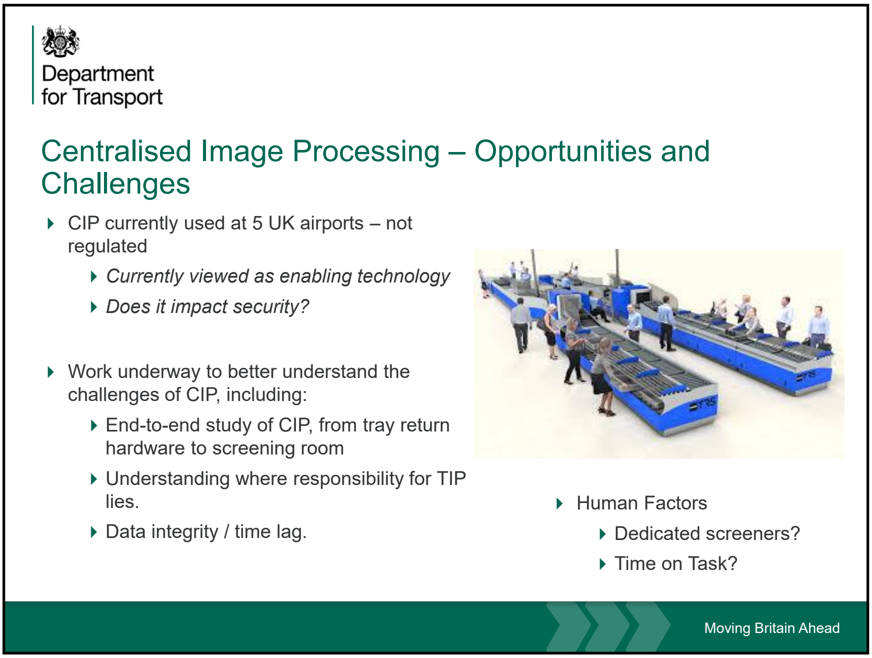

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Centralised Image Processing – Opportunities and Challenges

- CIP currently used at 5 UK airports – not regulated
  - *Currently viewed as enabling technology*
  - *Does it impact security?*
- Work underway to better understand the challenges of CIP, including:
  - End-to-end study of CIP, from tray return hardware to screening room
  - Understanding where responsibility for TIP lies.
  - Data integrity / time lag.
- Human Factors
  - Dedicated screeners?
  - Time on Task?

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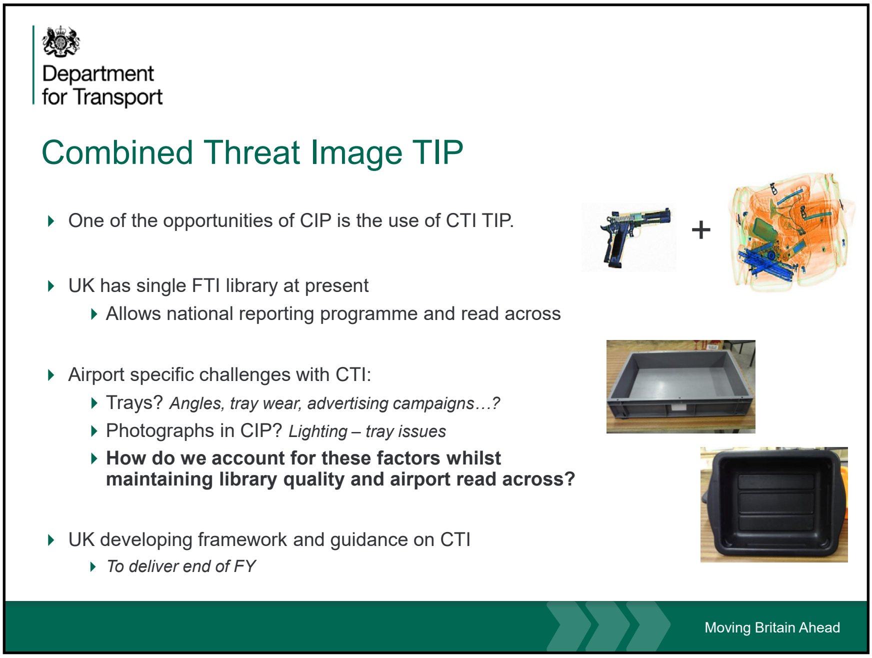

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Combined Threat Image TIP

- One of the opportunities of CIP is the use of CTI TIP.
- UK has single FTI library at present
  - Allows national reporting programme and read across
- Airport specific challenges with CTI:
  - Trays? *Angles, tray wear, advertising campaigns…?*
  - Photographs in CIP? *Lighting – tray issues*
  - **How do we account for these factors whilst maintaining library quality and airport read across?**
- UK developing framework and guidance on CTI
  - *To deliver end of FY*

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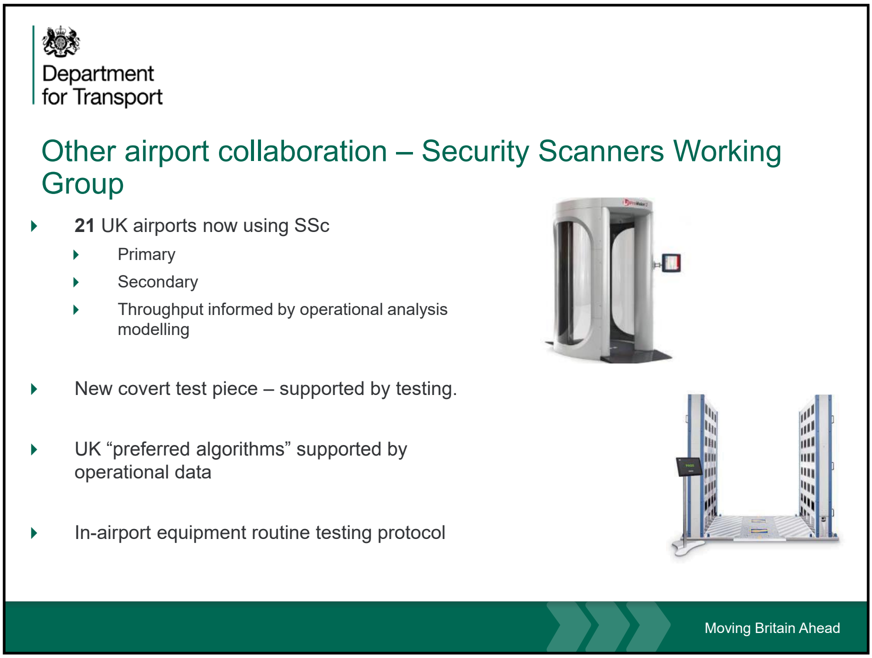

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Other airport collaboration – Security Scanners Working Group

- **21** UK airports now using SSc
  - Primary
  - Secondary
  - Throughput informed by operational analysis modelling
- New covert test piece – supported by testing.
- UK “preferred algorithms” supported by operational data
- In-airport equipment routine testing protocol

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for Transport

Many thanks for your attention!

Questions

?

Ben.jones1@dft.gsi.gov.uk

Moving Britain Ahead

16.6 Paolo Salieri: EU Supported Security Research Activities

EU Security Research

Paolo Salieri

European Commission

DG Migration and Home Affairs

Innovation and Industry for Security

Boston, November 15 2016

Summary

The Horizon 2020 Secure Societies programme represents by far the most significant source of funding in Europe for the development of security technology and innovation.

Why EU security research?

The challenge is about undertaking the research and innovation activities needed to mitigate risks and contribute to the protection of citizens, society and economy.

Disasters can come in any shape or size. A strong EU-wide security framework is a necessity, for better predictive, reactive and resilience-based capabilities if/ when adversity strikes.

Which kind of research?

- *An open challenge led and mission driven approach.*
- *Reducing the barrier to the cross-border dissemination of research outcomes.*
- *Engagement to create social trust in research-based security policies.*

How?

Projects are structured around the collaboration among practitioners, academia, industry.

Who cares?

Innovation outpaces the capacity for regulatory oversight. Unfortunately, crime, terrorism or natural catastrophes do not conform to the institutional aspiration of a predictable, long view of events and consequent policy responses.

Institutional bodies tasked with prevention and protection must invest in the long term.

Industry also needs to take the longer view to exploit the greater market opportunity the EU can offer.

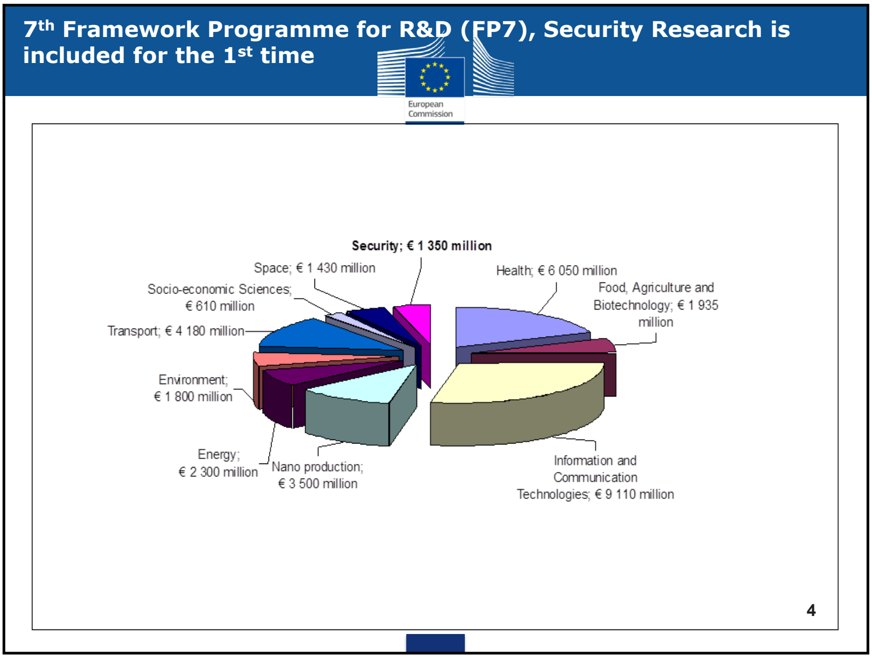
EU Treaty Title XIX - Research and technological development and space

Policy objectives:

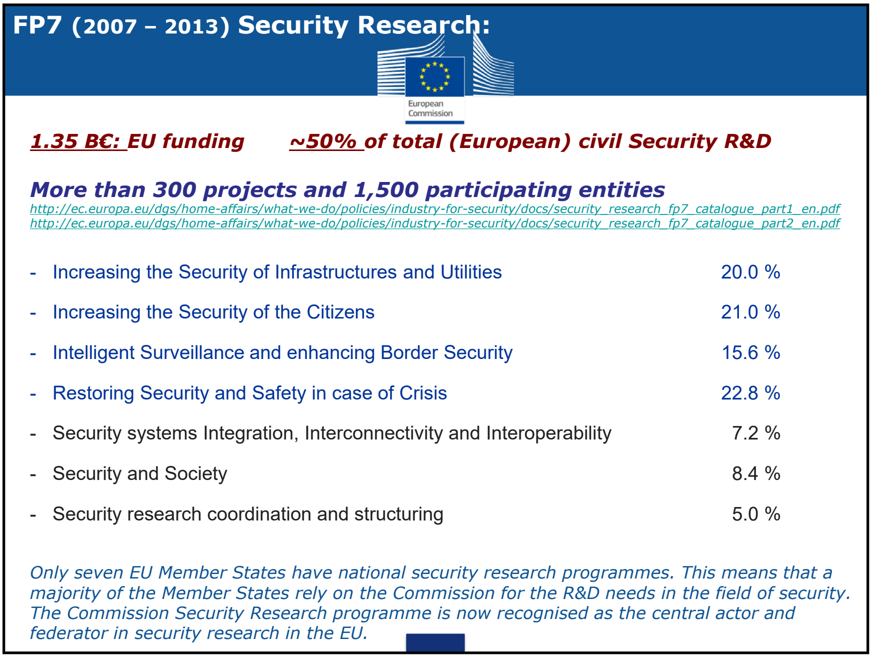
- *Contribute to setting up a European Research Area and Innovation,*
- *Generate knowledge in areas of interest to EU policies,*
- *Support the competitiveness of industry.*

PRINCIPLES:

- *Framework Programmes /Annual Work Programmes / Calls for proposals*
- *Collaborative R&D Min 3 entities from 3 countries*
- *Competitive selection based on Peer Review*
- *Grants (subventions): calls for proposals (shared costs, IPR to proposers)*



7th Framework Programme for R&D (FP7), Security Research is included for the 1st time



FP7 (2007 – 2013) Security Research:

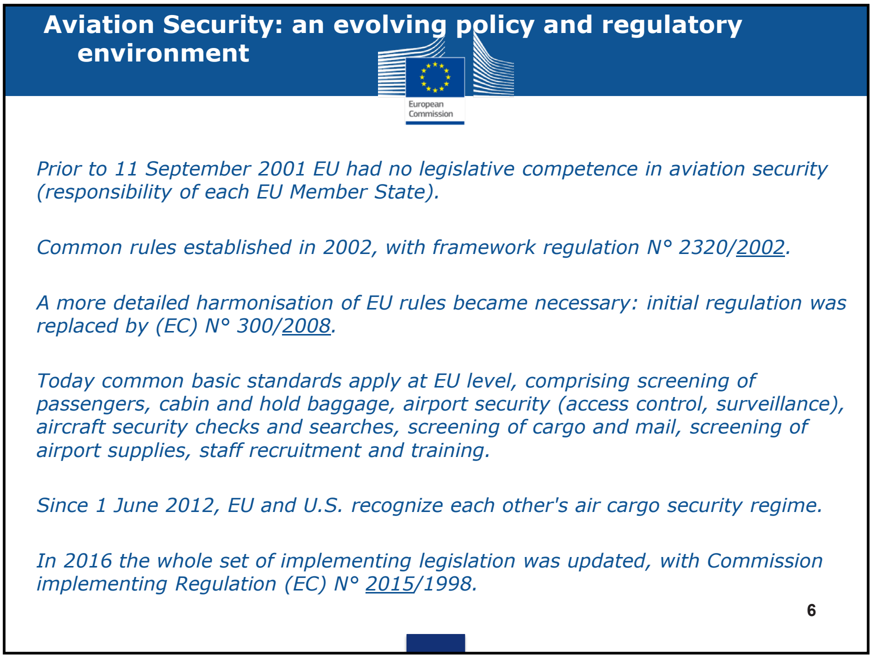
1.35 B€: EU funding **~50% of total (European) civil Security R&D**

More than 300 projects and 1,500 participating entities

http://ec.europa.eu/dgs/home-affairs/what-we-do/policies/industry-for-security/docs/security_research_fp7_catalogue_part1_en.pdf
http://ec.europa.eu/dgs/home-affairs/what-we-do/policies/industry-for-security/docs/security_research_fp7_catalogue_part2_en.pdf

- Increasing the Security of Infrastructures and Utilities	20.0 %
- Increasing the Security of the Citizens	21.0 %
- Intelligent Surveillance and enhancing Border Security	15.6 %
- Restoring Security and Safety in case of Crisis	22.8 %
- Security systems Integration, Interconnectivity and Interoperability	7.2 %
- Security and Society	8.4 %
- Security research coordination and structuring	5.0 %

Only seven EU Member States have national security research programmes. This means that a majority of the Member States rely on the Commission for the R&D needs in the field of security. The Commission Security Research programme is now recognised as the central actor and federator in security research in the EU.



Aviation Security: an evolving policy and regulatory environment

Prior to 11 September 2001 EU had no legislative competence in aviation security (responsibility of each EU Member State).

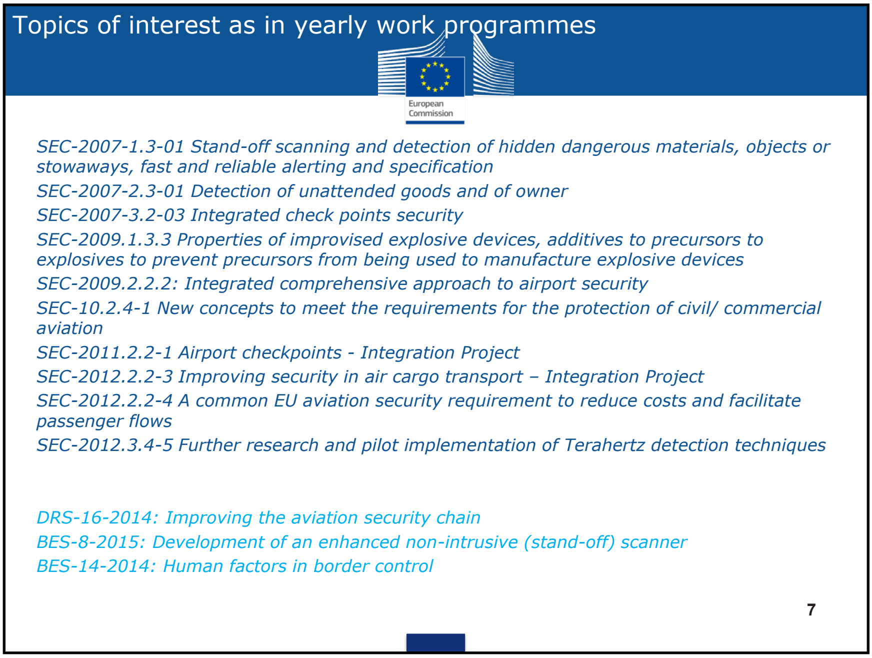
Common rules established in 2002, with framework regulation N° 2320/2002.

A more detailed harmonisation of EU rules became necessary: initial regulation was replaced by (EC) N° 300/2008.

Today common basic standards apply at EU level, comprising screening of passengers, cabin and hold baggage, airport security (access control, surveillance), aircraft security checks and searches, screening of cargo and mail, screening of airport supplies, staff recruitment and training.

Since 1 June 2012, EU and U.S. recognize each other's air cargo security regime.

In 2016 the whole set of implementing legislation was updated, with Commission implementing Regulation (EC) N° 2015/1998.



Topics of interest as in yearly work programmes

SEC-2007-1.3-01 Stand-off scanning and detection of hidden dangerous materials, objects or stowaways, fast and reliable alerting and specification

SEC-2007-2.3-01 Detection of unattended goods and of owner

SEC-2007-3.2-03 Integrated check points security

SEC-2009.1.3.3 Properties of improvised explosive devices, additives to precursors to explosives to prevent precursors from being used to manufacture explosive devices

SEC-2009.2.2.2: Integrated comprehensive approach to airport security

SEC-10.2.4-1 New concepts to meet the requirements for the protection of civil/ commercial aviation

SEC-2011.2.2-1 Airport checkpoints - Integration Project

SEC-2012.2.2-3 Improving security in air cargo transport – Integration Project

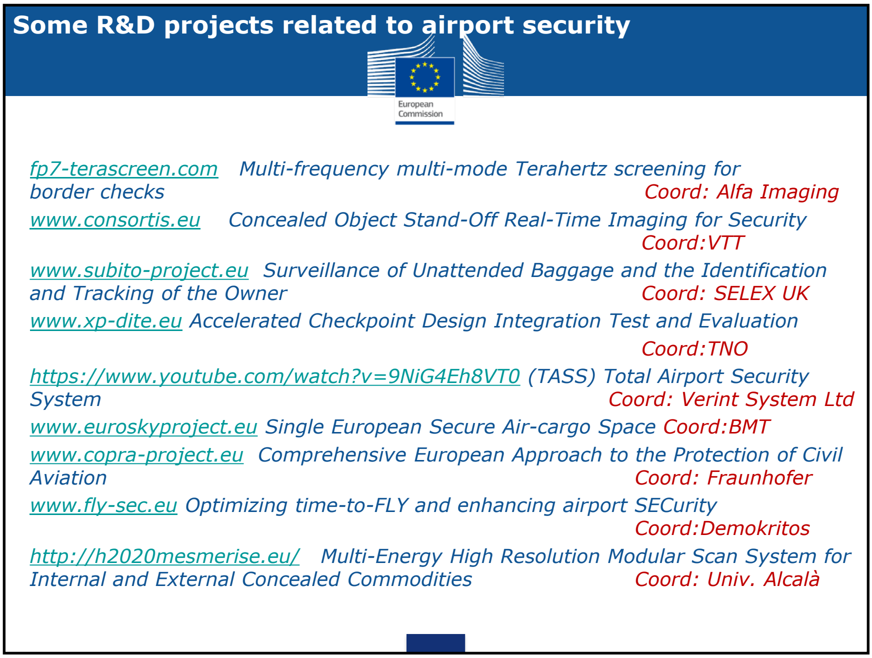
SEC-2012.2.2-4 A common EU aviation security requirement to reduce costs and facilitate passenger flows

SEC-2012.3.4-5 Further research and pilot implementation of Terahertz detection techniques

DRS-16-2014: Improving the aviation security chain

BES-8-2015: Development of an enhanced non-intrusive (stand-off) scanner

BES-14-2014: Human factors in border control



Some R&D projects related to airport security

fp7-terascreen.com Multi-frequency multi-mode Terahertz screening for border checks *Coord: Alfa Imaging*

www.consortis.eu Concealed Object Stand-Off Real-Time Imaging for Security *Coord:VTT*

www.subito-project.eu Surveillance of Unattended Baggage and the Identification and Tracking of the Owner *Coord: SELEX UK*

www.xp-dite.eu Accelerated Checkpoint Design Integration Test and Evaluation *Coord:TNO*

https://www.youtube.com/watch?v=9NiG4Eh8VT0 (TASS) Total Airport Security System *Coord: Verint System Ltd*

www.euroskyproject.eu Single European Secure Air-cargo Space *Coord:BMT*

www.copra-project.eu Comprehensive European Approach to the Protection of Civil Aviation *Coord: Fraunhofer*

www.fly-sec.eu Optimizing time-to-FLY and enhancing airport SECurity *Coord:Demokritos*

http://h2020mesmerise.eu/ Multi-Energy High Resolution Modular Scan System for Internal and External Concealed Commodities *Coord: Univ. Alcalà*

EU action plan on the security of explosives

http://ec.europa.eu/dgs/home-affairs/what-we-do/policies/crisis-and-terrorism/explosives/index_en.htm

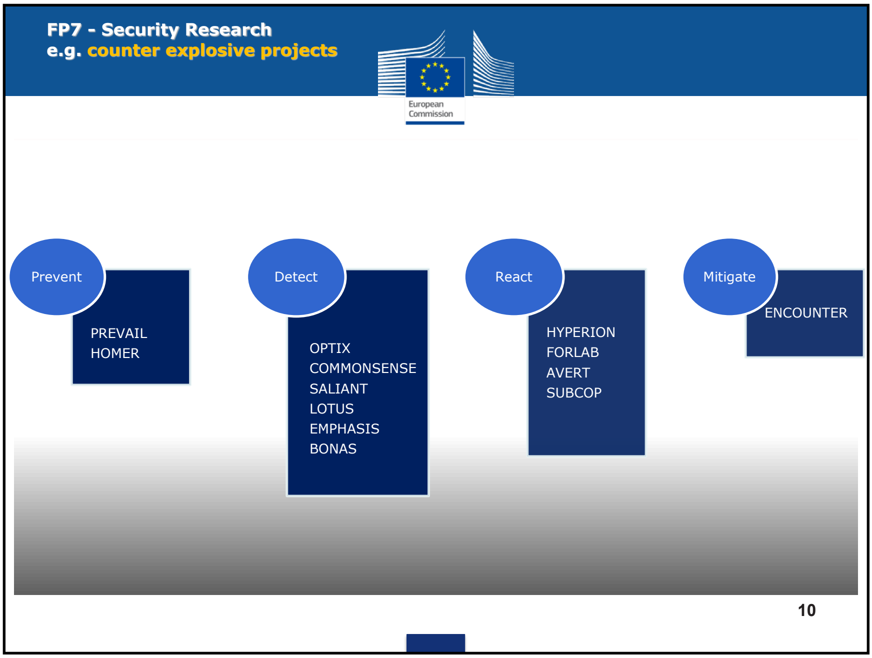
EU role: bring actors together and facilitate cooperation between Member States

better **exchange of information**

increased **operational cooperation**

stronger **cooperation with 3rd countries** and international organizations and initiatives

supporting action: **training**, funding, research and innovation



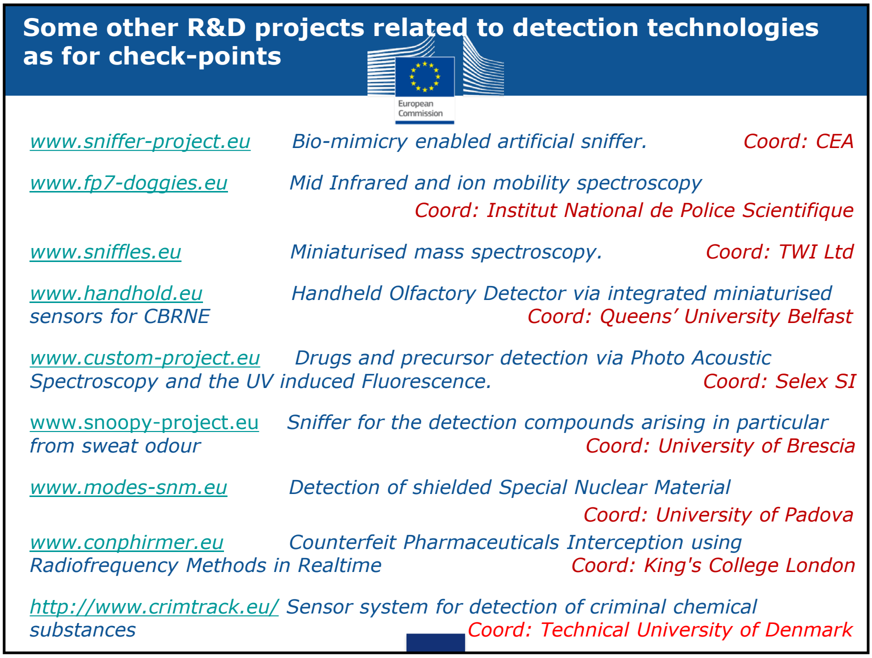
FP7 - Security Research e.g. counter explosive projects

Prevent
- PREVAIL
- HOMER

Detect
- OPTIX
- COMMONSENSE
- SALIANT
- LOTUS
- EMPHASIS
- BONAS

React
- HYPERION
- FORLAB
- AVERT
- SUBCOP

Mitigate
- ENCOUNTER



Some other R&D projects related to detection technologies as for check-points

European Commission

www.sniffer-project.eu Bio-mimicry enabled artificial sniffer. Coord: CEA

www.fp7-doggies.eu Mid Infrared and ion mobility spectroscopy
Coord: Institut National de Police Scientifique

www.sniffles.eu Miniaturised mass spectroscopy. Coord: TWI Ltd

www.handhold.eu Handheld Olfactory Detector via integrated miniaturised sensors for CBRNE
Coord: Queens' University Belfast

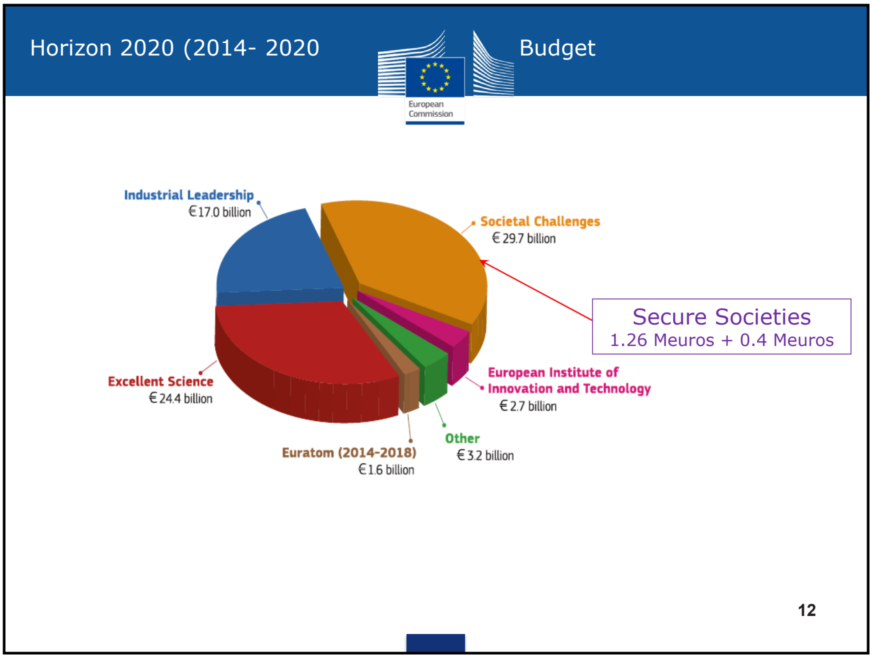
www.custom-project.eu Drugs and precursor detection via Photo Acoustic Spectroscopy and the UV induced Fluorescence. Coord: Selex SI

www.snoopy-project.eu Sniffer for the detection compounds arising in particular from sweat odour
Coord: University of Brescia

www.modes-snm.eu Detection of shielded Special Nuclear Material
Coord: University of Padova

www.conphirmer.eu Counterfeit Pharmaceuticals Interception using Radiofrequency Methods in Realtime Coord: King's College London

http://www.crimtrack.eu/ Sensor system for detection of criminal chemical substances
Coord: Technical University of Denmark



Horizon 2020 (2014- 2020 Budget

European Commission

Secure Societies
1.26 Meuros + 0.4 Meuros

Secure Societies *Protecting Freedom and Security of Europe and its citizens*

OBJECTIVES (as in legal basis)

1. **Fight crime, illegal trafficking and terrorism, including understanding and tackling terrorist ideas and beliefs**
2. **Protect and improve the resilience of critical infrastructures, supply chains and transport modes**
3. **Strengthen security through border management**
4. **Improve cyber security**
5. **Increase Europe's resilience to crises and disasters**
6. **Ensure privacy and freedom, including in the Internet and enhancing the societal legal and ethical understanding of all areas of security, risk and management**
7. **Enhance standardisation and interoperability of systems, including for emergency purposes**

6\. **Support the Union's external security policies including through conflict prevention and peace-building**

Secure Societies: Structure of yearly Work Programmes
4 separate / parallel calls for proposals

- ✓ **Disaster Resilient Societies (DRS)**
- ✓ Crisis management and civil protection, critical infrastructure protection
  2014: 80.40 M€, 2015: 89.73 M€, 2016: 19.50 M€, 2017: 23.75 M€
- ✓ **Fight against Crime and Terrorism (FCT)**
  Forensics, law enforcement capabilities, ethical/societal dimension
  2014: 56.77 M€, 2015: 42.16 M€, 2016: 44.20 M€, 2017: 54.00 M€
- ✓ **Border and External Security (BES)**
  Surveillance/crossing points, information management, supply chain (at border) security
  2014: 20.78 M€, 2015: 42.17 M€, 2016: 34.00 M€, 2017: 36.00 M€
- ✓ **Digital Security (DS)**
  Privacy, access control, trust e-Services, Secure information sharing
  2014: 47.04 M€, 2015: 50.21 M€, 2016: 63.50 M€, 2017: 56.10 M€

Work-programmes:
http://ec.europa.eu/research/participants/data/ref/h2020/wp/2014_2015/main/h2020-wp1415-security_en.pdf
http://ec.europa.eu/research/participants/data/ref/h2020/wp/2016_2017/main/h2020-wp1617-security_en.pdf

Catalogue of projects:
http://ec.europa.eu/dgs/home-affairs/what-we-do/policies/industry-for-security/docs/828s_catalogue_h2020_exe_en.pdf

Present Context

Sir Julian King appointed new Commissioner for Security Union (21/9/2016)

http://www.consilium.europa.eu/en/press/press-releases/2016/09/19-julian-king-new-commissioner-for-security-union/

Commission has proposed a regulation establishing a EU certification system for aviation security equipment and to promote a more competitive security industry (7/9/2016)

COM(2016) 491 final *http://europa.eu/rapid/press-release_IP-16-2943_en.htm*

The introduction of an EU certificate will allow equipment approved in one Member State also to be put on the market in others.

Discussion on-going for a Focus Area in Horizon 2020: "Supporting the Security Union" (to explicitly refer also to Transport Security).

Secure Societies WP 2016-2017 : additional calls

CIP-01-2016-2017: Prevention, detection, response and mitigation of the combination of physical and cyber threats to the critical infrastructure of Europe.

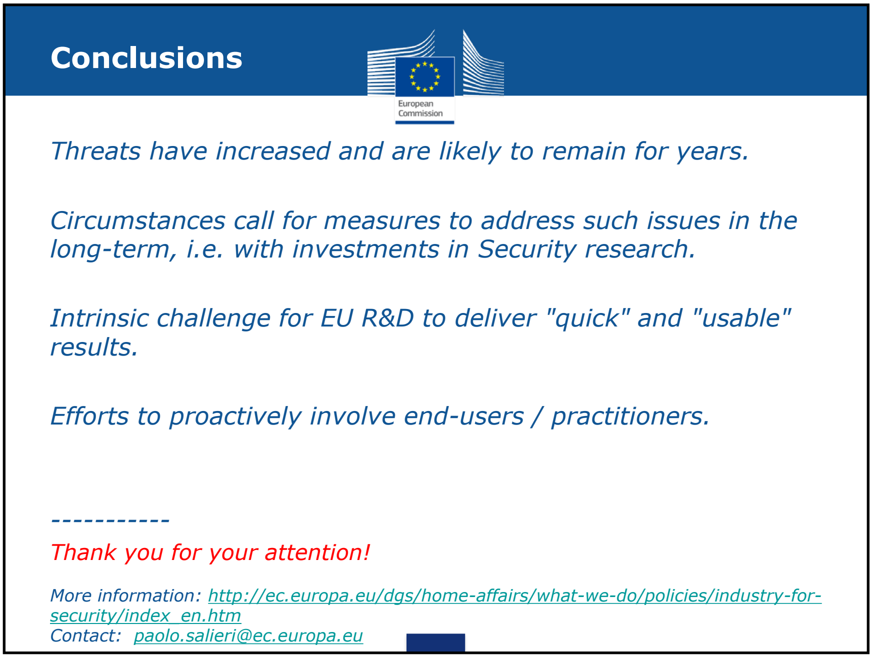
Scope: Proposals should focus on one of the following critical infrastructures: Water Systems, Energy Infrastructure (power plants and distribution), Transport Infrastructure and means of transportation, Communication Infrastructure, Health Services, Financial Services.

20 M€ in 2016 and 20 M€ in 2017

SEC-21–GM-2016-2017: Pan European Networks of practitioners and other actors in the field of security (possibly those active in airport security)

15.50 M€ in 2016 and 16.30 M€ in 2017

A practitioner is someone who is qualified or registered to practice a particular occupation, profession in the field of security or civil protection.



Conclusions

Threats have increased and are likely to remain for years.

Circumstances call for measures to address such issues in the long-term, i.e. with investments in Security research.

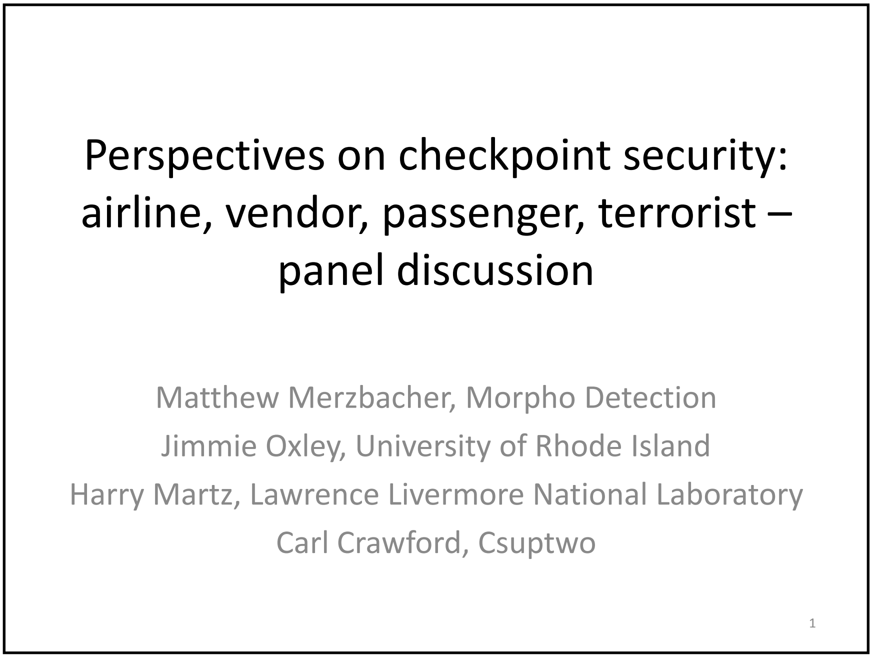
Intrinsic challenge for EU R&D to deliver "quick" and "usable" results.

Efforts to proactively involve end-users / practitioners.

Thank you for your attention!

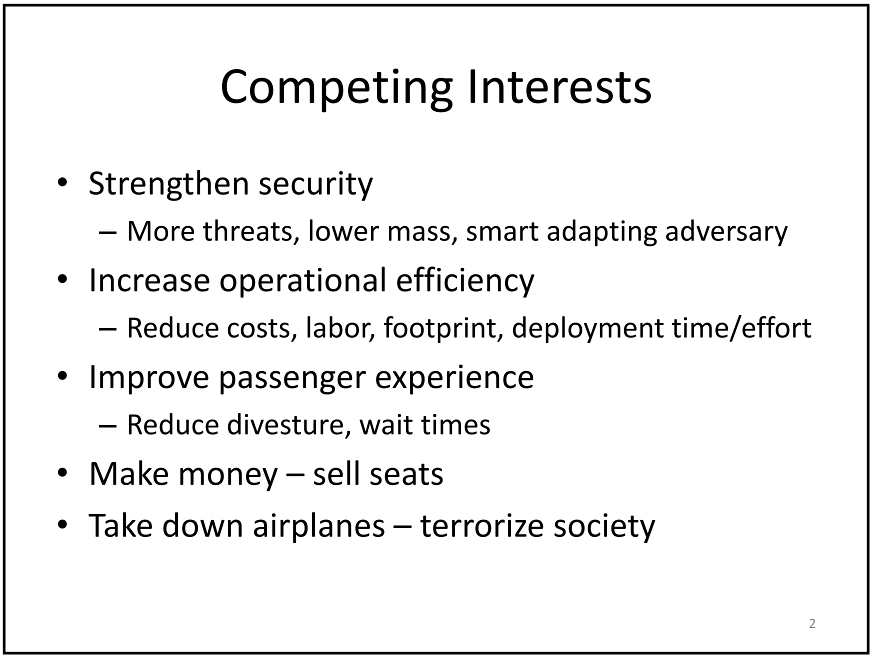
More information: http://ec.europa.eu/dgs/home-affairs/what-we-do/policies/industry-for-security/index_en.htm
Contact: paolo.salieri@ec.europa.eu

16.7 Matthew Merzbacher, Jimmie Oxley & Harry Martz: Perspectives on Checkpoint Security: Airline, Vendor, Passenger, Terrorist



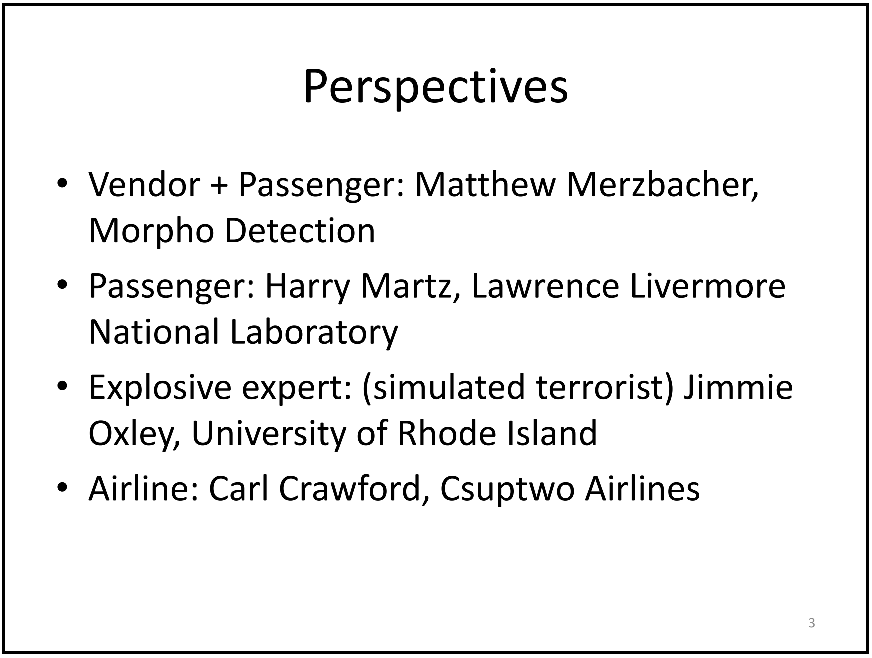
Perspectives on checkpoint security: airline, vendor, passenger, terrorist – panel discussion

Matthew Merzbacher, Morpho Detection
Jimmie Oxley, University of Rhode Island
Harry Martz, Lawrence Livermore National Laboratory
Carl Crawford, Csuptwo



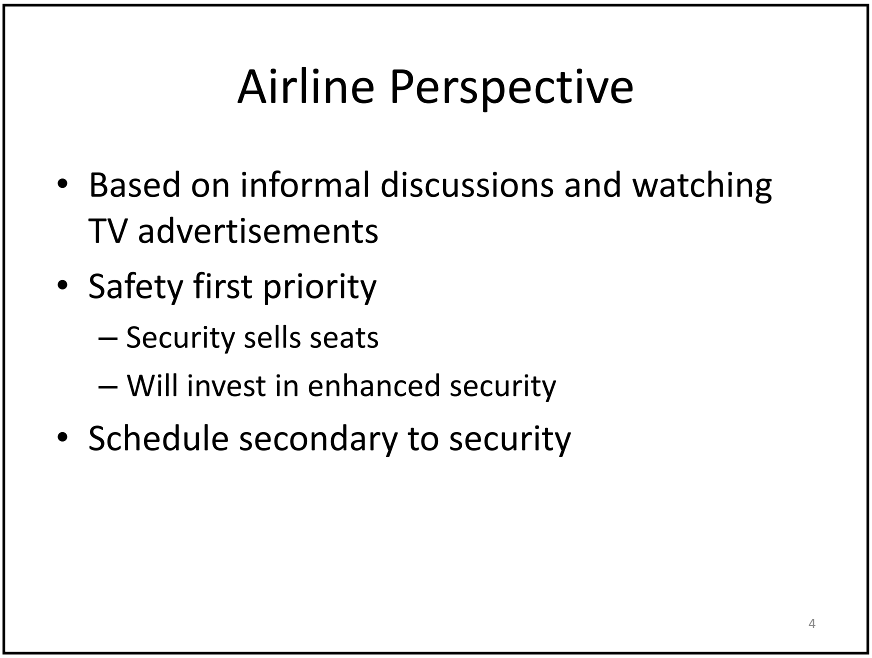
Competing Interests

- Strengthen security
  - More threats, lower mass, smart adapting adversary
- Increase operational efficiency
  - Reduce costs, labor, footprint, deployment time/effort
- Improve passenger experience
  - Reduce divesture, wait times
- Make money – sell seats
- Take down airplanes – terrorize society



Perspectives

- Vendor + Passenger: Matthew Merzbacher, Morpho Detection
- Passenger: Harry Martz, Lawrence Livermore National Laboratory
- Explosive expert: (simulated terrorist) Jimmie Oxley, University of Rhode Island
- Airline: Carl Crawford, Csuptwo Airlines



Airline Perspective

- Based on informal discussions and watching TV advertisements
- Safety first priority
  - Security sells seats
  - Will invest in enhanced security
- Schedule secondary to security

Passenger Perspective (I)

- Safe travels
- Walk directly to gate – invisible security
  - No divestiture
  - No wait times in lines
  - No pat-downs

Passenger Perspective (II)

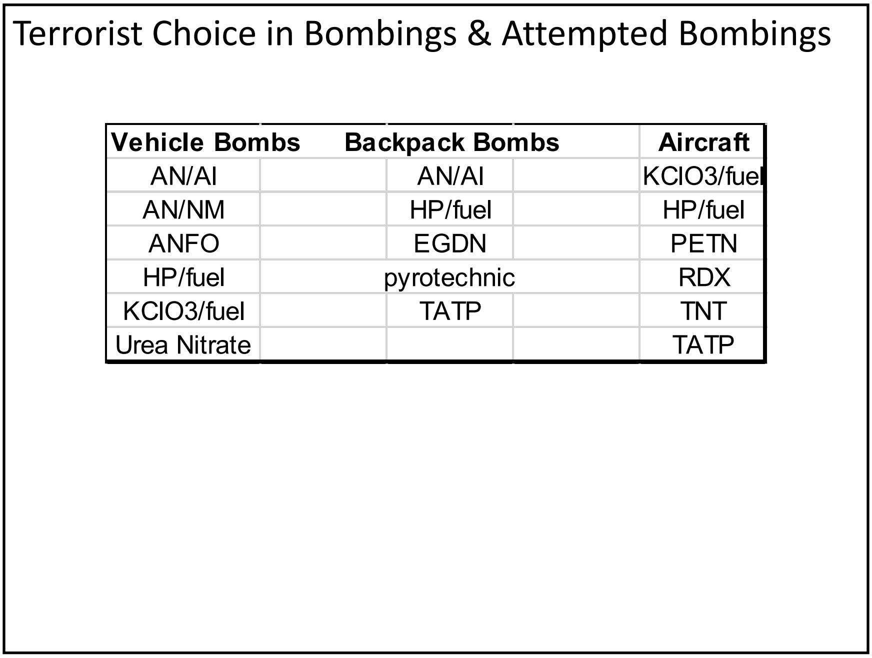
- Regular passengers want:
  - consistency of experience [especially experienced travelers]
  - (it is better to have a half hour in line every time than 5 minutes usually and 1 hour other times, because you have to plan for 1 hour no matter what)
  - better directions and controls so that the "newbies" don't get in the way
- Less Experienced passengers want:
  - Openness
    - explanation for what's being done and why
    - a feeling that common sense is prevailing over procedure
    - my MiL was infuriated by a random pat-down she received when she was well over 80 years old

Vendor Perspective

- Consistent revenue stream
- Opportunity to experiment/investigate with new idea
  - Learn by try and fail
- Open dialogue regarding requirements and expectations
  - Flexibility of solution

Terrorist (simulated) Perspective

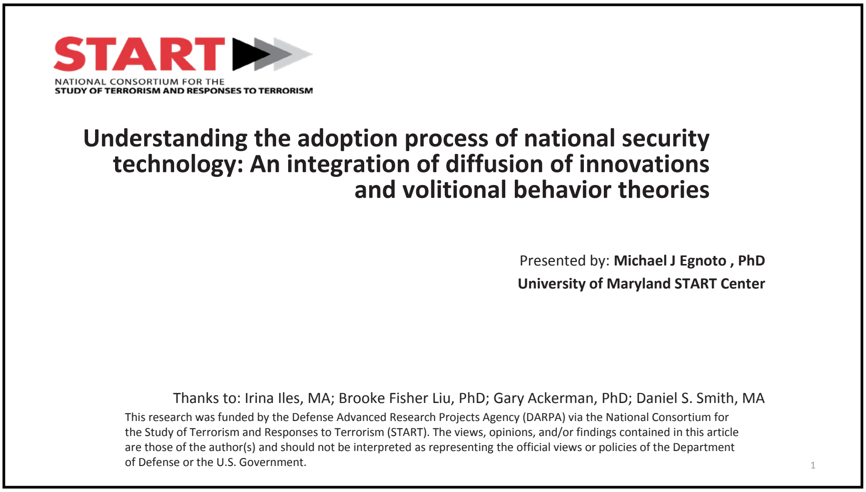
- Choice of Explosive
  - For large bombs it must be possible to acquire or make large amounts of explosive
  - However for transportation targets small amounts can cause great destruction.
- Explosives aren't the only weapon available to terrorists
  - Where ever there is a crowd of people
  - Vehicle assault
  - Stabbing
  - Shooting



Terrorist Choice in Bombings & Attempted Bombings

Vehicle Bombs	**Backpack Bombs**	**Aircraft**
AN/Al	AN/Al	KClO3/fuel
AN/NM	HP/fuel	HP/fuel
ANFO	EGDN	PETN
HP/fuel	pyrotechnic	RDX
KClO3/fuel	TATP	TNT
Urea Nitrate		TATP

16.8 Michael Egnoto: Insights for Mobile Radiation Detector Adoption



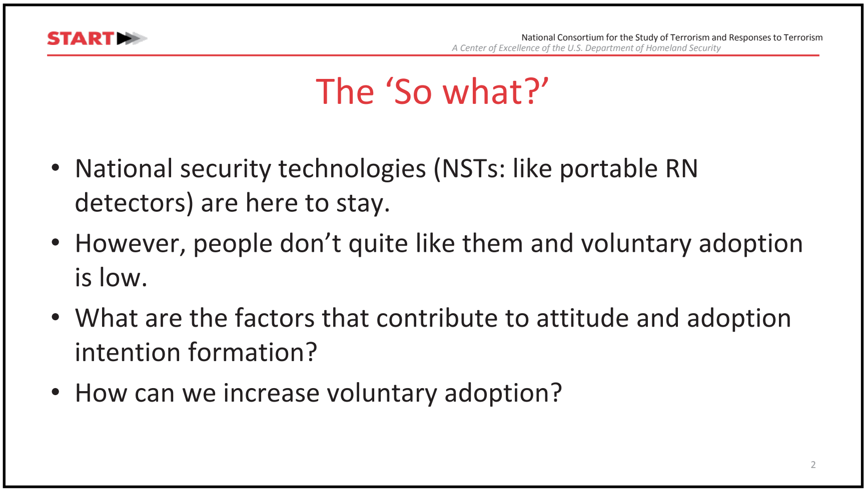
START
NATIONAL CONSORTIUM FOR THE
STUDY OF TERRORISM AND RESPONSES TO TERRORISM

Understanding the adoption process of national security technology: An integration of diffusion of innovations and volitional behavior theories

Presented by: **Michael J Egnoto , PhD**
University of Maryland START Center

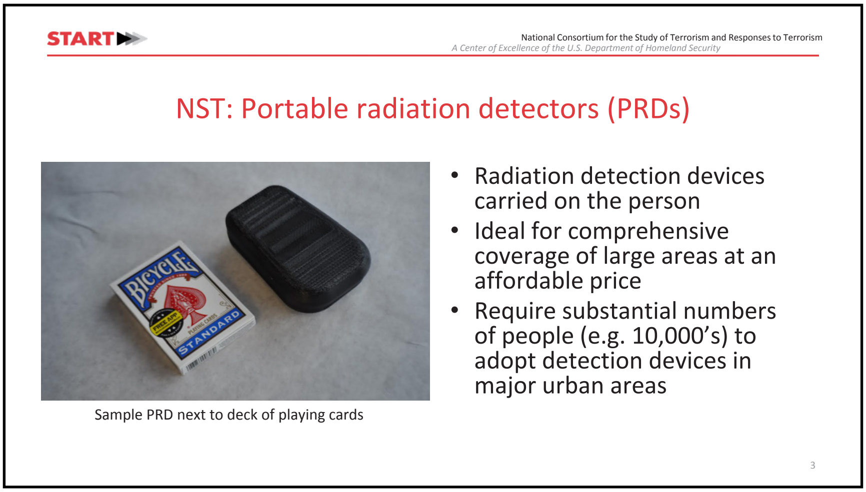
Thanks to: Irina Iles, MA; Brooke Fisher Liu, PhD; Gary Ackerman, PhD; Daniel S. Smith, MA

This research was funded by the Defense Advanced Research Projects Agency (DARPA) via the National Consortium for the Study of Terrorism and Responses to Terrorism (START). The views, opinions, and/or findings contained in this article are those of the author(s) and should not be interpreted as representing the official views or policies of the Department of Defense or the U.S. Government.



The 'So what?'

- National security technologies (NSTs: like portable RN detectors) are here to stay.
- However, people don't quite like them and voluntary adoption is low.
- What are the factors that contribute to attitude and adoption intention formation?
- How can we increase voluntary adoption?

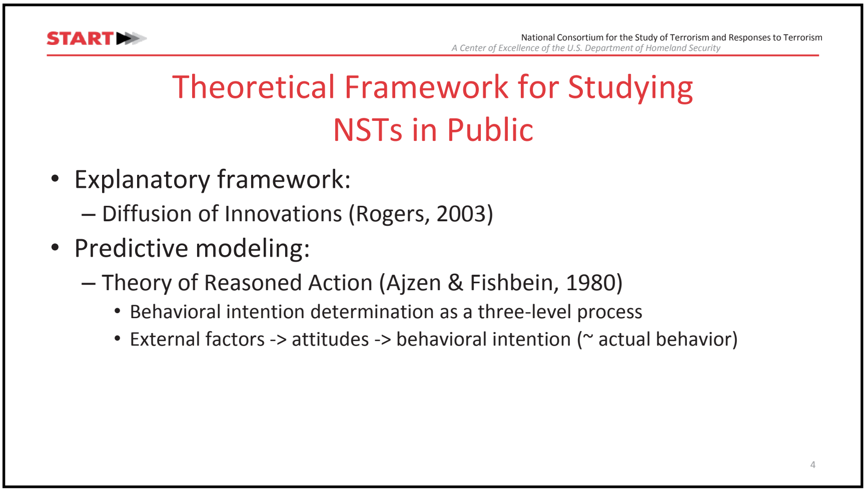


National Consortium for the Study of Terrorism and Responses to Terrorism
A Center of Excellence of the U.S. Department of Homeland Security

NST: Portable radiation detectors (PRDs)

Sample PRD next to deck of playing cards

- Radiation detection devices carried on the person
- Ideal for comprehensive coverage of large areas at an affordable price
- Require substantial numbers of people (e.g. 10,000’s) to adopt detection devices in major urban areas



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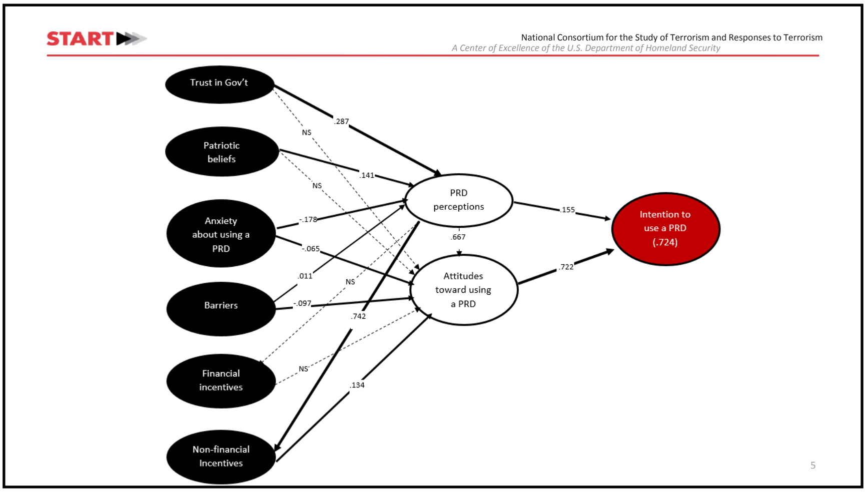
Theoretical Framework for Studying NSTs in Public

- Explanatory framework:
  - – Diffusion of Innovations (Rogers, 2003)
- Predictive modeling:
  - – Theory of Reasoned Action (Ajzen & Fishbein, 1980)
    - Behavioral intention determination as a three-level process
    - External factors -> attitudes -> behavioral intention (~ actual behavior)



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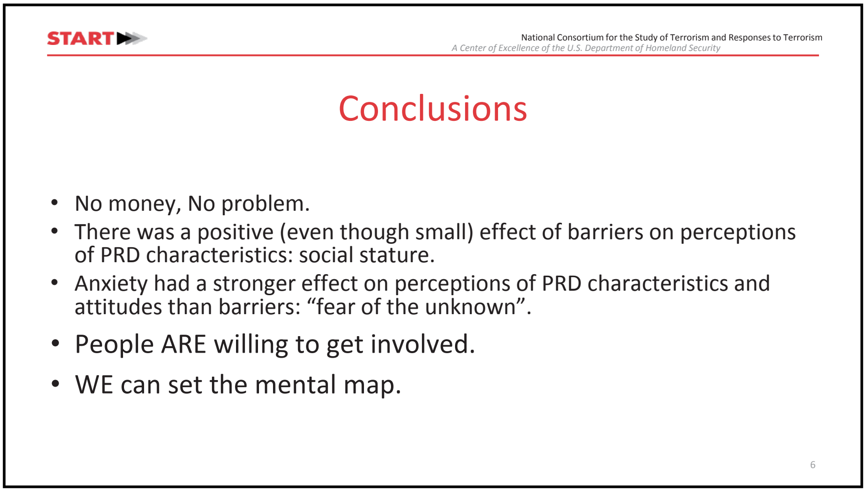

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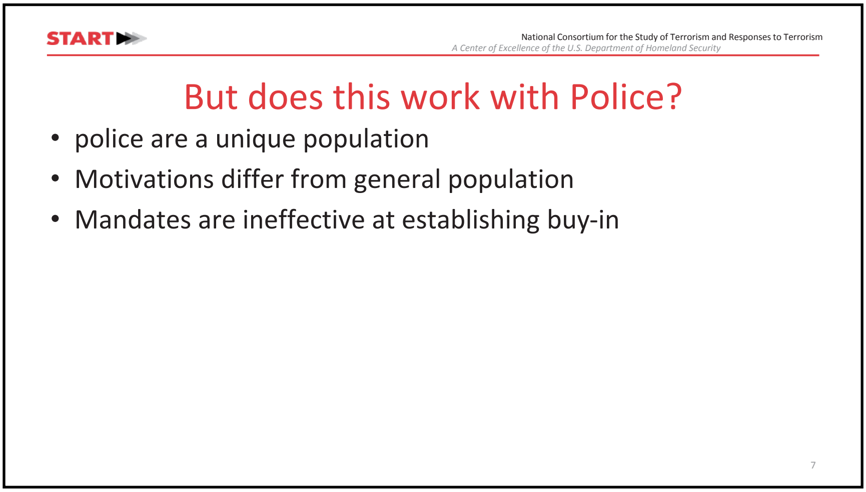
Conclusions

- No money, No problem.
- There was a positive (even though small) effect of barriers on perceptions of PRD characteristics: social stature.
- Anxiety had a stronger effect on perceptions of PRD characteristics and attitudes than barriers: “fear of the unknown”.
- People ARE willing to get involved.
- WE can set the mental map.



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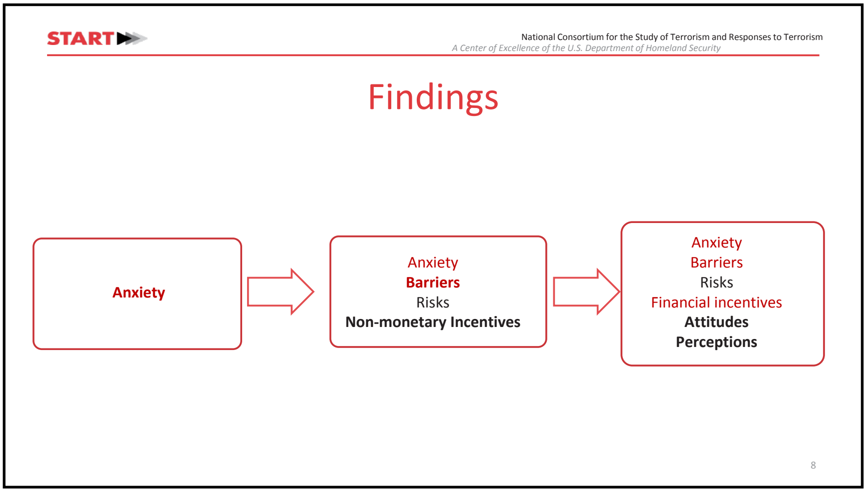
But does this work with Police?

- police are a unique population
- Motivations differ from general population
- Mandates are ineffective at establishing buy-in



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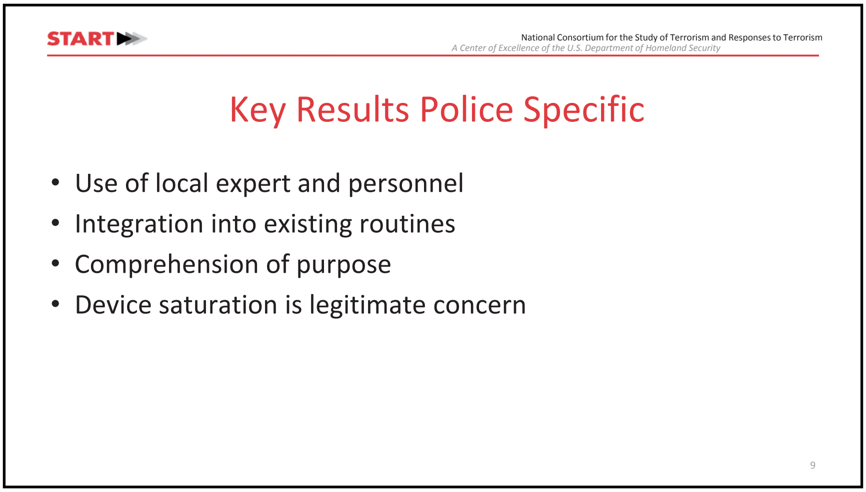
Findings

Anxiety

Anxiety
Barriers
Risks
Non-monetary Incentives

Anxiety
Barriers
Risks
Financial incentives
Attitudes
Perceptions



Key Results Police Specific

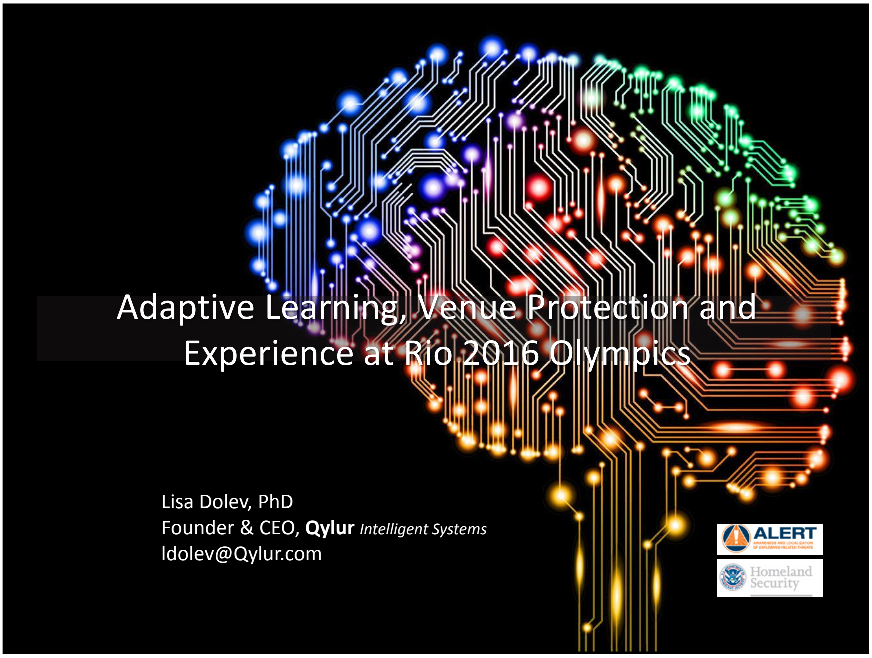
- Use of local expert and personnel
- Integration into existing routines
- Comprehension of purpose
- Device saturation is legitimate concern

Contact

Mike Egnoto
megnoto@umd.edu

www.start.umd.edu

16.9 Lisa Dolev: Adaptive Learning, Venue Protection and Experience at the Rio Olympics



Adaptive Learning, Venue Protection and
Experience at Rio 2016 Olympics

Lisa Dolev, PhD
Founder & CEO, **Qylur** *Intelligent Systems*
ldolev@Qylur.com

16.10 Malcolm Slaney: The Importance of Meta-Data

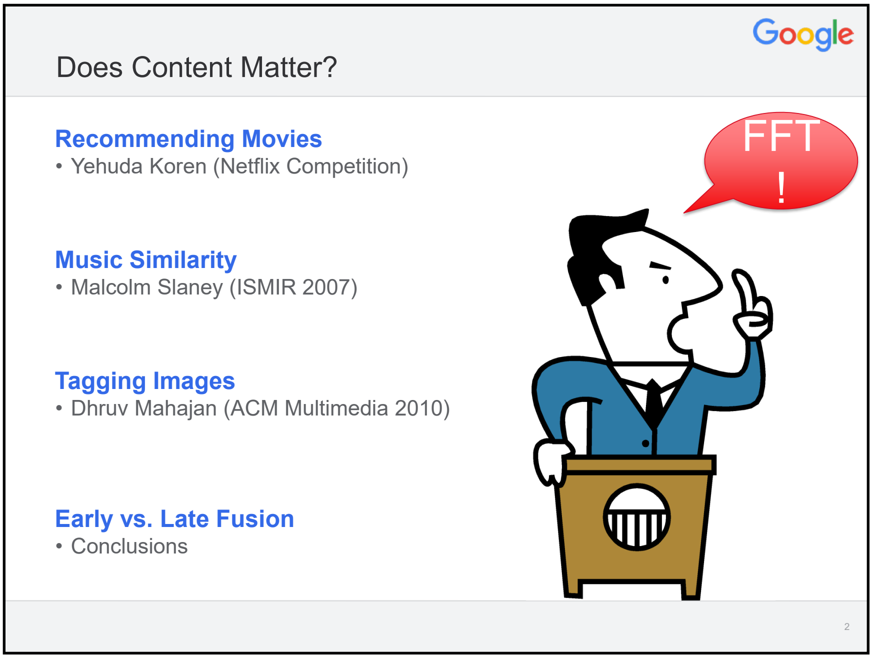
Google

Does Content Matter?

November 15, 2016

Malcolm Slaney

Not a Google project!



Does Content Matter?

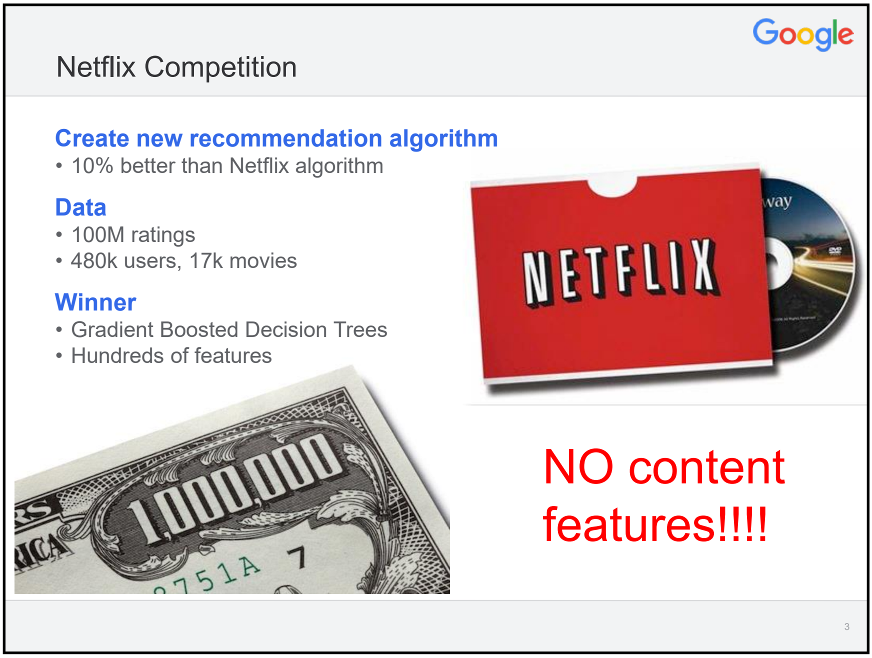
Google

Recommending Movies
- Yehuda Koren (Netflix Competition)

Music Similarity
- Malcolm Slaney (ISMIR 2007)

Tagging Images
- Dhruv Mahajan (ACM Multimedia 2010)

Early vs. Late Fusion
- Conclusions



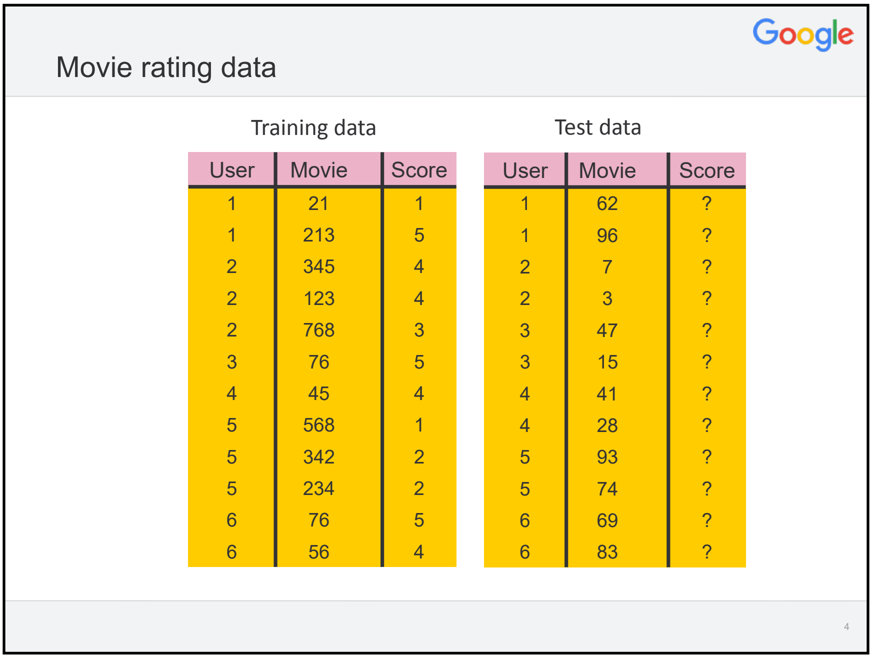
Netflix Competition

Create new recommendation algorithm
- 10% better than Netflix algorithm

Data
- 100M ratings
- 480k users, 17k movies

Winner
- Gradient Boosted Decision Trees
- Hundreds of features

NO content features!!!!



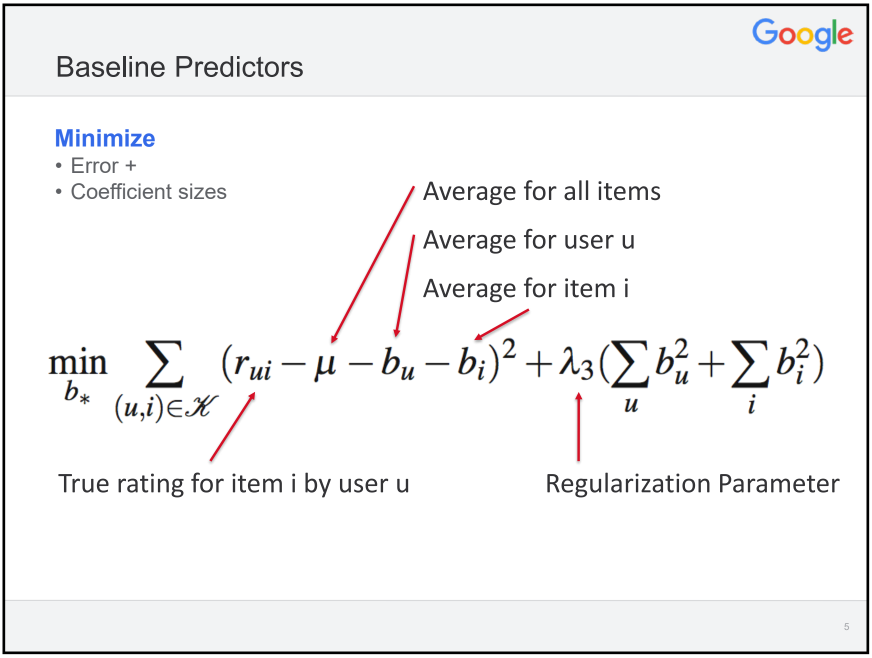
Movie rating data

Training data

User	Movie	Score
1	21	1
1	213	5
2	345	4
2	123	4
2	768	3
3	76	5
4	45	4
5	568	1
5	342	2
5	234	2
6	76	5
6	56	4

Test data

User	Movie	Score
1	62	?
1	96	?
2	7	?
2	3	?
3	47	?
3	15	?
4	41	?
4	28	?
5	93	?
5	74	?
6	69	?
6	83	?



Baseline Predictors

Minimize
- Error +
- Coefficient sizes

Average for all items

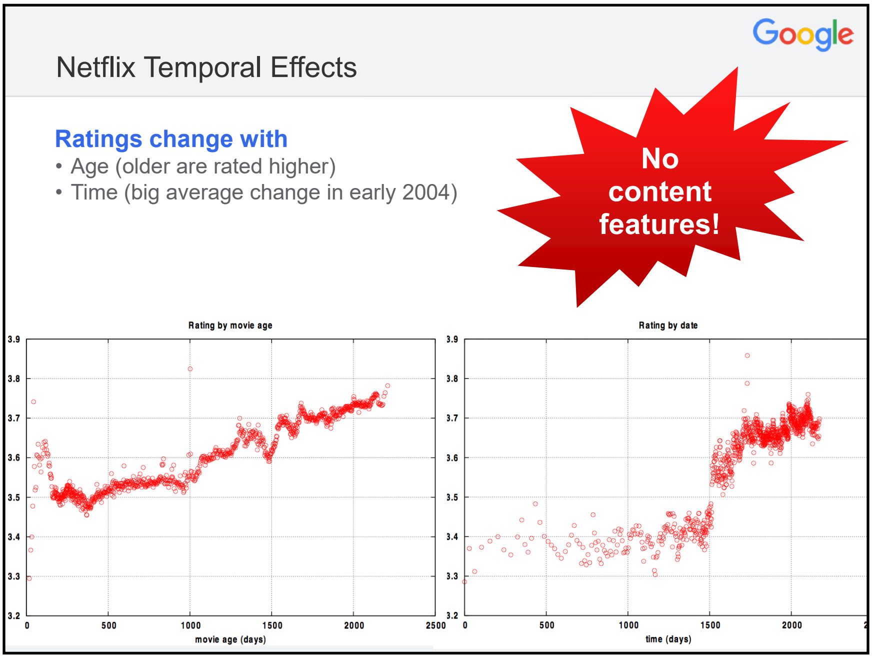
Average for user u

Average for item i

$$\min_{b_*} \sum_{(u,i)\in\mathcal{K}} (r_{ui}-\mu-b_u-b_i)^2+\lambda_3\left(\sum_u b_u^2+\sum_i b_i^2\right)$$

True rating for item i by user u

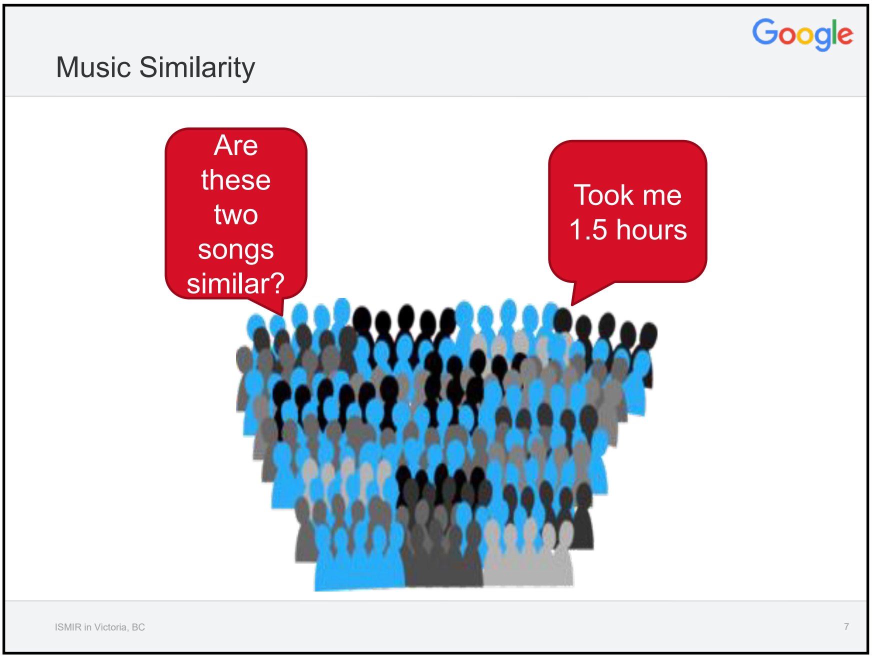
Regularization Parameter



Netflix Temporal Effects

Ratings change with
- Age (older are rated higher)
- Time (big average change in early 2004)

No content features!



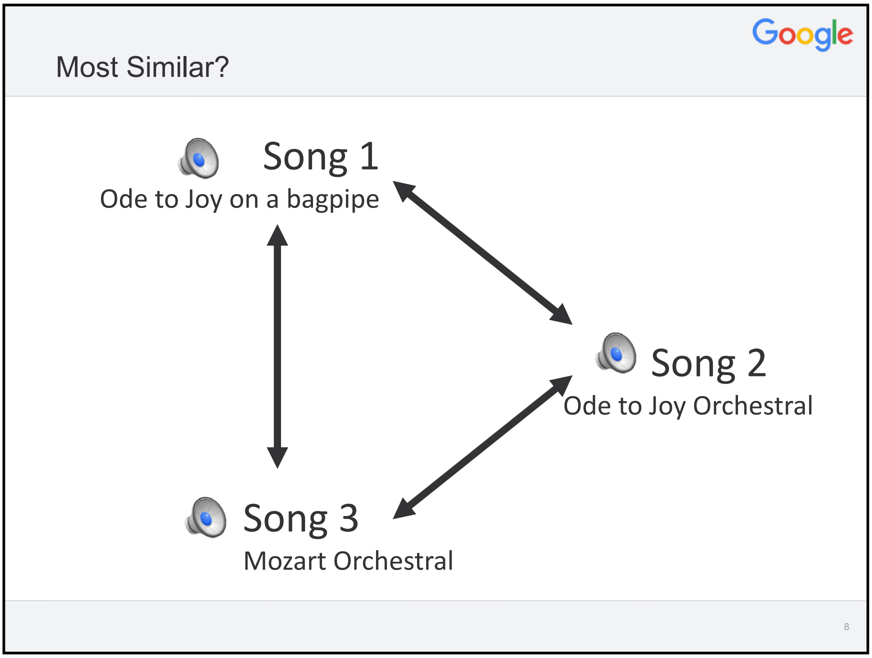
Music Similarity

Are these two songs similar?

Took me 1.5 hours

ISMIR in Victoria, BC

7



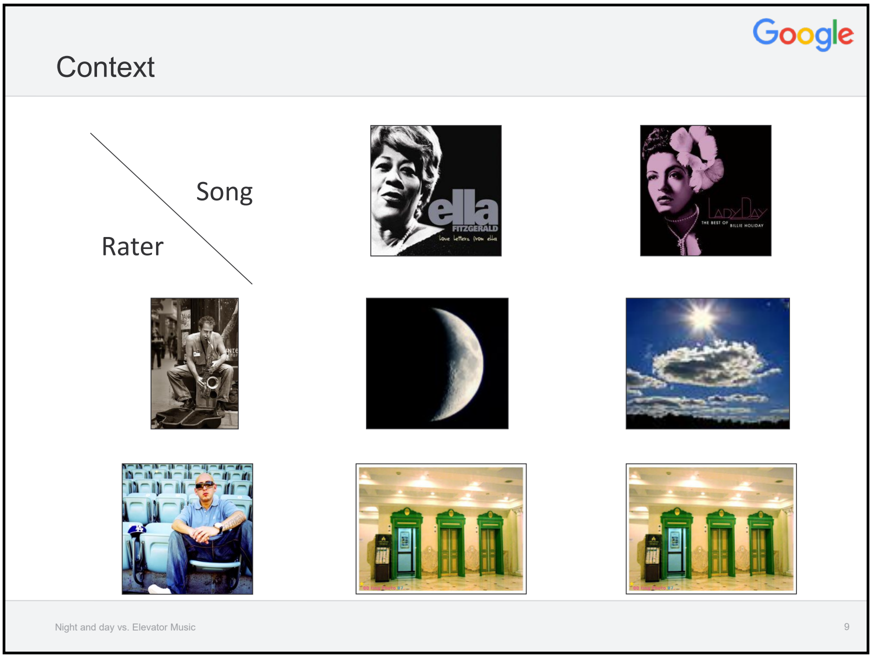
Most Similar?

Song 1
Ode to Joy on a bagpipe

Song 2
Ode to Joy Orchestral

Song 3
Mozart Orchestral

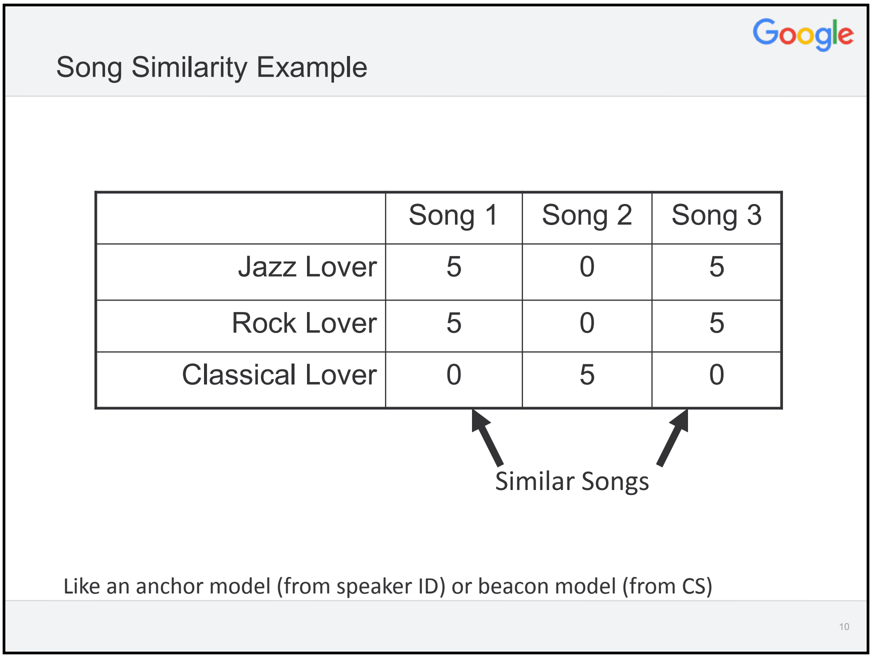
8



Context

Night and day vs. Elevator Music

9



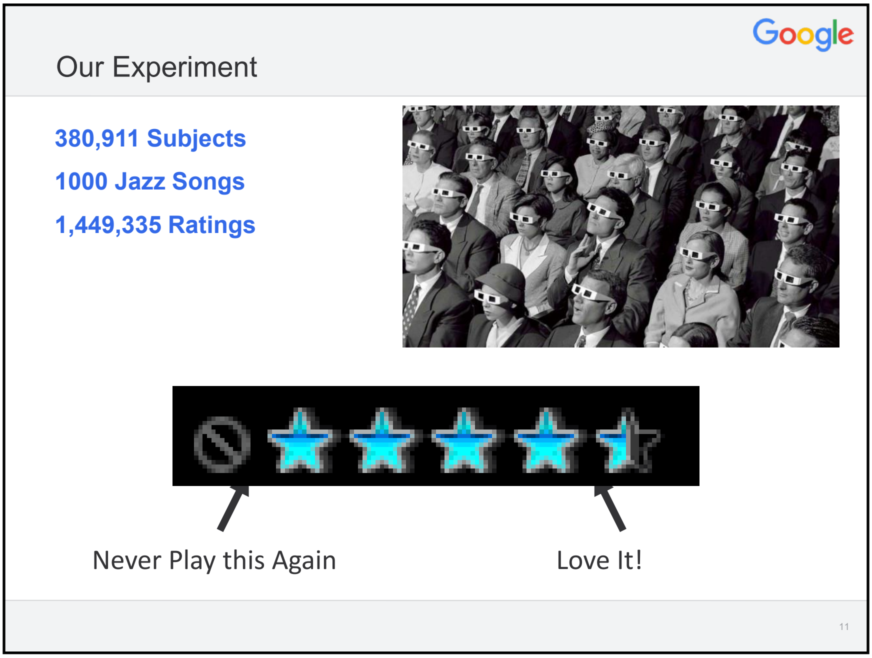
Song Similarity Example

	Song 1	Song 2	Song 3
Jazz Lover	5	0	5
Rock Lover	5	0	5
Classical Lover	0	5	0

Similar Songs

Like an anchor model (from speaker ID) or beacon model (from CS)

10



Our Experiment

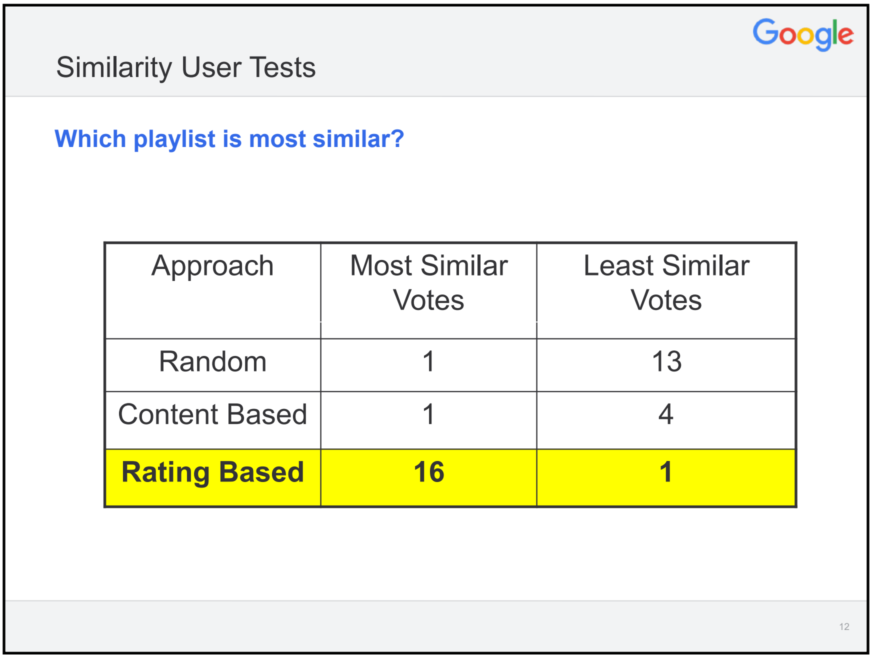
380,911 Subjects

1000 Jazz Songs

1,449,335 Ratings

Never Play this Again

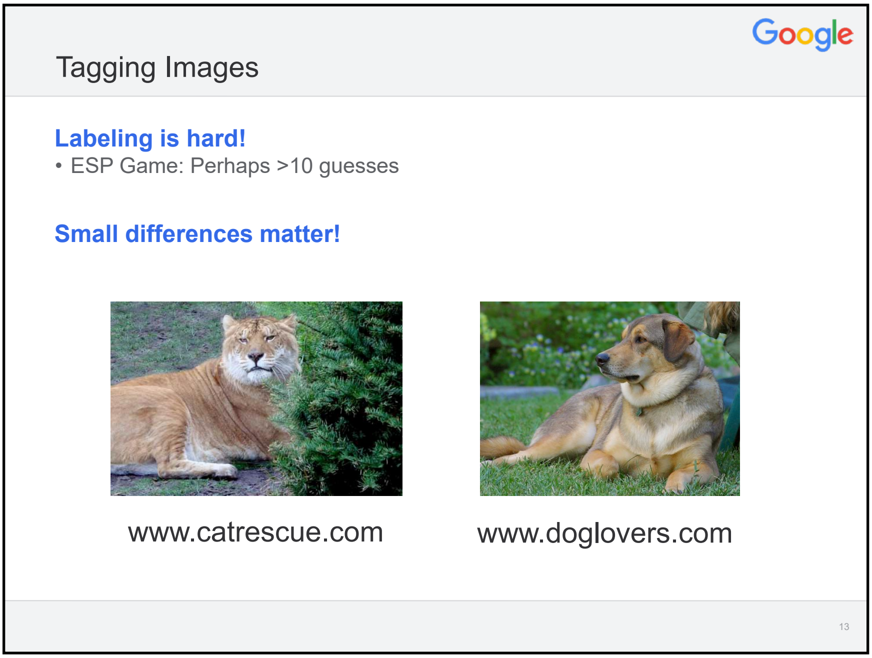
Love It!



Similarity User Tests

Which playlist is most similar?

Approach	Most Similar Votes	Least Similar Votes
Random	1	13
Content Based	1	4
Rating Based	**16**	**1**

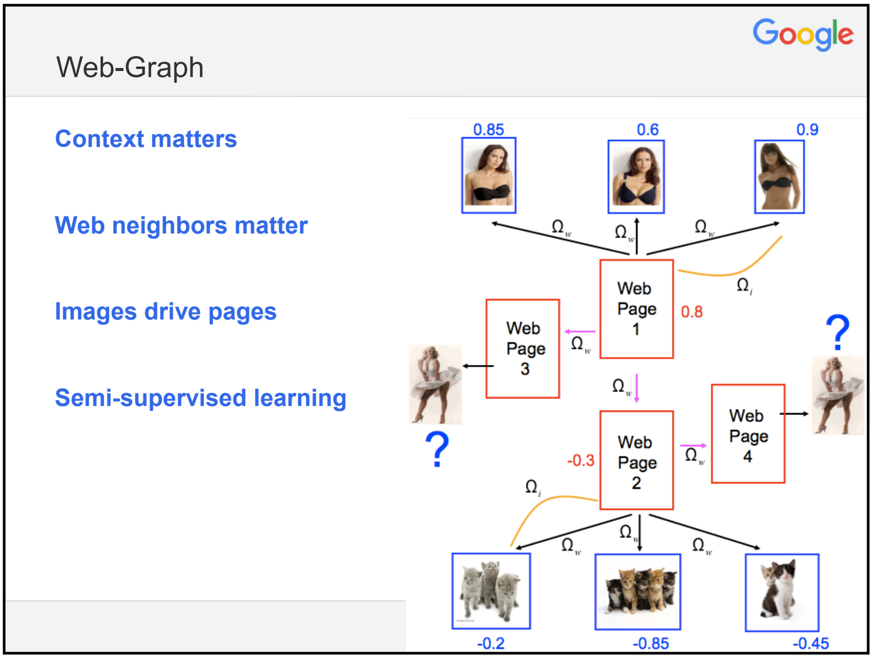


Tagging Images

Labeling is hard!

- ESP Game: Perhaps >10 guesses

Small differences matter!



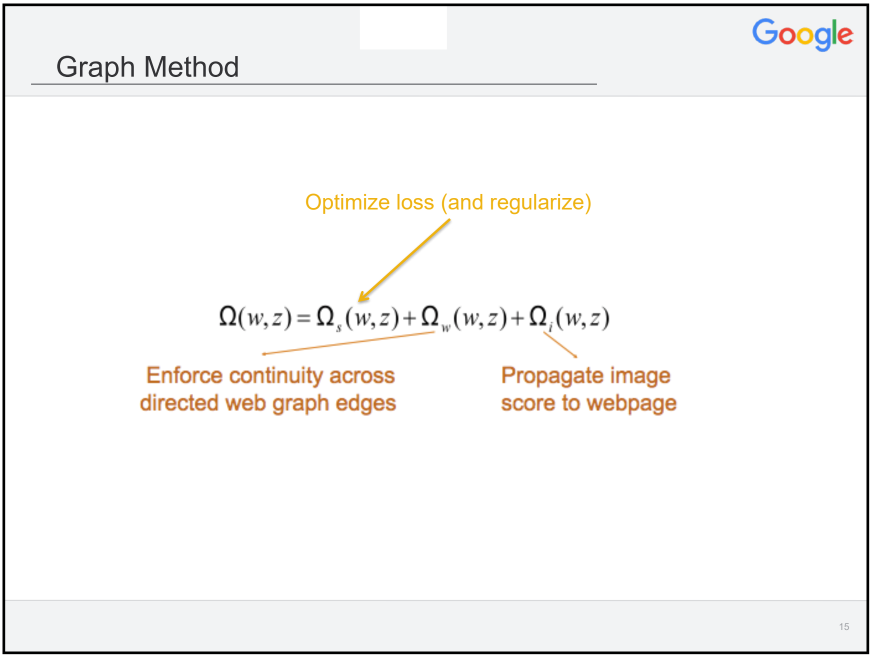
Web-Graph

Context matters

Web neighbors matter

Images drive pages

Semi-supervised learning



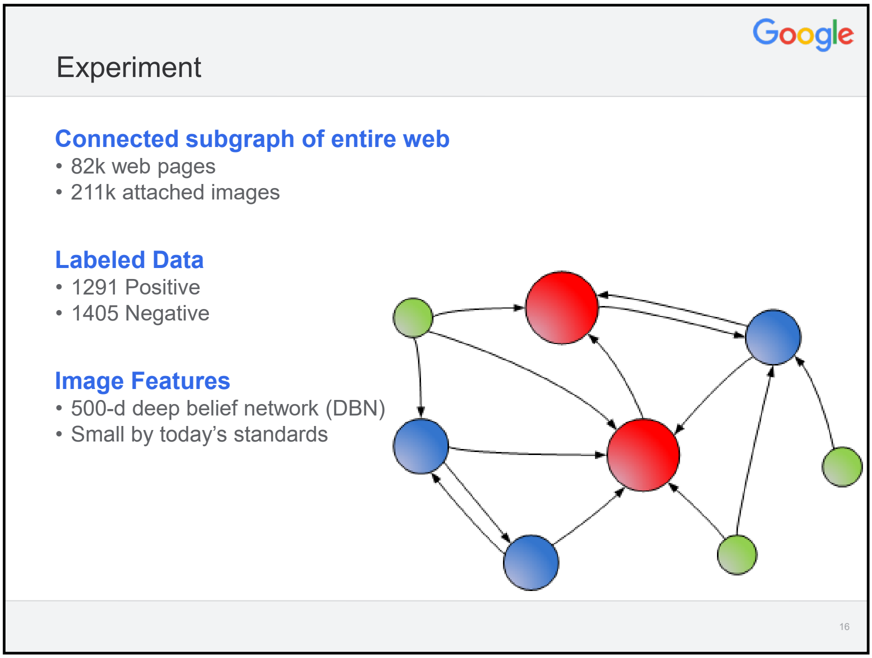
Graph Method

Optimize loss (and regularize)

$$\Omega(w,z)=\Omega_s(w,z)+\Omega_w(w,z)+\Omega_i(w,z)$$

Enforce continuity across directed web graph edges

Propagate image score to webpage

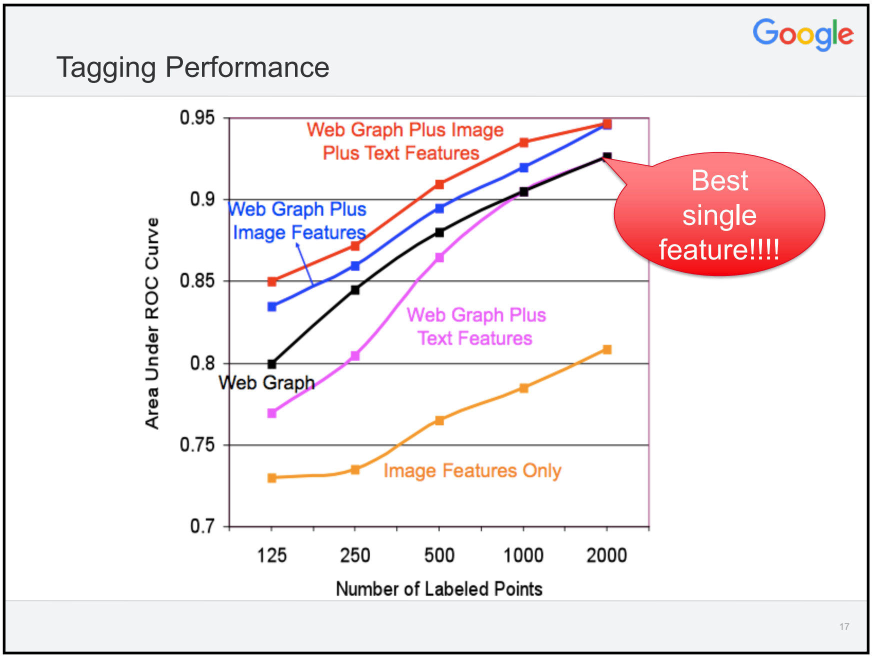


Experiment

Connected subgraph of entire web
- 82k web pages
- 211k attached images

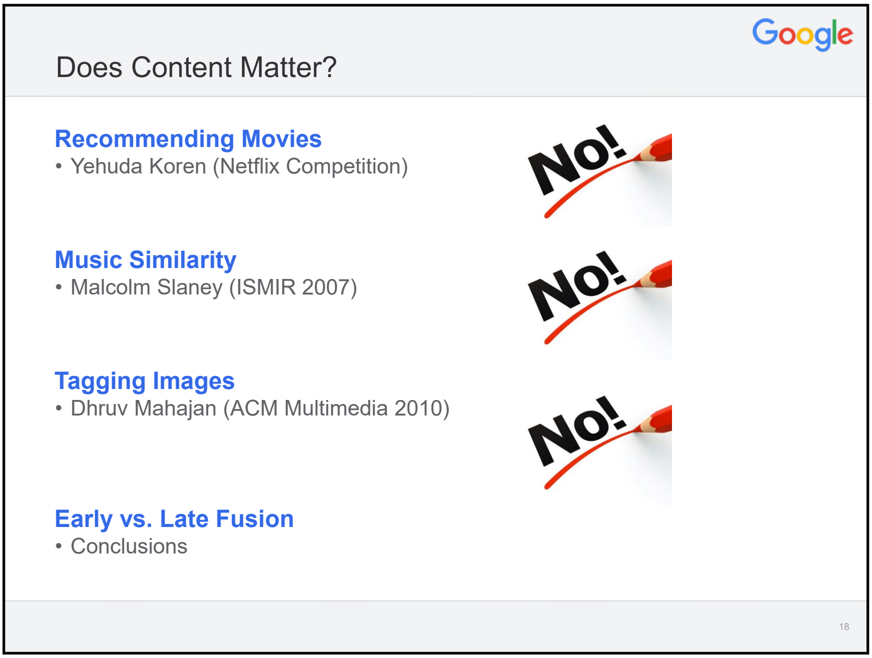
Labeled Data
- 1291 Positive
- 1405 Negative

Image Features
- 500-d deep belief network (DBN)
- Small by today's standards



Tagging Performance

Best single feature!!!!



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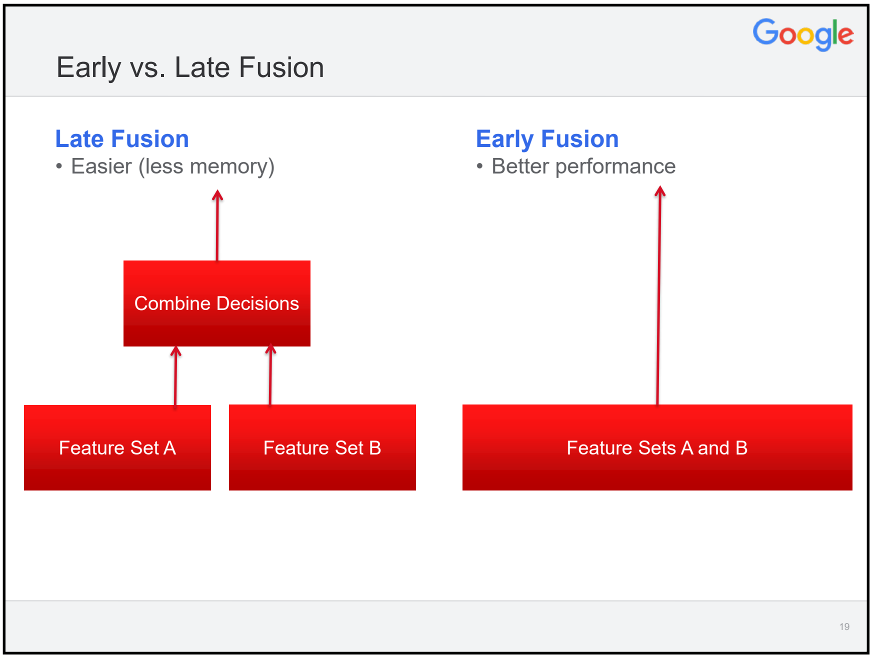
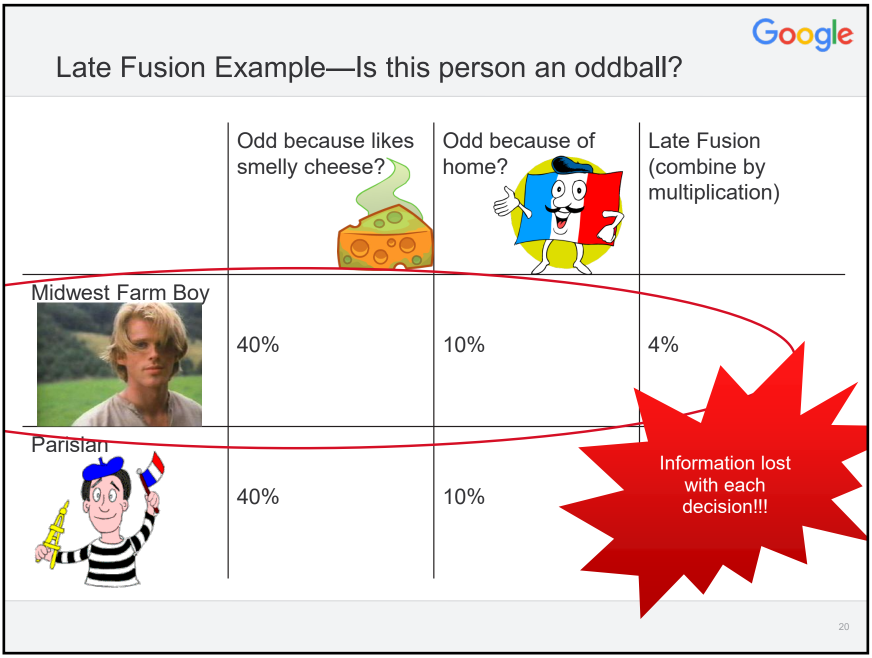
Early vs. Late Fusion
- Conclusions



Early vs. Late Fusion

Late Fusion
- Easier (less memory)

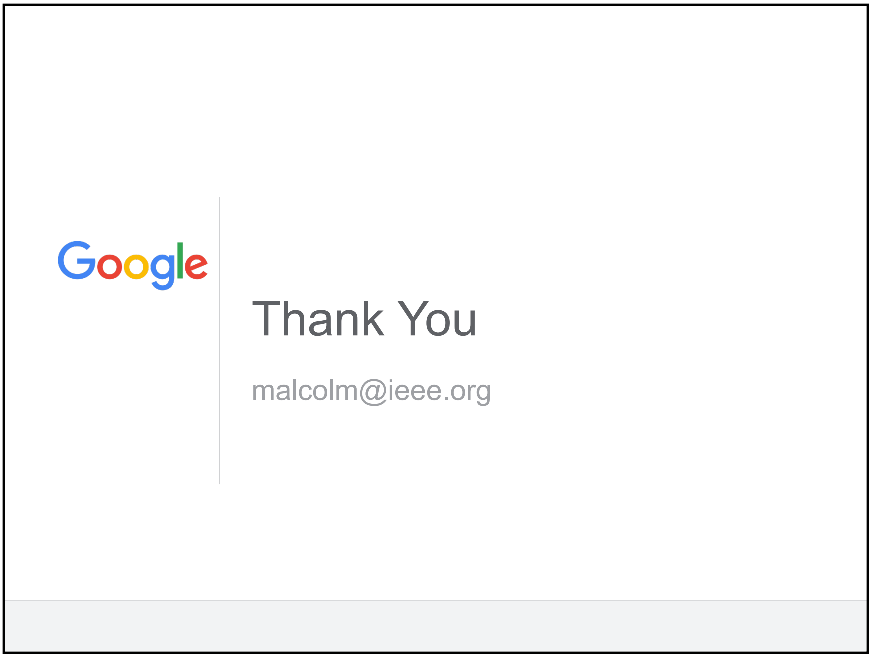
Early Fusion
- Better performance



Late Fusion Example—Is this person an oddball?

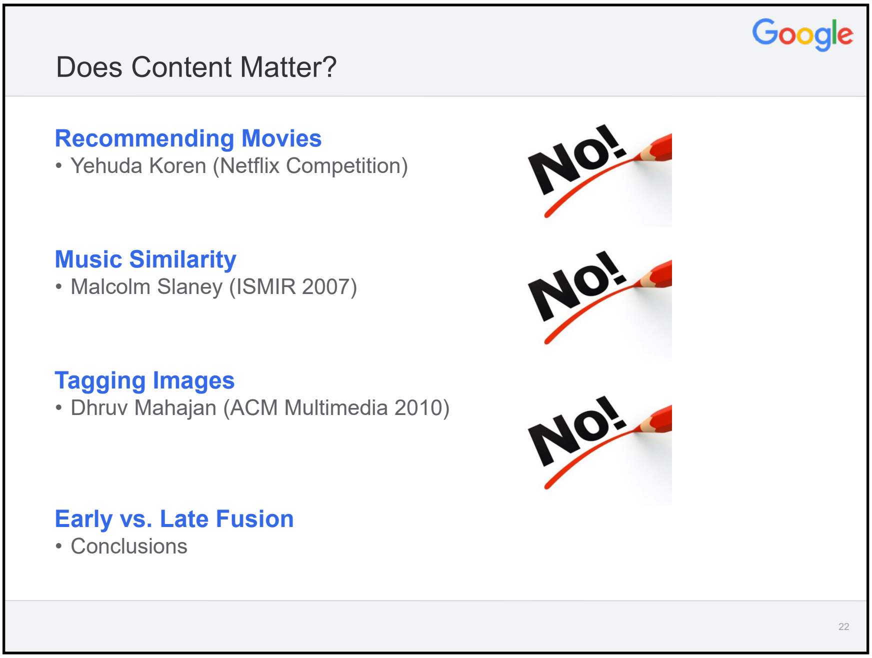
	Odd because likes smelly cheese?	Odd because of home?	Late Fusion (combine by multiplication)
Midwest Farm Boy	40%	10%	4%
Parisian	40%	10%	

Information lost with each decision!!!



Thank You

malcolm@ieee.org



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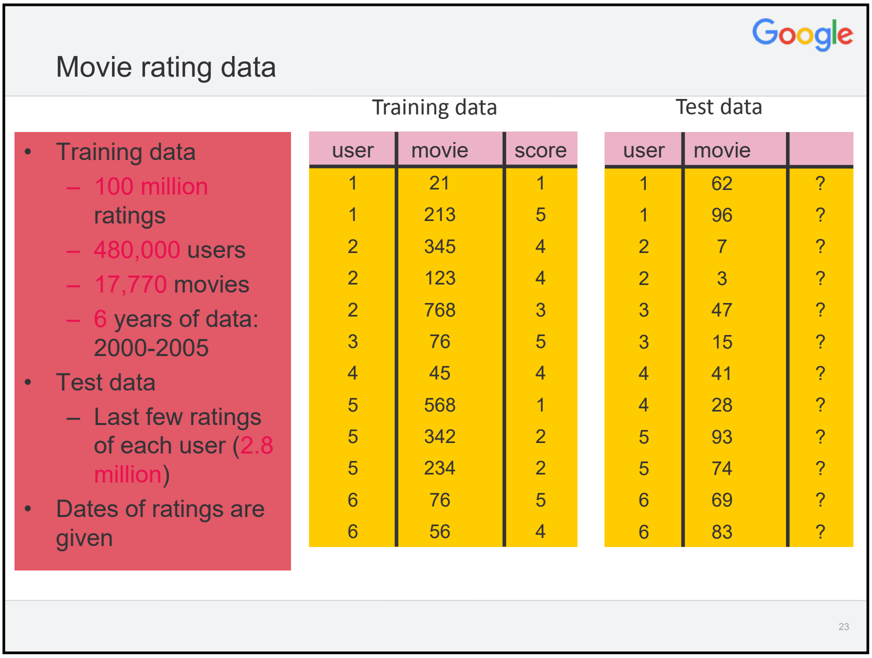

Movie rating data

- Training data
  - 100 million ratings
  - 480,000 users
  - 17,770 movies
  - 6 years of data: 2000-2005
- Test data
  - Last few ratings of each user (2.8 million)
- Dates of ratings are given

Training data

user	movie	score
1	21	1
1	213	5
2	345	4
2	123	4
2	768	3
3	76	5
4	45	4
5	568	1
5	342	2
5	234	2
6	76	5
6	56	4

Test data

user	movie	
1	62	?
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4	28	?
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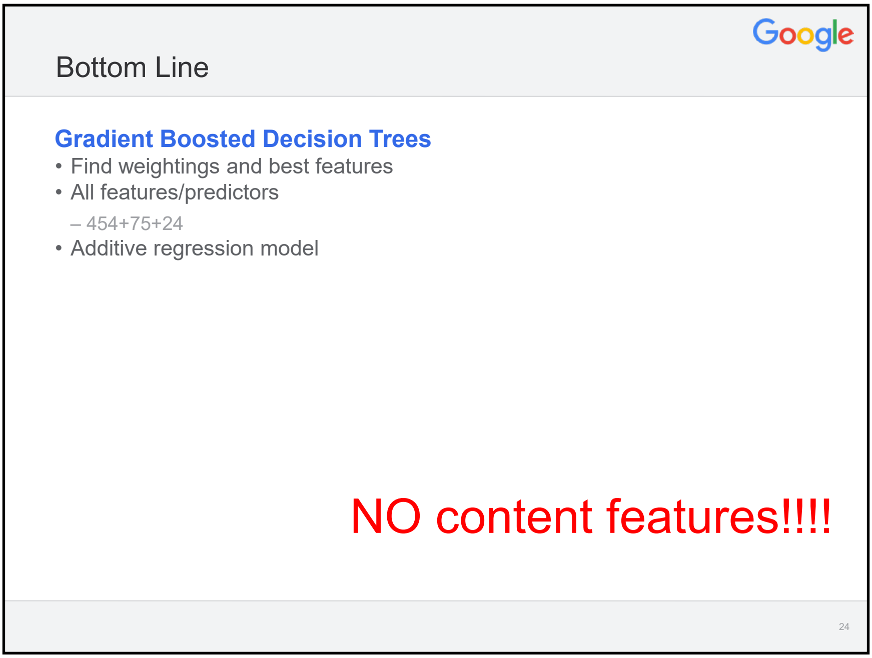
6	83	?

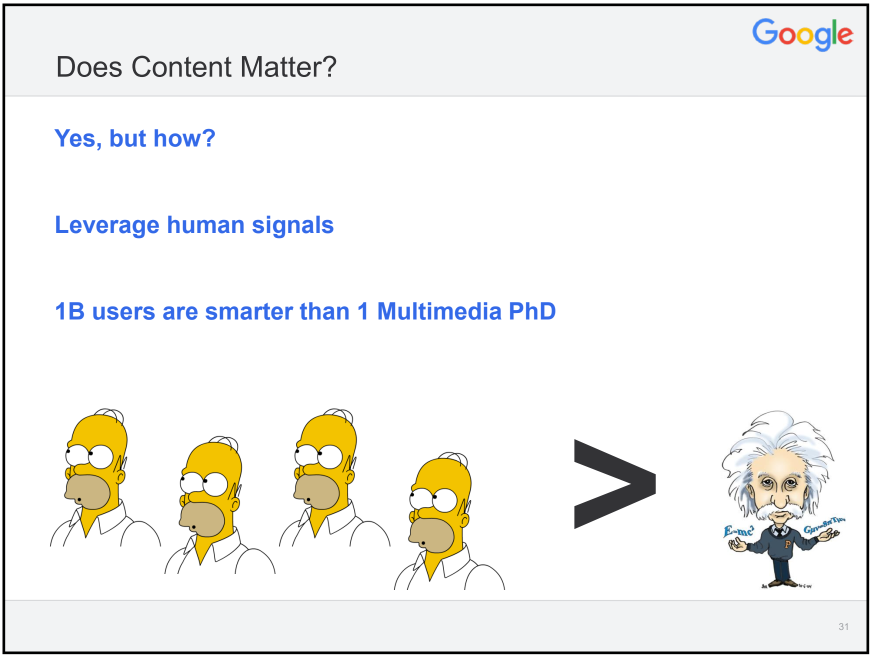


Bottom Line

Gradient Boosted Decision Trees

- Find weightings and best features
- All features/predictors
  - 454+75+24
- Additive regression model

NO content features!!!!

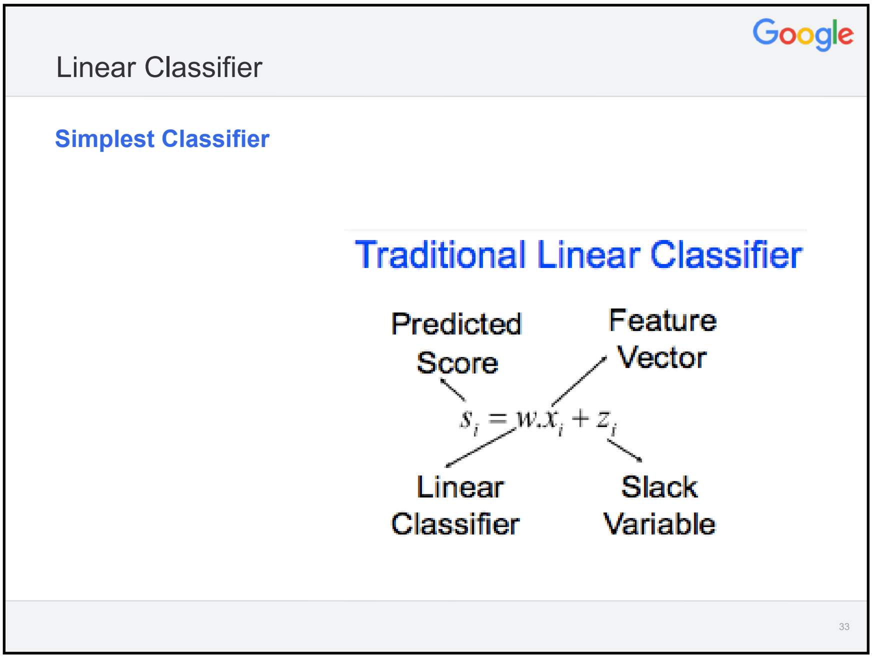


Does Content Matter?

Yes, but how?

Leverage human signals

1B users are smarter than 1 Multimedia PhD

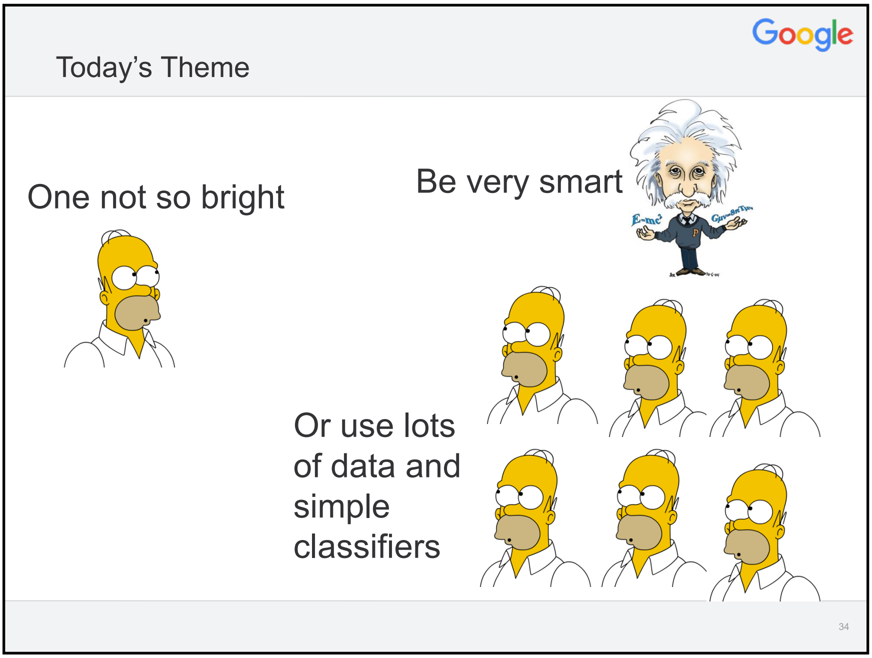


Linear Classifier

Simplest Classifier

Traditional Linear Classifier

$s_i = w.x_i + z_i$

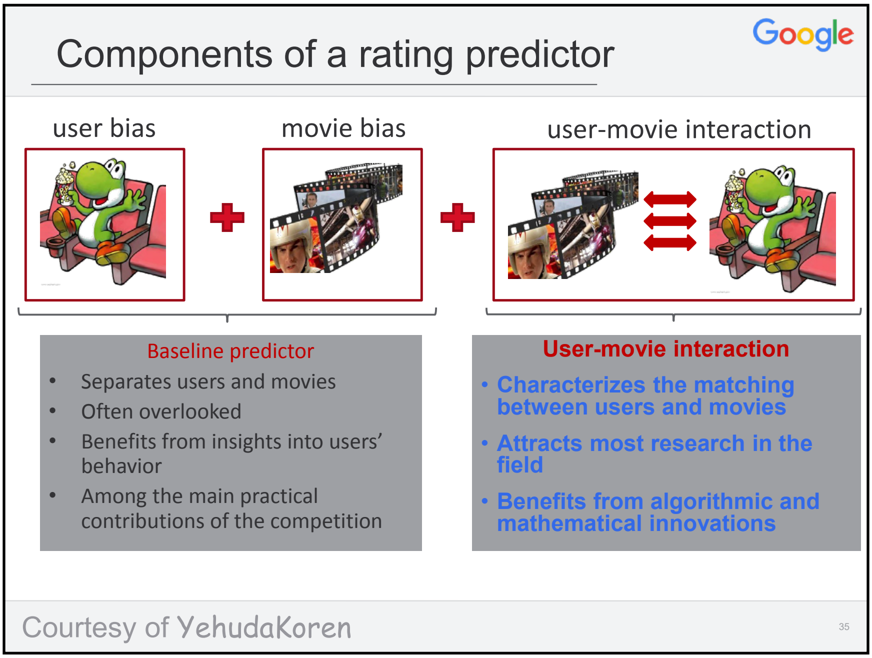


Today's Theme

One not so bright

Be very smart

Or use lots of data and simple classifiers



Components of a rating predictor

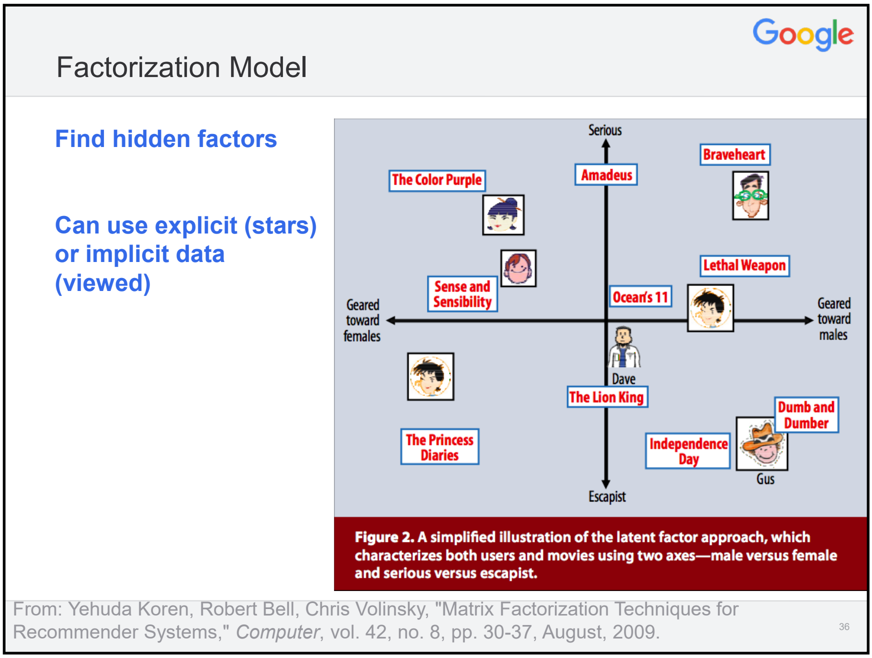
Baseline predictor

- Separates users and movies
- Often overlooked
- Benefits from insights into users' behavior
- Among the main practical contributions of the competition

User-movie interaction

- **Characterizes the matching between users and movies**
- **Attracts most research in the field**
- **Benefits from algorithmic and mathematical innovations**

Courtesy of YehudaKoren



Google

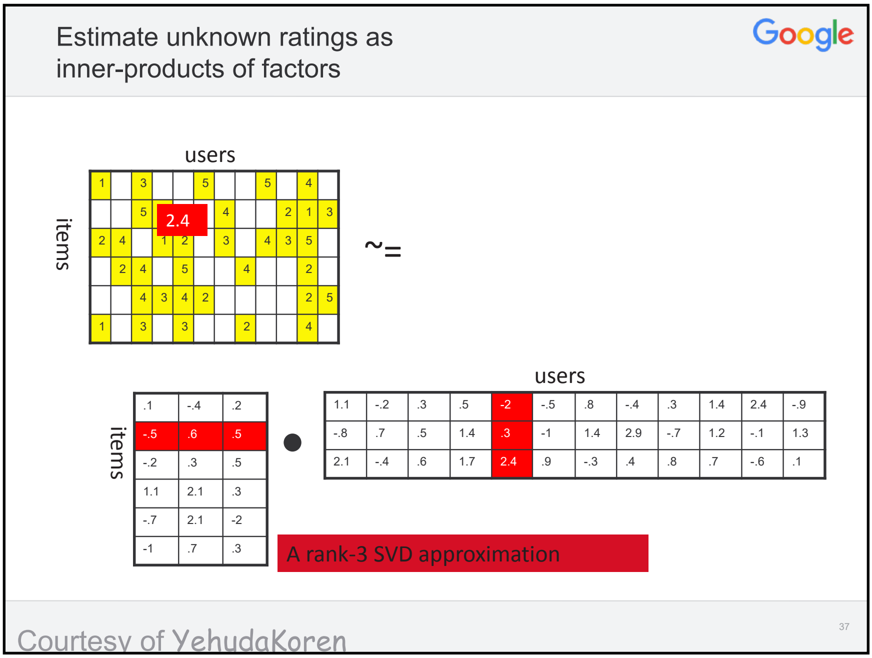
Factorization Model

Find hidden factors

Can use explicit (stars) or implicit data (viewed)

Figure 2. A simplified illustration of the latent factor approach, which characterizes both users and movies using two axes—male versus female and serious versus escapist.

From: Yehuda Koren, Robert Bell, Chris Volinsky, "Matrix Factorization Techniques for Recommender Systems," *Computer*, vol. 42, no. 8, pp. 30-37, August, 2009.



Google

Estimate unknown ratings as inner-products of factors

users

items

1		3			5			5		4	
		5		2.4		4			2	1	3
2	4		1	2		3		4	3	5	
	2	4		5			4			2	
		4	3	4	2					2	5
1		3		3			2			4	

~=

items

.1	-.4	.2
-.5	.6	.5
-.2	.3	.5
1.1	2.1	.3
-.7	2.1	-2
-1	.7	.3

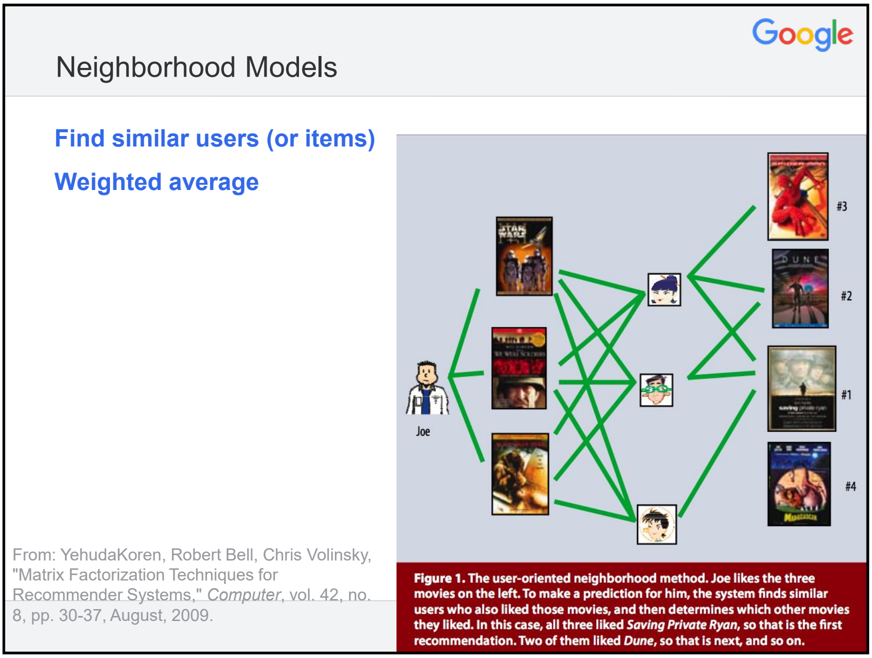
●

users

1.1	-.2	.3	.5	-2	-.5	.8	-.4	.3	1.4	2.4	-.9
-.8	.7	.5	1.4	.3	-1	1.4	2.9	-.7	1.2	-.1	1.3
2.1	-.4	.6	1.7	2.4	.9	-.3	.4	.8	.7	-.6	.1

A rank-3 SVD approximation

Courtesy of YehudaKoren



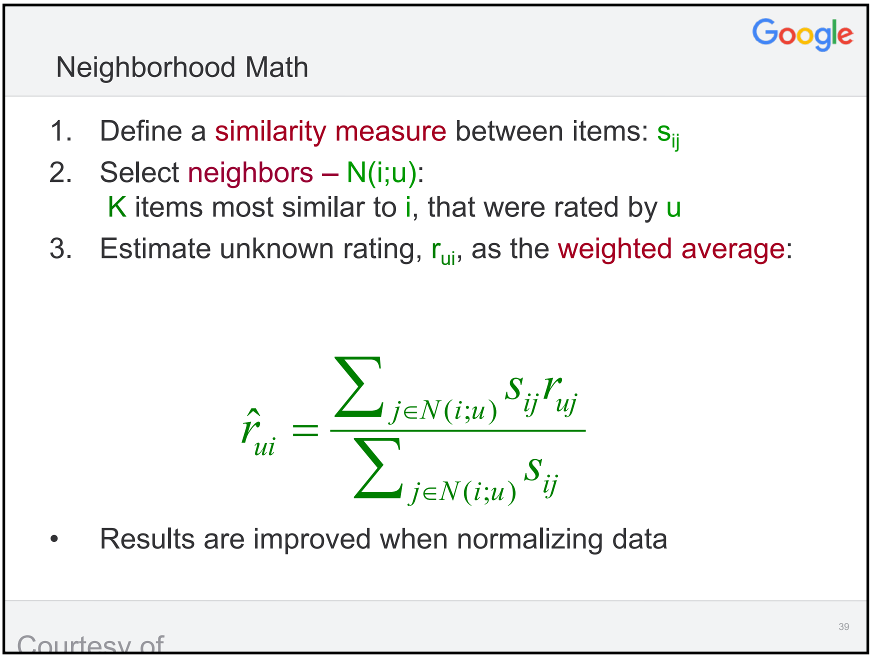
Neighborhood Models

Find similar users (or items)

Weighted average

Figure 1. The user-oriented neighborhood method. Joe likes the three movies on the left. To make a prediction for him, the system finds similar users who also liked those movies, and then determines which other movies they liked. In this case, all three liked *Saving Private Ryan*, so that is the first recommendation. Two of them liked *Dune*, so that is next, and so on.

From: YehudaKoren, Robert Bell, Chris Volinsky, "Matrix Factorization Techniques for Recommender Systems," *Computer*, vol. 42, no. 8, pp. 30-37, August, 2009.



Neighborhood Math

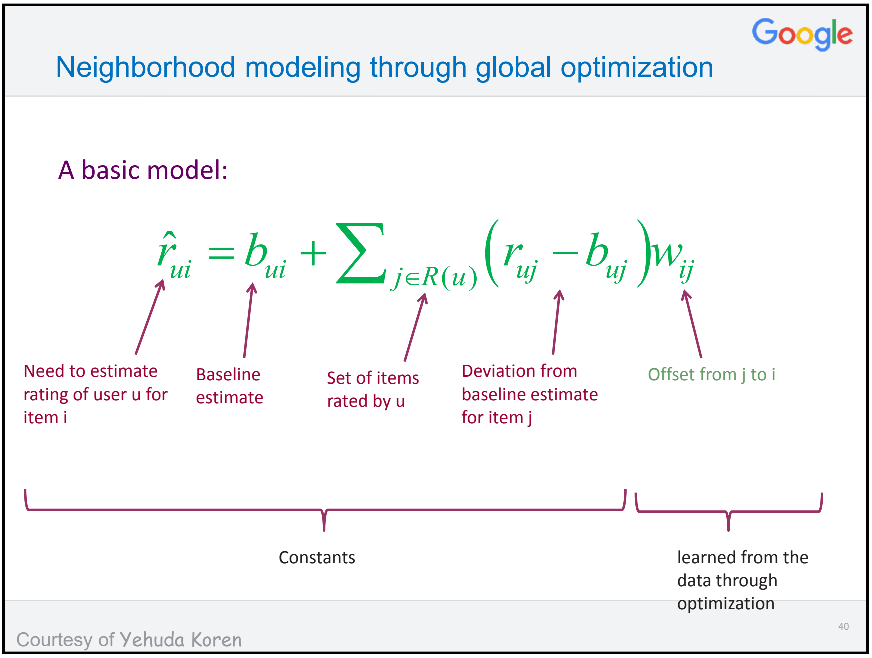
1. Define a similarity measure between items: s_{ij}
2. Select neighbors – N(i;u):
   K items most similar to i, that were rated by u
3. Estimate unknown rating, r_{ui}, as the weighted average:

$$\hat{r}_{ui} = \frac{\sum_{j \in N(i;u)} s_{ij} r_{uj}}{\sum_{j \in N(i;u)} s_{ij}}$$

- Results are improved when normalizing data

Courtesy of

39



Neighborhood modeling through global optimization

A basic model:

$$\underbrace{\hat{r}_{ui} = b_{ui} + \sum_{j\in R(u)} \left(r_{uj} - b_{uj}\right)}_{\text{Constants}} \underbrace{w_{ij}}_{\text{learned from the data through optimization}}$$

Need to estimate rating of user u for item i

Baseline estimate

Set of items rated by u

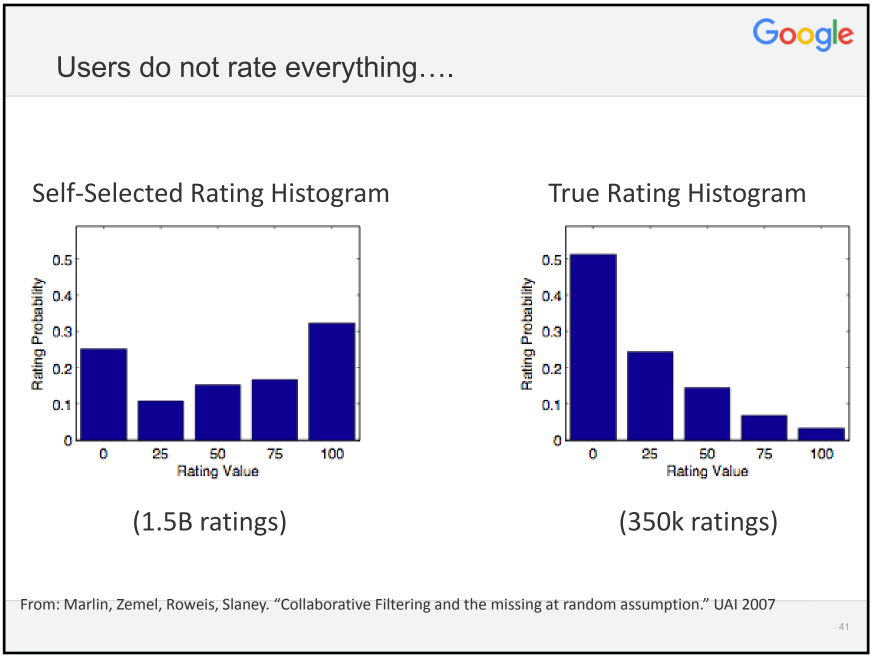
Deviation from baseline estimate for item j

Offset from j to i

Constants

learned from the data through optimization

Courtesy of Yehuda Koren



Users do not rate everything….

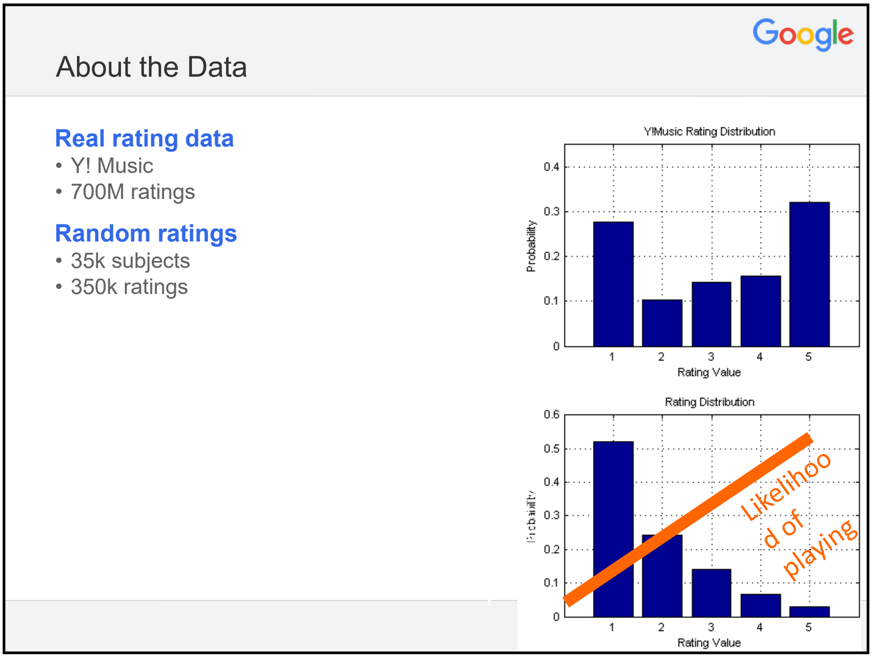
Self-Selected Rating Histogram

True Rating Histogram

(1.5B ratings)

(350k ratings)

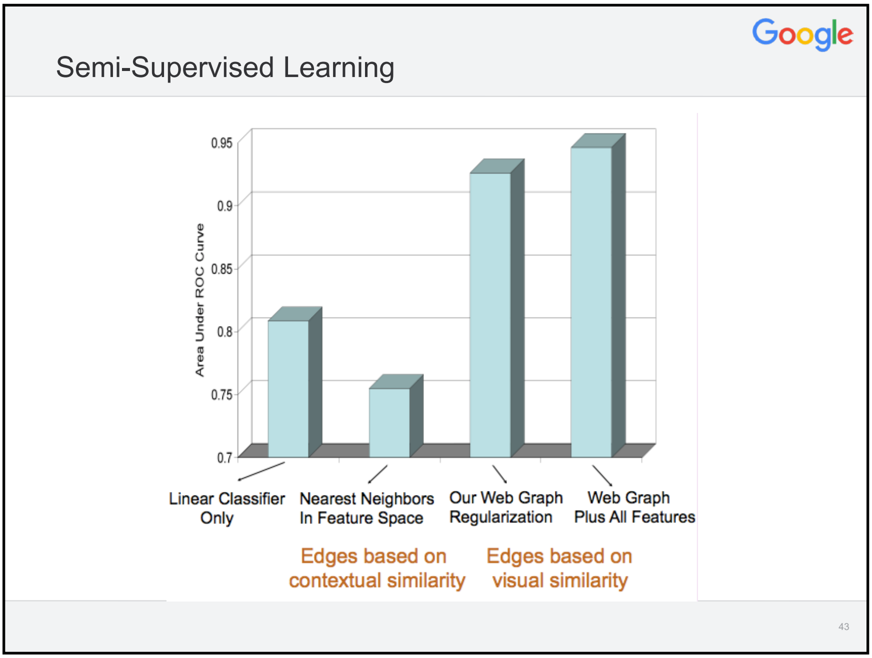
From: Marlin, Zemel, Roweis, Slaney. “Collaborative Filtering and the missing at random assumption.” UAI 2007



About the Data

Real rating data
- Y! Music
- 700M ratings

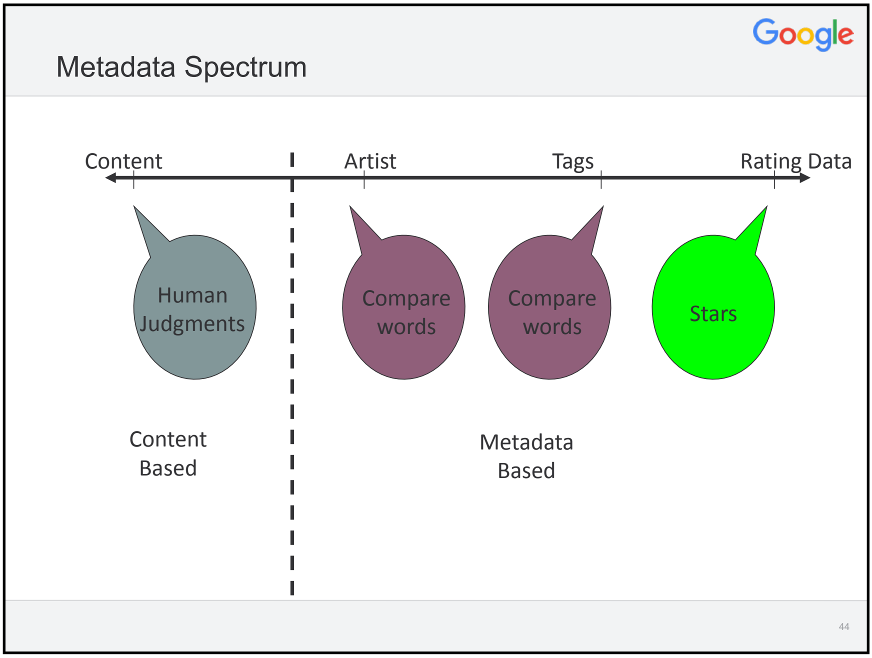
Random ratings
- 35k subjects
- 350k ratings



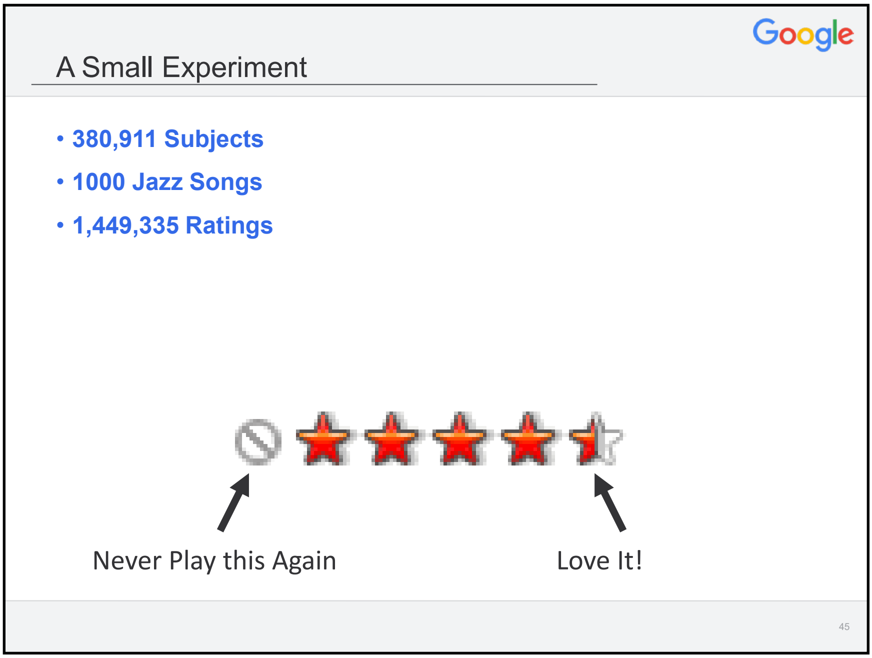
Semi-Supervised Learning

Edges based on contextual similarity

Edges based on visual similarity



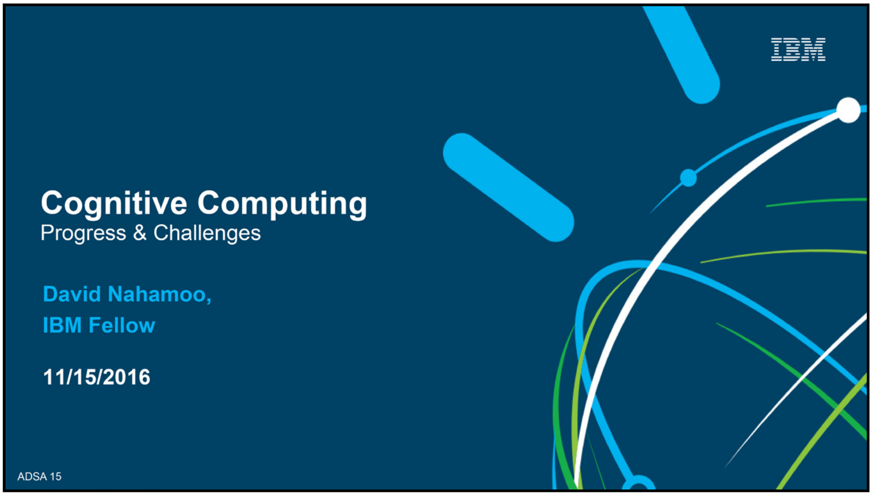
Metadata Spectrum



A Small Experiment

- 380,911 Subjects
- 1000 Jazz Songs
- 1,449,335 Ratings

16.11 David Namahoo: Scope, the Technical Challenges, and the Progress in Building Cognitive Computers



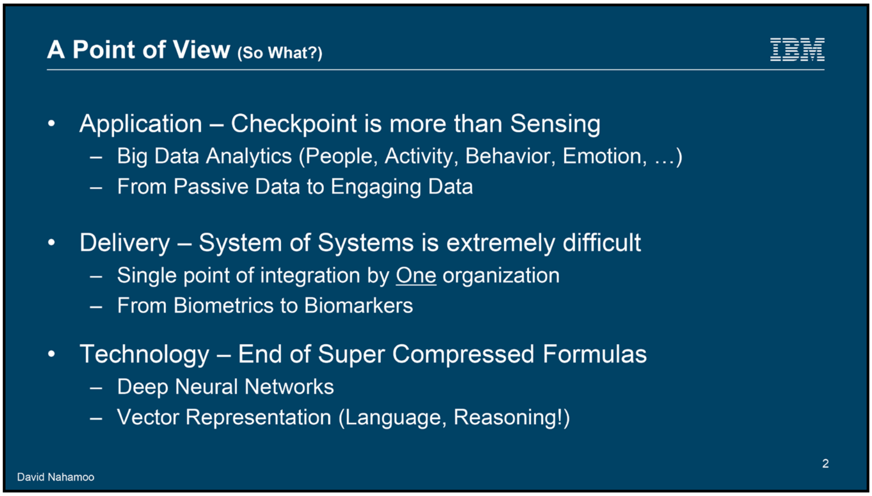
IBM

Cognitive Computing

Progress & Challenges

David Nahamoo,
IBM Fellow

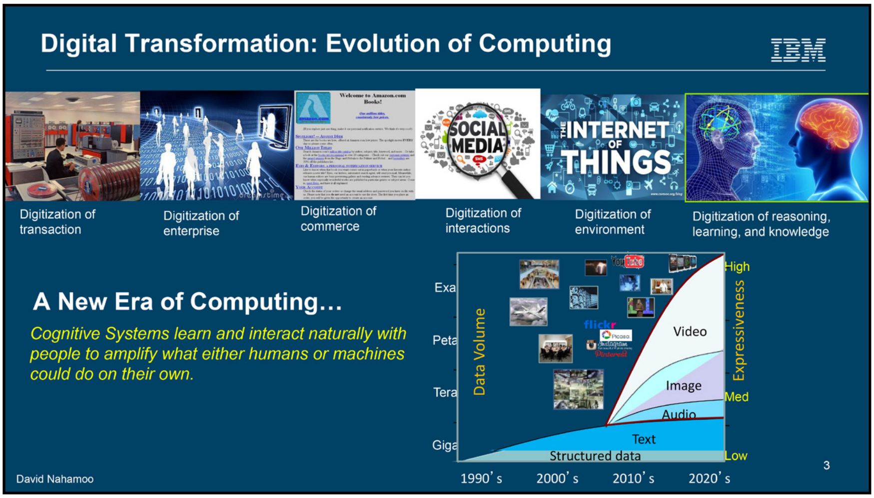
11/15/2016



A Point of View (So What?)

IBM

- Application – Checkpoint is more than Sensing
  - Big Data Analytics (People, Activity, Behavior, Emotion, …)
  - From Passive Data to Engaging Data
- Delivery – System of Systems is extremely difficult
  - Single point of integration by One organization
  - From Biometrics to Biomarkers
- Technology – End of Super Compressed Formulas
  - Deep Neural Networks
  - Vector Representation (Language, Reasoning!)



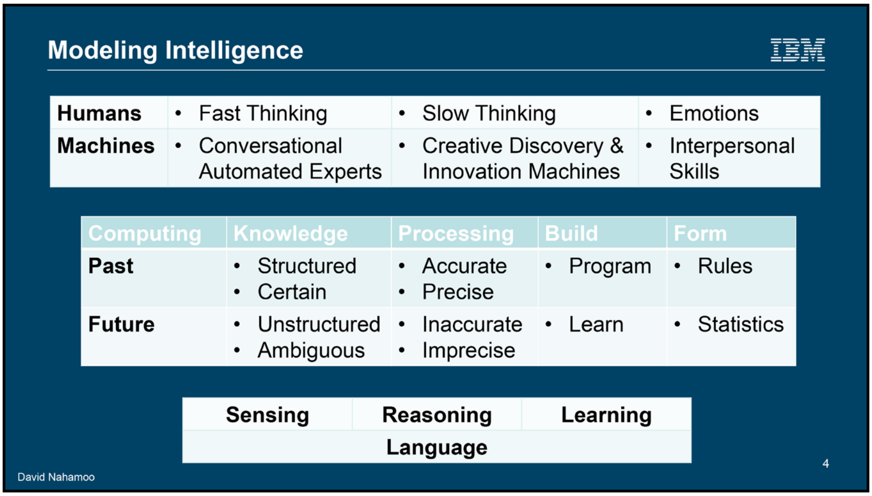
Digital Transformation: Evolution of Computing

A New Era of Computing…

Cognitive Systems learn and interact naturally with people to amplify what either humans or machines could do on their own.

David Nahamoo

3



Modeling Intelligence

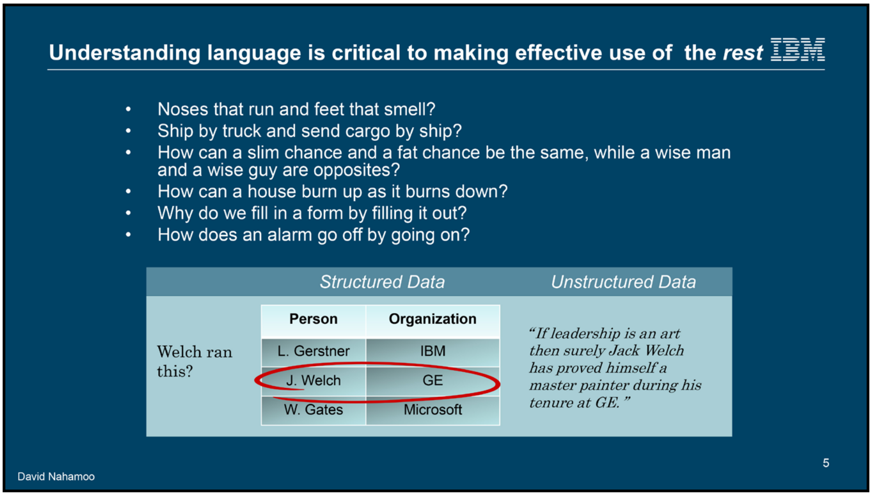
Humans	• Fast Thinking	• Slow Thinking	• Emotions
Machines	• Conversational Automated Experts	• Creative Discovery & Innovation Machines	• Interpersonal Skills

Computing	Knowledge	Processing	Build	Form
Past	• Structured • Certain	• Accurate • Precise	• Program	• Rules
Future	• Unstructured • Ambiguous	• Inaccurate • Imprecise	• Learn	• Statistics

Sensing	**Reasoning**	**Learning**
	Language	

David Nahamoo

4



Understanding language is critical to making effective use of the *rest*

- Noses that run and feet that smell?
- Ship by truck and send cargo by ship?
- How can a slim chance and a fat chance be the same, while a wise man and a wise guy are opposites?
- How can a house burn up as it burns down?
- Why do we fill in a form by filling it out?
- How does an alarm go off by going on?

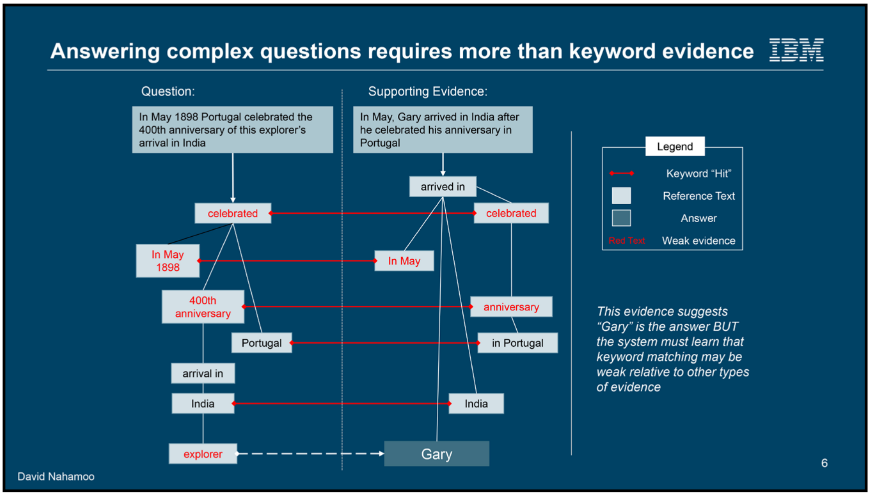
Structured Data | *Unstructured Data*

Welch ran this?

Person	Organization
L. Gerstner	IBM
J. Welch	GE
W. Gates	Microsoft

"If leadership is an art then surely Jack Welch has proved himself a master painter during his tenure at GE."

David Nahamoo



Answering complex questions requires more than keyword evidence

Question:

In May 1898 Portugal celebrated the 400th anniversary of this explorer's arrival in India

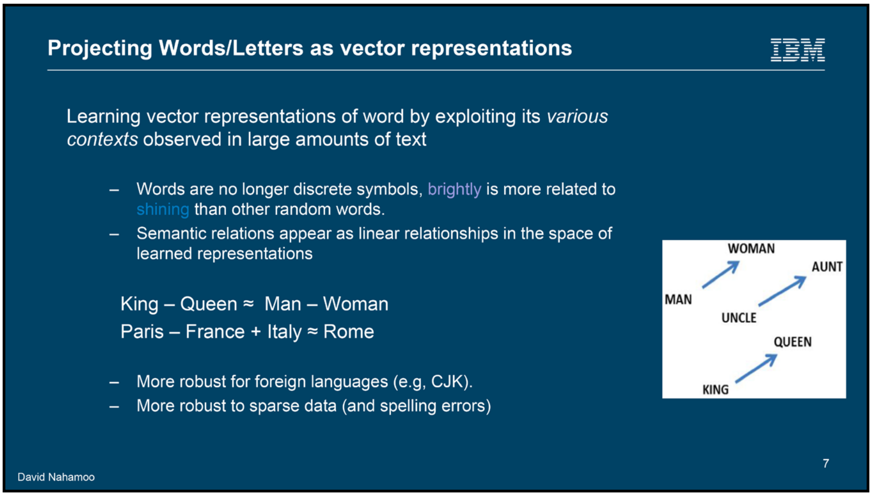
Supporting Evidence:

In May, Gary arrived in India after he celebrated his anniversary in Portugal

Legend
- ↔ Keyword "Hit"
- ☐ Reference Text
- ▨ Answer
- Red Text Weak evidence

This evidence suggests "Gary" is the answer BUT the system must learn that keyword matching may be weak relative to other types of evidence

David Nahamoo



Projecting Words/Letters as vector representations

Learning vector representations of word by exploiting its *various contexts* observed in large amounts of text

- Words are no longer discrete symbols, brightly is more related to shining than other random words.
- Semantic relations appear as linear relationships in the space of learned representations

King – Queen ≈ Man – Woman
Paris – France + Italy ≈ Rome

- More robust for foreign languages (e.g, CJK).
- More robust to sparse data (and spelling errors)

David Nahamoo

7

Visual data provides key insights that can transform industries

Medical Imaging
- Diagnosis?
- Clinical Features?
- Similar Cases?

Health and Wellness
- What food?
- Portion size?
- Nutrition?

Safety and Security
- Persons?
- Activities?
- Behaviors?

Retail
- Fashions?
- Products?
- Trends?

Real Estate / Insurance
- Condition?
- Style?
- Value?

Satellite
- Counts?
- Patterns?
- Environment?

David Nahamoo

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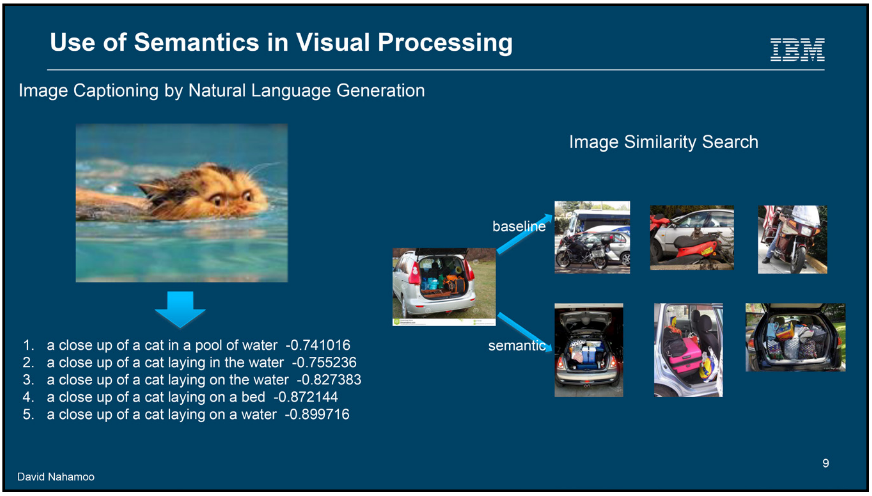

Use of Semantics in Visual Processing

IBM

Image Captioning by Natural Language Generation

1. a close up of a cat in a pool of water -0.741016
2. a close up of a cat laying in the water -0.755236
3. a close up of a cat laying on the water -0.827383
4. a close up of a cat laying on a bed -0.872144
5. a close up of a cat laying on a water -0.899716

Image Similarity Search

David Nahamoo

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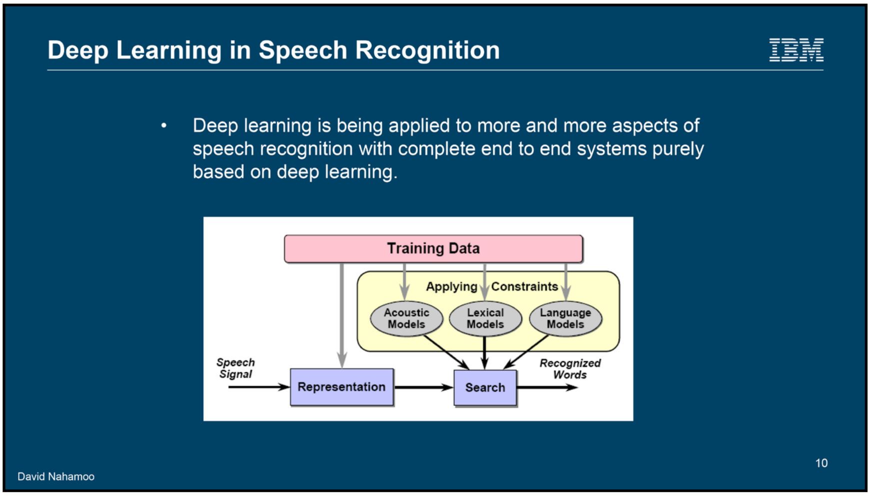

Deep Learning in Speech Recognition

IBM

- Deep learning is being applied to more and more aspects of speech recognition with complete end to end systems purely based on deep learning.

David Nahamoo

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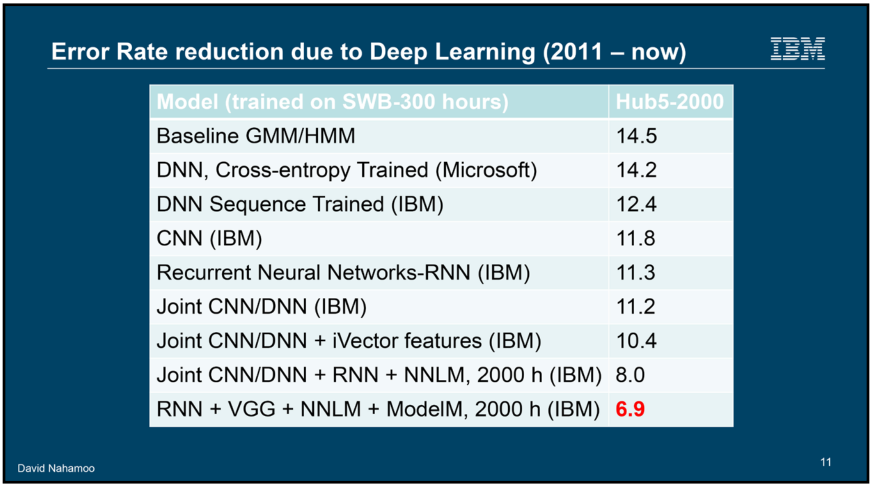
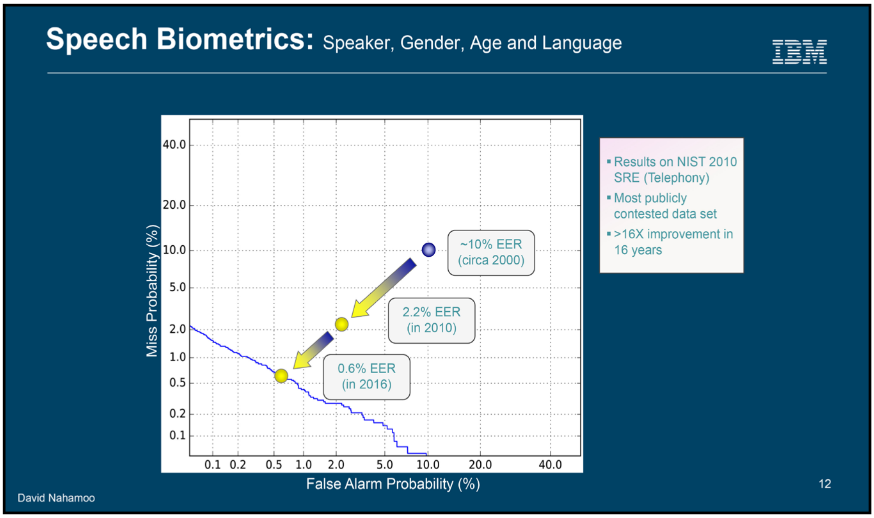


Error Rate reduction due to Deep Learning (2011 – now)

Model (trained on SWB-300 hours)	Hub5-2000
Baseline GMM/HMM	14.5
DNN, Cross-entropy Trained (Microsoft)	14.2
DNN Sequence Trained (IBM)	12.4
CNN (IBM)	11.8
Recurrent Neural Networks-RNN (IBM)	11.3
Joint CNN/DNN (IBM)	11.2
Joint CNN/DNN + iVector features (IBM)	10.4
Joint CNN/DNN + RNN + NNLM, 2000 h (IBM)	8.0
RNN + VGG + NNLM + ModelM, 2000 h (IBM)	6.9

David Nahamoo



Speech Biometrics: Speaker, Gender, Age and Language

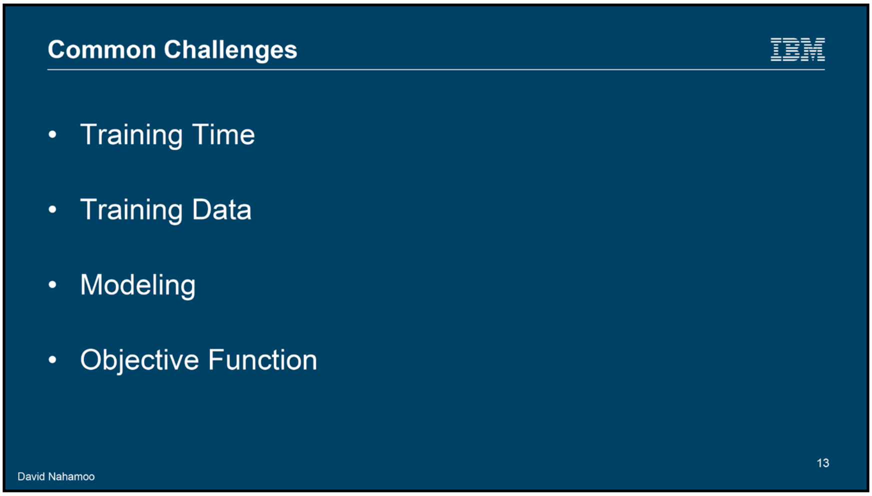
~10% EER
(circa 2000)

2.2% EER
(in 2010)

0.6% EER
(in 2016)

- Results on NIST 2010 SRE (Telephony)
- Most publicly contested data set
- >16X improvement in 16 years

David Nahamoo



Common Challenges

- Training Time
- Training Data
- Modeling
- Objective Function

David Nahamoo

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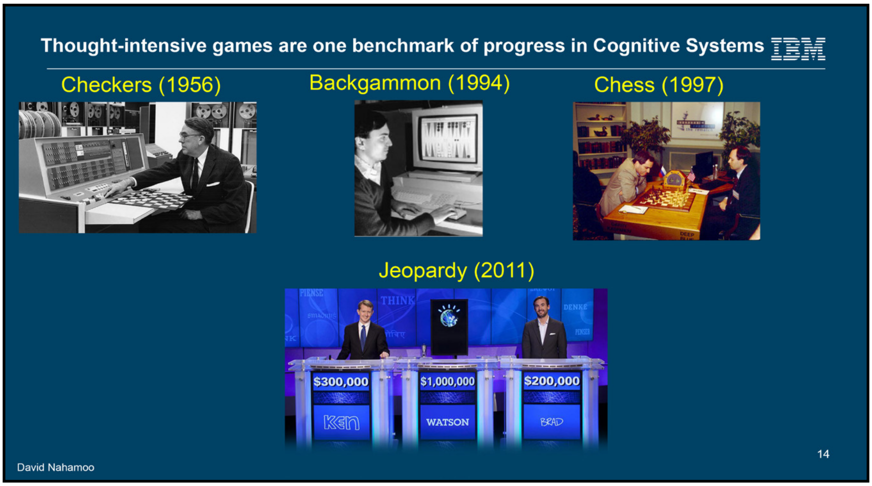


Thought-intensive games are one benchmark of progress in Cognitive Systems

Checkers (1956)

Backgammon (1994)

Chess (1997)

Jeopardy (2011)

David Nahamoo

14

Thank You

David Nahamoo
nahamoo@us.ibm.com

16.12 Homer Pien: Data Analytics in Medicine and Possible Application to Aviation Security

AI and Analytics in Healthcare

Presentation at
ADSA15 Workshop

Homer Pien, PhD
SVP Lead Innovations, CTO Imaging
November 2016

innovation + you

PHILIPS

16.13 Michael Ellenbogan: Tribute to Richard Bijjani

Richard Bijjani, PhD

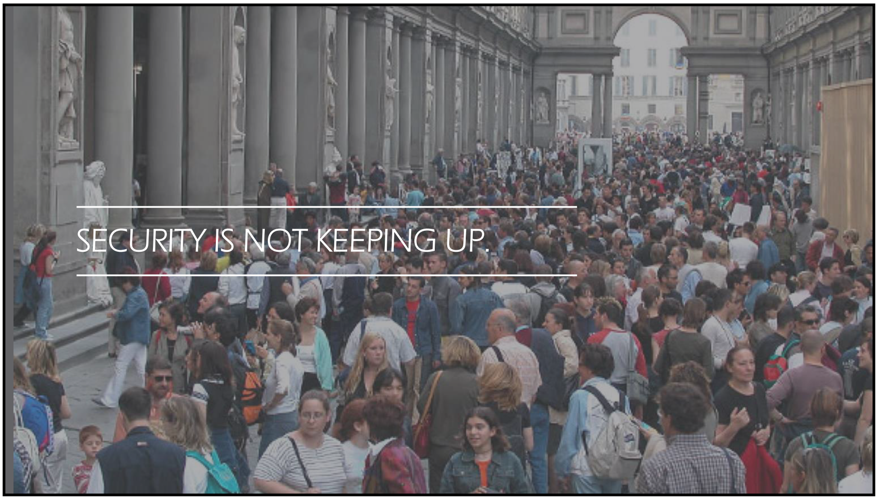
April 19, 1962 – August 19, 2016

16.14 Michael Ellenbogan: Evolv's Products for the Checkpoint

evolv
technology

SECURITY THAT
WORKS IN A
CHANGING WORLD

IN TODAY'S WORLD, ANYTHING CAN
BE A TARGET.



SECURITY IS NOT KEEPING UP.

THE
NEW
NORMAL?

LONG LINES

FALSE ALARMS

MISSED THREATS

INCOMPLETE COVERAGE

$$$

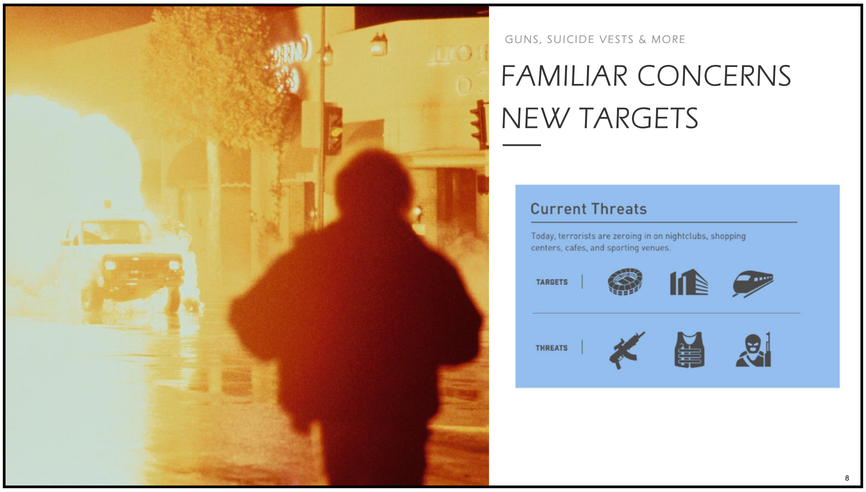
MORE PEOPLE +
MORE TIME +
MORE $$

$175b

ESTIMATED
ECONOMIC IMPACT

MASS CASUALTIES

MILLIONS
OF SOFT
TARGETS



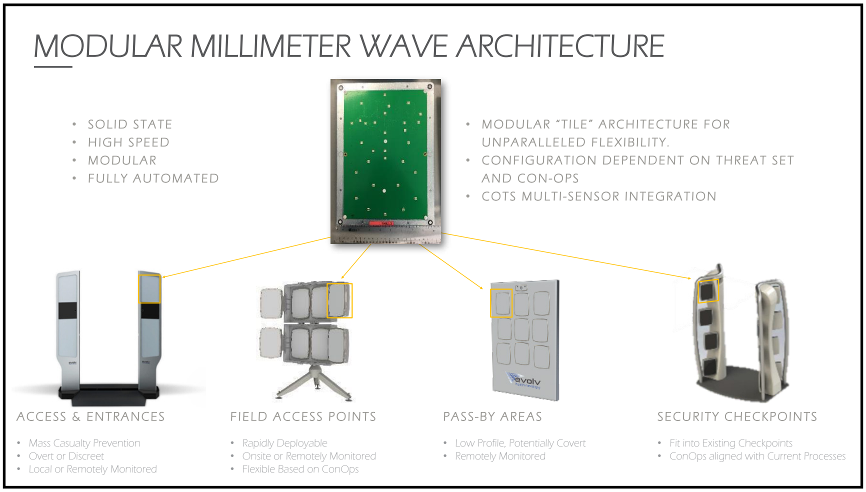
GUNS, SUICIDE VESTS & MORE

FAMILIAR CONCERNS
NEW TARGETS

Current Threats

Today, terrorists are zeroing in on nightclubs, shopping centers, cafes, and sporting venues.

THIS IS NOT OK.



MODULAR MILLIMETER WAVE ARCHITECTURE

- SOLID STATE
- HIGH SPEED
- MODULAR
- FULLY AUTOMATED

- MODULAR "TILE" ARCHITECTURE FOR UNPARALLELED FLEXIBILITY.
- CONFIGURATION DEPENDENT ON THREAT SET AND CON-OPS
- COTS MULTI-SENSOR INTEGRATION

ACCESS & ENTRANCES

- Mass Casualty Prevention
- Overt or Discreet
- Local or Remotely Monitored

FIELD ACCESS POINTS

- Rapidly Deployable
- Onsite or Remotely Monitored
- Flexible Based on ConOps

PASS-BY AREAS

- Low Profile, Potentially Covert
- Remotely Monitored

SECURITY CHECKPOINTS

- Fit into Existing Checkpoints
- ConOps aligned with Current Processes

EVOLV EDGE

Mass Casualty Threats

Fully Automated

High Throughput

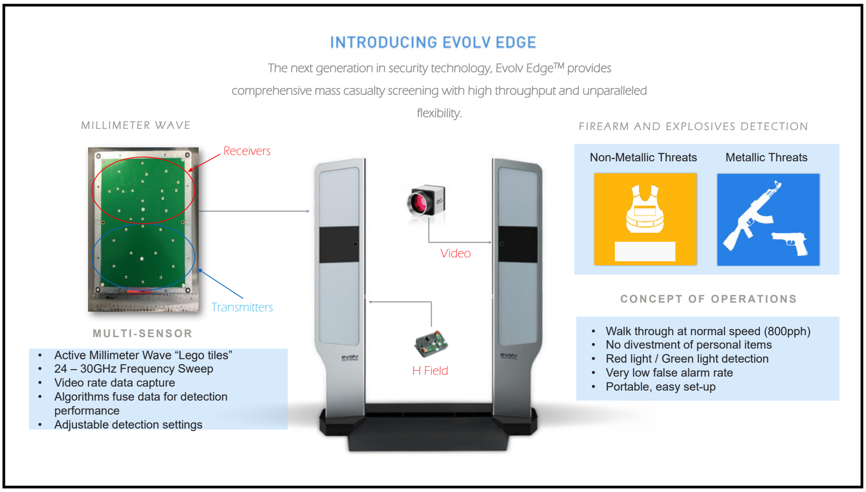
Low False Alarm Rate

Unparalleled Flexibility

INTRODUCING EVOLV EDGE

INTRODUCING EVOLV EDGE

Mass casualty threat detection
Fully automated
Up to 800pph
Low false alarm rate
No divestment required



INTRODUCING EVOLV EDGE

The next generation in security technology, Evolv Edge^{TM} provides comprehensive mass casualty screening with high throughput and unparalleled flexibility.

MILLIMETER WAVE

MULTI-SENSOR

- Active Millimeter Wave “Lego tiles”
- 24 – 30GHz Frequency Sweep
- Video rate data capture
- Algorithms fuse data for detection performance
- Adjustable detection settings

FIREARM AND EXPLOSIVES DETECTION

Non-Metallic Threats	Metallic Threats

CONCEPT OF OPERATIONS

- Walk through at normal speed (800pph)
- No divestment of personal items
- Red light / Green light detection
- Very low false alarm rate
- Portable, easy set-up

INTRODUCING EVOLV EDGE

Open Architecture

USB-3 Hardware Interface

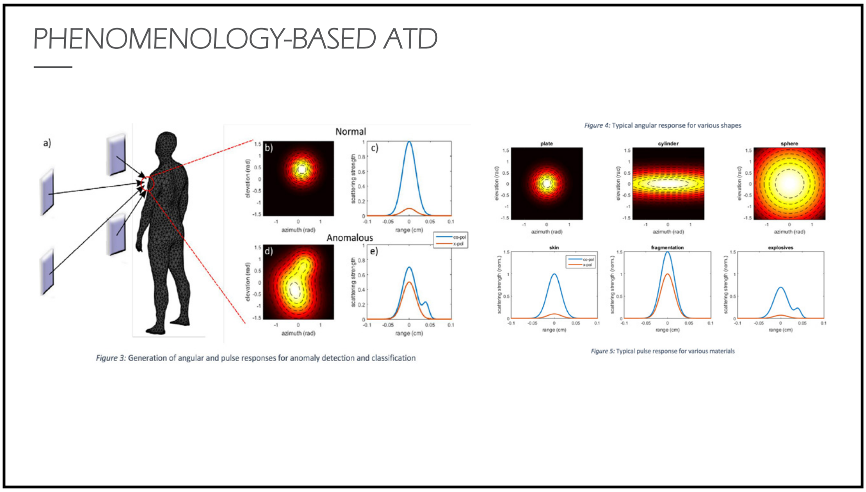
API's Available to Facilitate Software Integration

EXPLOSIVE SIGNATURE DATA

Lossless Dielectrics: C4, Det Cord, Poor Man's C4, Detasheet

Absorbing Dielectrics: TNT-Cast, BINARIES, COMP B, Emulsion

Highly Absorbing Dielectrics: Cast Boosters, Smokeless Powder, AN-AL (Cold Pack), SEMTEX



PHENOMENOLOGY-BASED ATD

Figure 3: Generation of angular and pulse responses for anomaly detection and classification

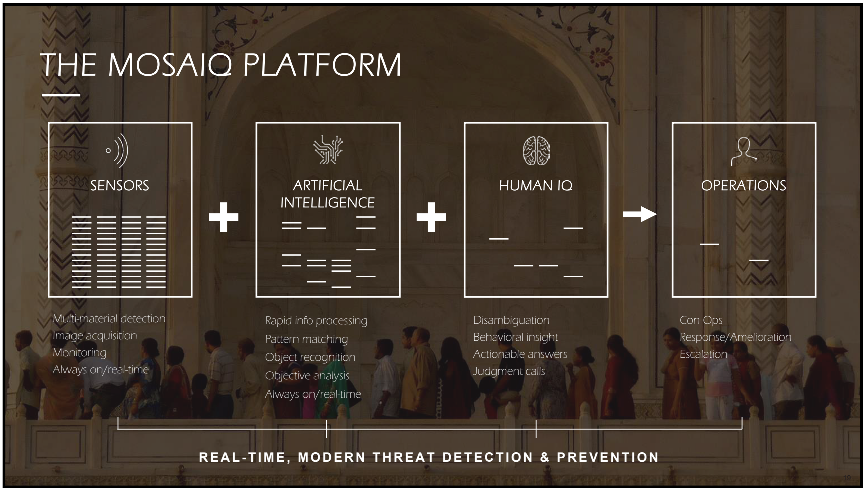
Figure 4: Typical angular response for various shapes

Figure 5: Typical pulse response for various materials

A color-coded readout on the intuitive user interface indicates the type of threat detected.

DETECT TODAY'S THREATS

Spot firearms and non-metallic explosives with near-zero false positives. Millimeter wave and magnetometer sensors can detect concealed long guns, suicide vests, and IEDs.



THE MOSAIQ PLATFORM

SENSORS
+
ARTIFICIAL INTELLIGENCE
+
HUMAN IQ
→
OPERATIONS

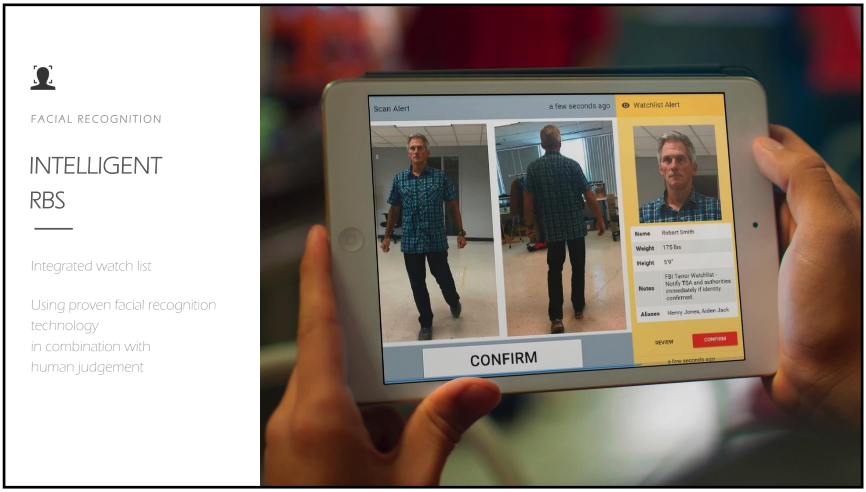
- Multi-material detection
- Image acquisition
- Monitoring
- Always on/real-time

- Rapid info processing
- Pattern matching
- Object recognition
- Objective analysis
- Always on/real-time

- Disambiguation
- Behavioral insight
- Actionable answers
- Judgment calls

- Con Ops
- Response/Amelioration
- Escalation

REAL-TIME, MODERN THREAT DETECTION & PREVENTION



FACIAL RECOGNITION

INTELLIGENT RBS

Integrated watch list

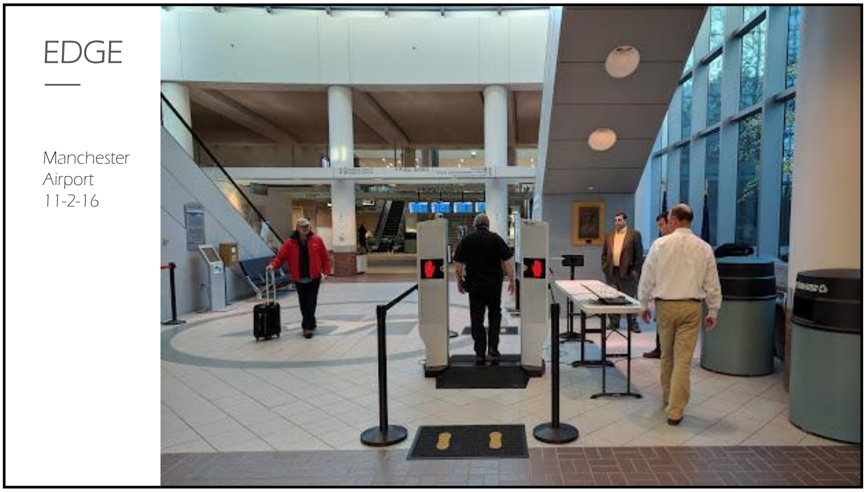
Using proven facial recognition technology
in combination with
human judgement

Scan Alert — a few seconds ago

Watchlist Alert

Name: Robert Smith
Weight: 175 lbs
Height: 5'9"
Notes: FBI Terror Watchlist - Notify TSA and authorities immediately if identity confirmed.
Aliases: Henry Jones, Aiden Jack

a few seconds ago



EDGE

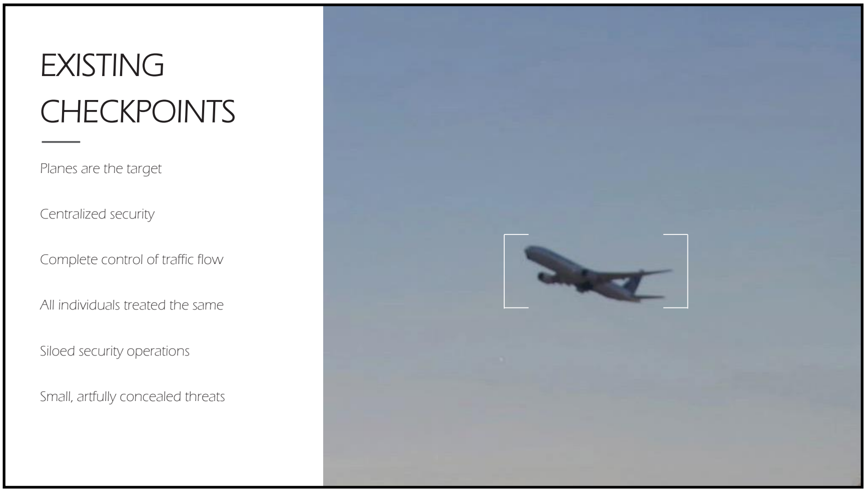
Manchester
Airport
11-2-16

FIREARM AND EXPLOSIVES DETECTION

HIGH-THROUGHPUT
FULLY AUTOMATED
MASS CASUALTY THREAT
DETECTION

WELCOME TO THE FUTURE OF PHYSICAL SECURITY

evolv technology



EXISTING CHECKPOINTS

Planes are the target

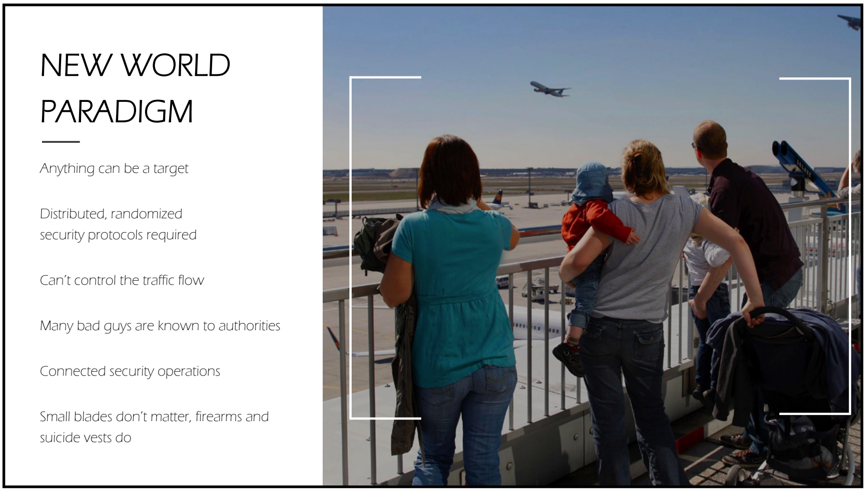
Centralized security

Complete control of traffic flow

All individuals treated the same

Siloed security operations

Small, artfully concealed threats



NEW WORLD PARADIGM

Anything can be a target

Distributed, randomized security protocols required

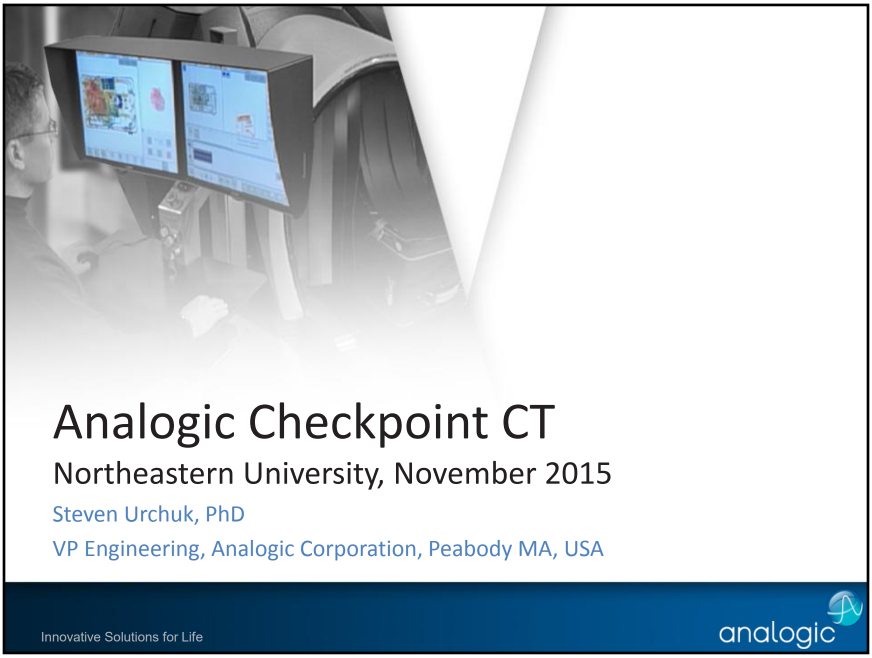
Can’t control the traffic flow

Many bad guys are known to authorities

Connected security operations

Small blades don’t matter, firearms and suicide vests do

16.15 Steve Urchuk: Analogic's Checkpoint CT System



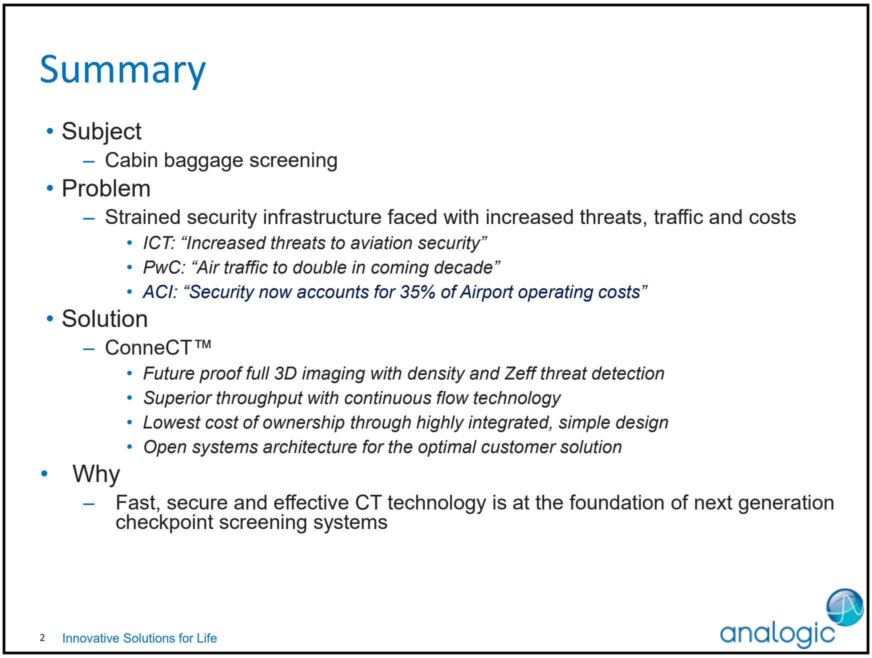
Analogic Checkpoint CT

Northeastern University, November 2015

Steven Urchuk, PhD

VP Engineering, Analogic Corporation, Peabody MA, USA

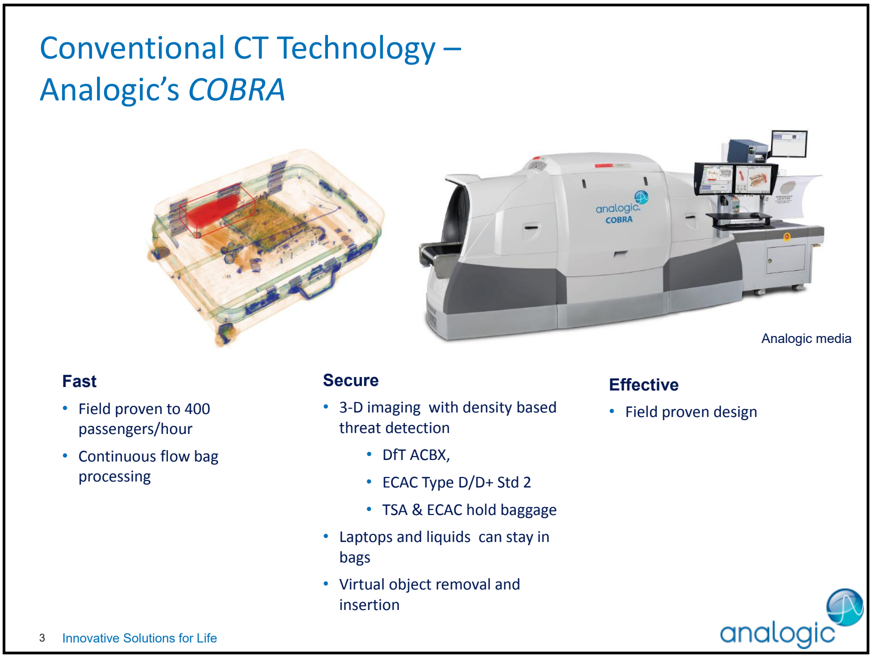
Innovative Solutions for Life



Summary

- Subject
  - Cabin baggage screening
- Problem
  - Strained security infrastructure faced with increased threats, traffic and costs
    - *ICT: "Increased threats to aviation security"*
    - *PwC: "Air traffic to double in coming decade"*
    - *ACI: "Security now accounts for 35% of Airport operating costs"*
- Solution
  - ConneCT™
    - *Future proof full 3D imaging with density and Zeff threat detection*
    - *Superior throughput with continuous flow technology*
    - *Lowest cost of ownership through highly integrated, simple design*
    - *Open systems architecture for the optimal customer solution*
- Why
  - Fast, secure and effective CT technology is at the foundation of next generation checkpoint screening systems

2 Innovative Solutions for Life



Conventional CT Technology – Analogic's *COBRA*

Analogic media

Fast

- Field proven to 400 passengers/hour
- Continuous flow bag processing

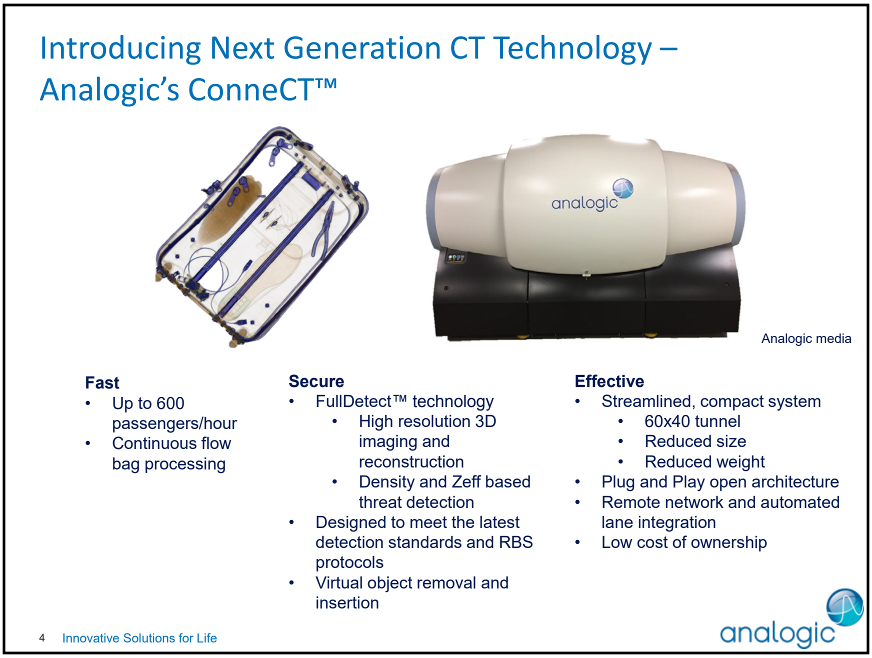
Secure

- 3-D imaging with density based threat detection
    - DfT ACBX,
    - ECAC Type D/D+ Std 2
    - TSA & ECAC hold baggage
- Laptops and liquids can stay in bags
- Virtual object removal and insertion

Effective

- Field proven design

3 Innovative Solutions for Life



Introducing Next Generation CT Technology – Analogic's ConneCT™

Analogic media

Fast

- Up to 600 passengers/hour
- Continuous flow bag processing

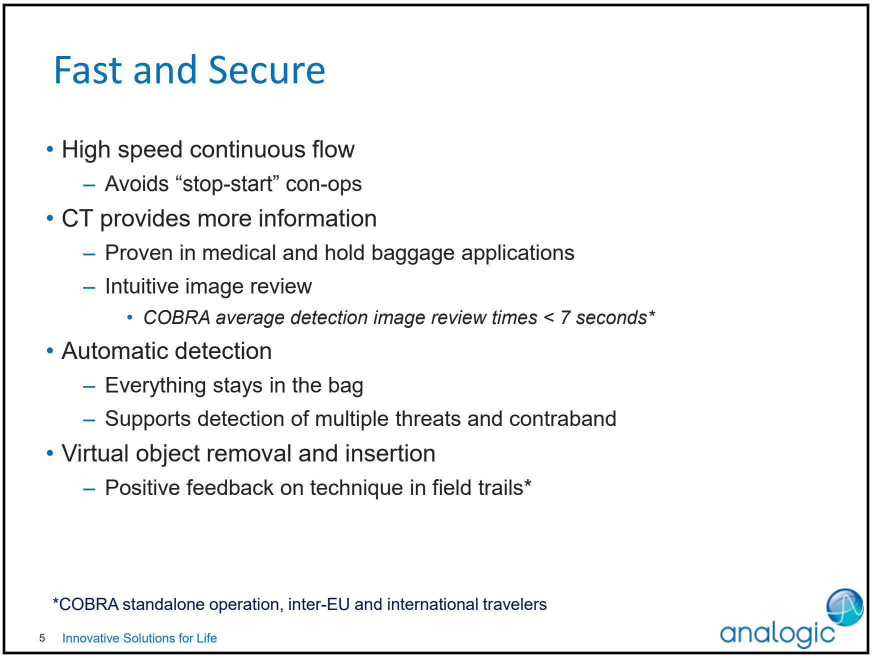
Secure

- FullDetect™ technology
    - High resolution 3D imaging and reconstruction
    - Density and Zeff based threat detection
- Designed to meet the latest detection standards and RBS protocols
- Virtual object removal and insertion

Effective

- Streamlined, compact system
    - 60x40 tunnel
    - Reduced size
    - Reduced weight
- Plug and Play open architecture
- Remote network and automated lane integration
- Low cost of ownership

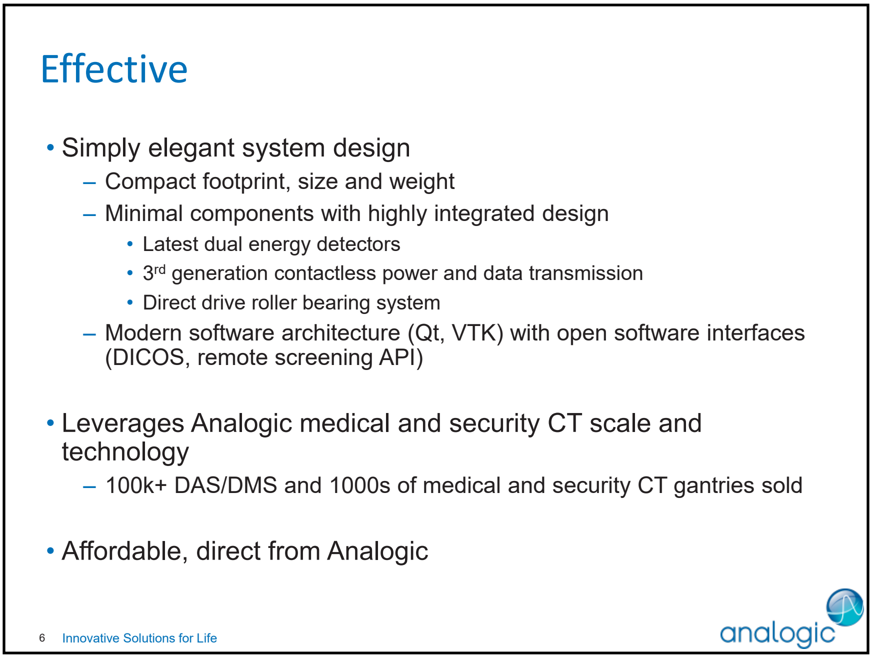
4 Innovative Solutions for Life



Fast and Secure

- High speed continuous flow
  - Avoids “stop-start” con-ops
- CT provides more information
  - Proven in medical and hold baggage applications
  - Intuitive image review
    - *COBRA average detection image review times < 7 seconds**
- Automatic detection
  - Everything stays in the bag
  - Supports detection of multiple threats and contraband
- Virtual object removal and insertion
  - Positive feedback on technique in field trails*

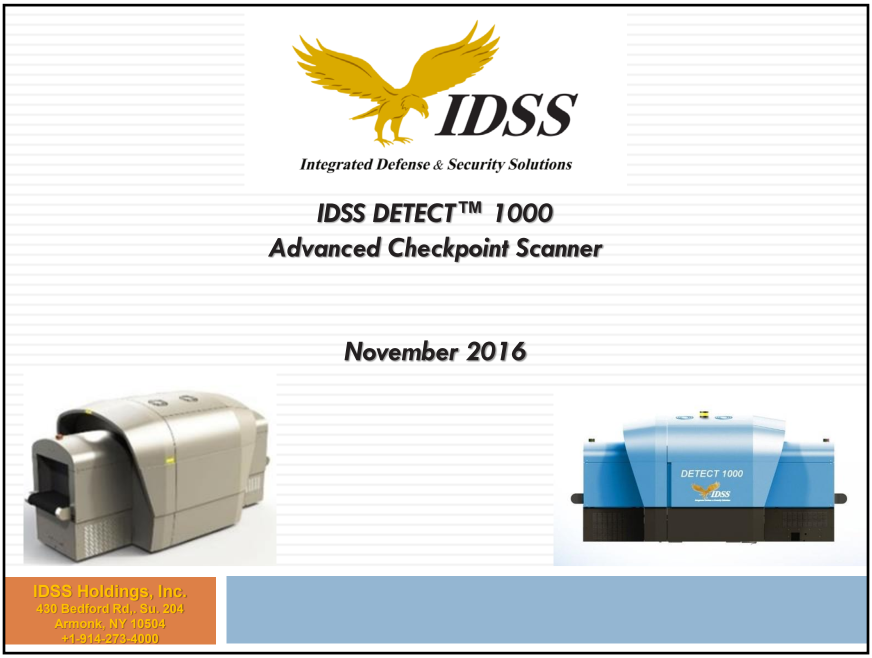
*COBRA standalone operation, inter-EU and international travelers



Effective

- Simply elegant system design
  - Compact footprint, size and weight
  - Minimal components with highly integrated design
    - Latest dual energy detectors
    - 3rd generation contactless power and data transmission
    - Direct drive roller bearing system
  - Modern software architecture (Qt, VTK) with open software interfaces (DICOS, remote screening API)
- Leverages Analogic medical and security CT scale and technology
  - 100k+ DAS/DMS and 1000s of medical and security CT gantries sold
- Affordable, direct from Analogic

16.16 Patricia Krall: IDSS's Checkpoint Scanner



Integrated Defense & Security Solutions

IDSS DETECT™ 1000
Advanced Checkpoint Scanner

November 2016

IDSS Holdings, Inc.
430 Bedford Rd,, Su. 204
Armonk, NY 10504
+1-914-273-4000

IDSS Key Personnel –
A World Renowned Security Team!

Integrated Defense & Security Solutions

Joseph Paresi
Chairman and CEO

Bernard Gordon
Board Member

Peter Marino
Board Member

Paul Efron
Board Member

Doug Boyd, PhD
Technical Advisor

Jim Connelly, PhD
CTO

Jeff Hamel
President

Patricia Krall
Executive VP

John Halinski
Senior Advisor
Former Deputy
Administrator of TSA

Barbara Zylinski
Marketing
DHS and Legislative
Support

Daniel Poder
Software
Engineering
Operational Software

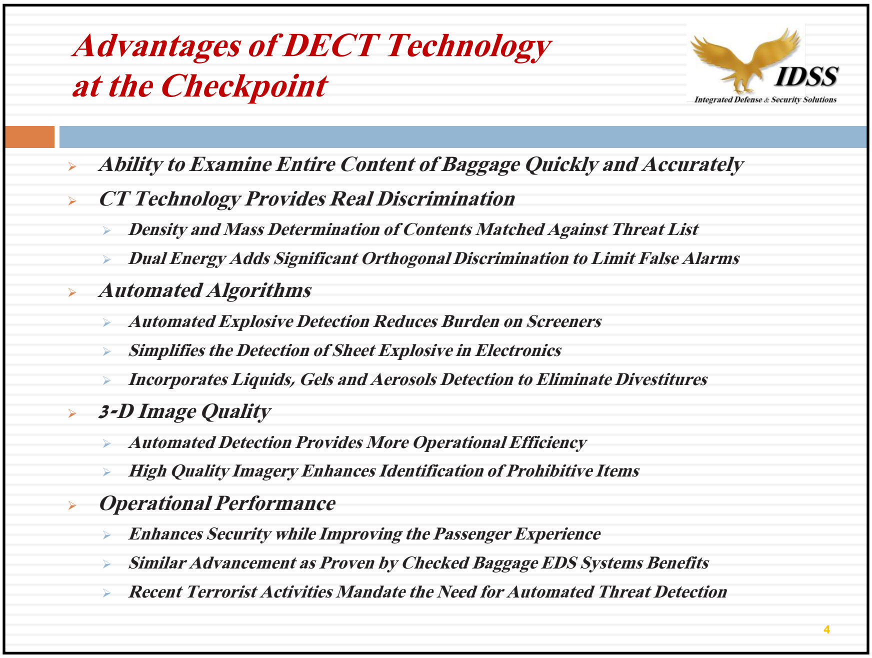
- ***Joseph Paresi – Founder, Chairman and CEO of IDSS***
  - EVP L-1 Identity Solutions (NYSE: ID), Corp VP t L-3 Communications Corporation (NYSE: LLL), Founder & President L-3 Security & Detection Systems, Director of Technology at Lockheed Martin (NYSE: LMT) & Loral (NYSE: LOR) Corporations
- ***Bernard M. Gordon – Co-Founder & IDSS Board Member***
  - Retired Founder, Chairman & CEO of Analogic Corp (NASDAQ: ALOG). National Medal of Technology from President Reagan, Considered "the Father of High-speed, A/D Conversion"
- ***Peter Marino – IDSS Board Member***
  - Co-Chairman Engility, Senior Advisor Director of National Intelligence, Defense Science Board, QinetiQ North America
- ***Paul Efron – IDSS Board Member***
  - Advisory Director Goldman Sachs
- ***Douglas Boyd –Chairman & CEO of TeleSecurity Sciences***
  - Founder of Imatron and InVision Technologies
- ***Dr. James Connelly – IDSS Chief Technology Officer***
  - Director of Technology at L-3 Security & Detection Systems, Former TSA Security Lead for Explosive Detection Systems Doctorate in Computer Engineering from Carnegie Mellon University
- ***Jeffrey Hamel – President of IDSS Security Solutions***
  - Senior Vice President at MorphoTrust USA & Raytheon
- ***Patricia Krall – IDSS Executive Vice President***
  - Originator of eXaminer 6000 and VP at L-3 Security & Detection Systems
- ***Daniel Poder – Director of IDSS Software Solutions***
  - Director of Software Development at MorphoTrust USA

Evolving Threats Drives the Need to Deploy More Advanced Technology

IDSS
Integrated Defense & Security Solutions

- *Terrorists Have Learned to Exploit Weaknesses of X-ray Scanners*
  - *Non-Metallic Detonators*
  - *Explosives Hidden in Electronics*
    - *Two Recent IEDs in Laptops in Somalia!*
  - *Home Made Explosives (HME) are a Major Threat from ISIS and Al Qaeda*
  - *Recent Terrorist Activities Mandate the Need for Automated Threat Detection*
- *DHS Wants Enhanced Threat Detection*
  - *Recognize that Visual Assisted Detection is Too Difficult for Officers to Find*
  - *DHS/TSA Fully Support CT-based Automatic Explosive Detection*

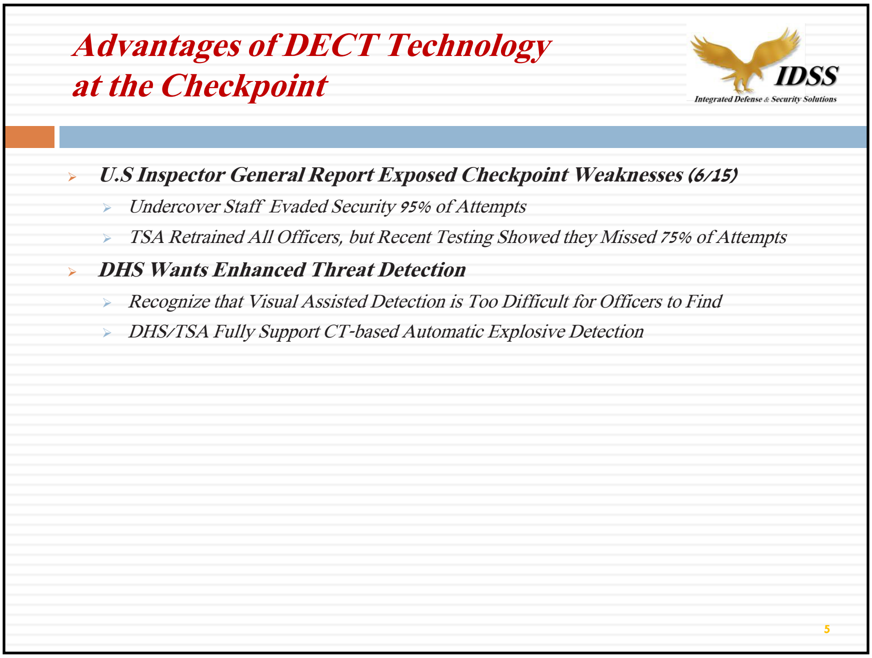
The DETECT™ 1000 Addresses All These Needs and
Formal Test Results Have Validated Its Exceptional Capabilities



Advantages of DECT Technology at the Checkpoint

IDSS
Integrated Defense & Security Solutions

- *Ability to Examine Entire Content of Baggage Quickly and Accurately*
- *CT Technology Provides Real Discrimination*
  - *Density and Mass Determination of Contents Matched Against Threat List*
  - *Dual Energy Adds Significant Orthogonal Discrimination to Limit False Alarms*
- *Automated Algorithms*
  - *Automated Explosive Detection Reduces Burden on Screeners*
  - *Simplifies the Detection of Sheet Explosive in Electronics*
  - *Incorporates Liquids, Gels and Aerosols Detection to Eliminate Divestitures*
- *3-D Image Quality*
  - *Automated Detection Provides More Operational Efficiency*
  - *High Quality Imagery Enhances Identification of Prohibitive Items*
- *Operational Performance*
  - *Enhances Security while Improving the Passenger Experience*
  - *Similar Advancement as Proven by Checked Baggage EDS Systems Benefits*
  - *Recent Terrorist Activities Mandate the Need for Automated Threat Detection*



Advantages of DECT Technology at the Checkpoint

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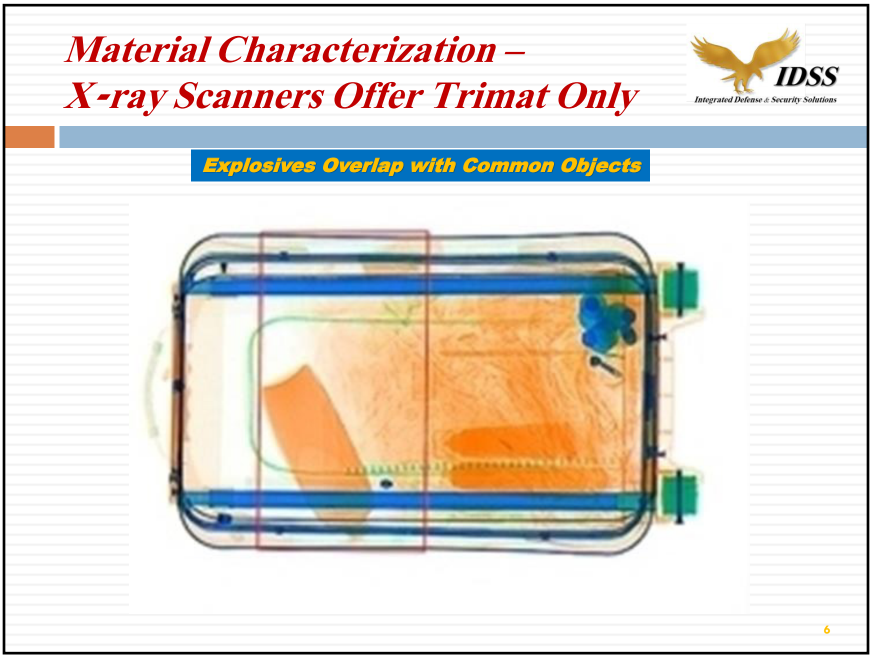
- ***U.S Inspector General Report Exposed Checkpoint Weaknesses (6/15)***
  - *Undercover Staff Evaded Security 95% of Attempts*
  - *TSA Retrained All Officers, but Recent Testing Showed they Missed 75% of Attempts*
- ***DHS Wants Enhanced Threat Detection***
  - *Recognize that Visual Assisted Detection is Too Difficult for Officers to Find*
  - *DHS/TSA Fully Support CT-based Automatic Explosive Detection*



Material Characterization – X-ray Scanners Offer Trimat Only

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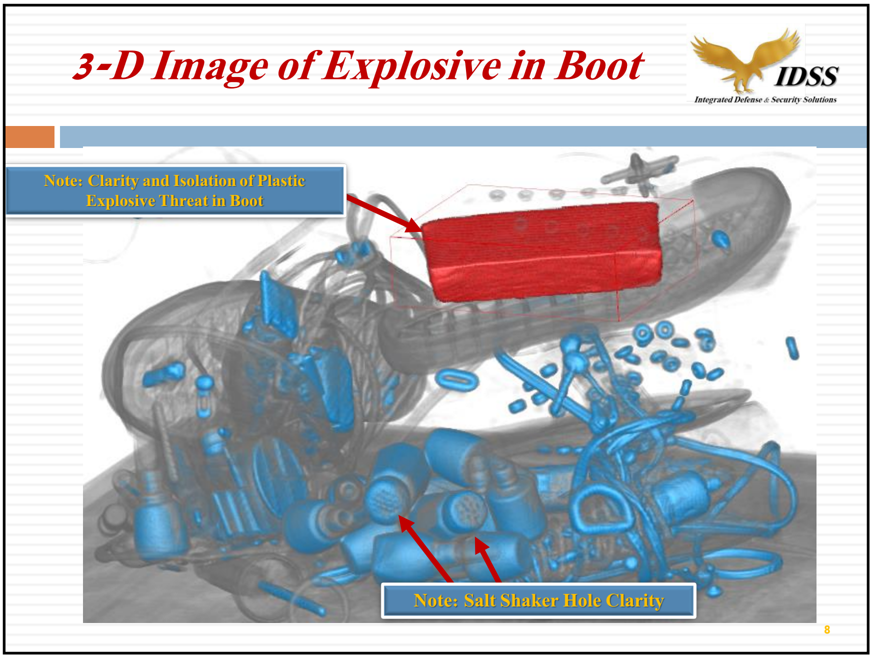
Explosives Overlap with Common Objects

TSA DETECT Successful Operational Trials in EU

IDSS
Integrated Defense & Security Solutions



3-D Image of Explosive in Boot

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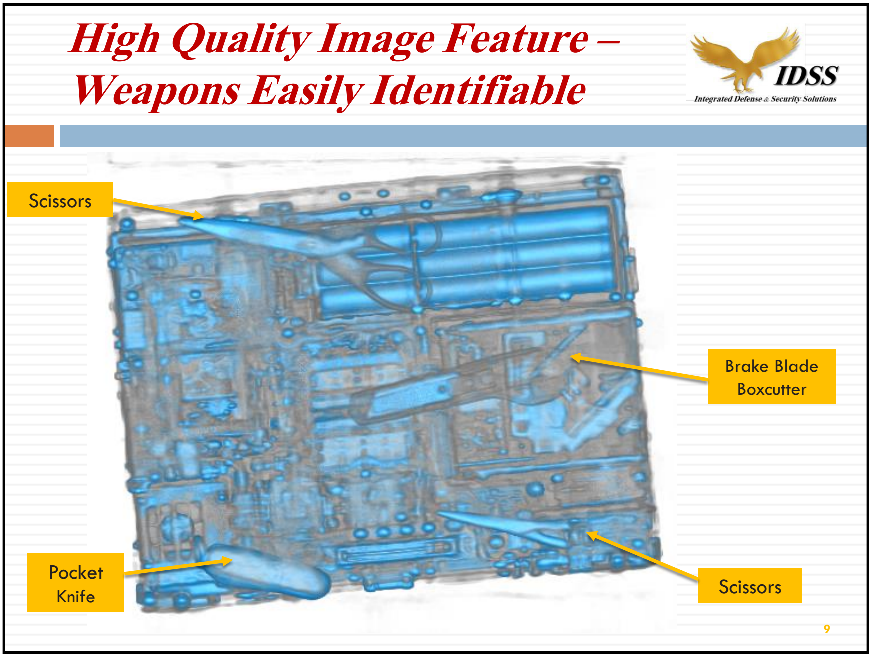
Integrated Defense & Security Solutions

Note: Clarity and Isolation of Plastic Explosive Threat in Boot

Note: Salt Shaker Hole Clarity



High Quality Image Feature – Weapons Easily Identifiable

Scissors

Brake Blade Boxcutter

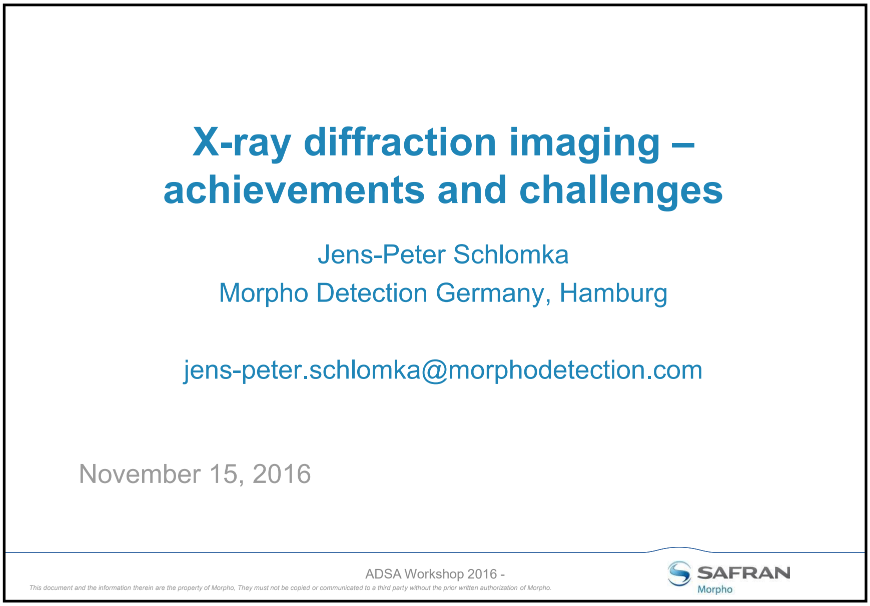
Pocket Knife

Scissors

DETECT™ 1000

- *Fully Automated Detection Significantly Simplifies the Security Screening Process*
- *Low False Alarms Limit the Number of Bags Needing Secondary Screening*
- *High Image Quality Supports Quick Prohibited Items Detection*
- *Improved Security while also Improving and Expediting the Passenger Experience*

16.17 Jens-Peter Schlomka: X-Ray Diffraction Imaging - Achievements and Challenges



X-ray diffraction imaging – achievements and challenges

Jens-Peter Schlomka
Morpho Detection Germany, Hamburg

jens-peter.schlomka@morphodetection.com

November 15, 2016

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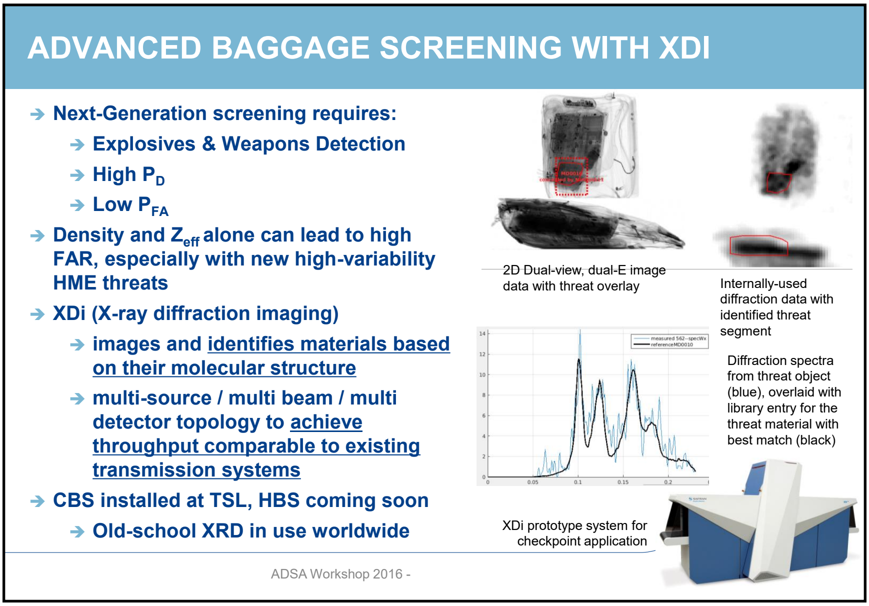

ADVANCED BAGGAGE SCREENING WITH XDI

- Next-Generation screening requires:
  - Explosives & Weapons Detection
  - High P_D
  - Low P_{FA}
- Density and Z_{eff} alone can lead to high FAR, especially with new high-variability HME threats
- XDi (X-ray diffraction imaging)
  - images and identifies materials based on their molecular structure
  - multi-source / multi beam / multi detector topology to achieve throughput comparable to existing transmission systems
- CBS installed at TSL, HBS coming soon
  - Old-school XRD in use worldwide

2D Dual-view, dual-E image data with threat overlay

Internally-used diffraction data with identified threat segment

Diffraction spectra from threat object (blue), overlaid with library entry for the threat material with best match (black)

XDi prototype system for checkpoint application

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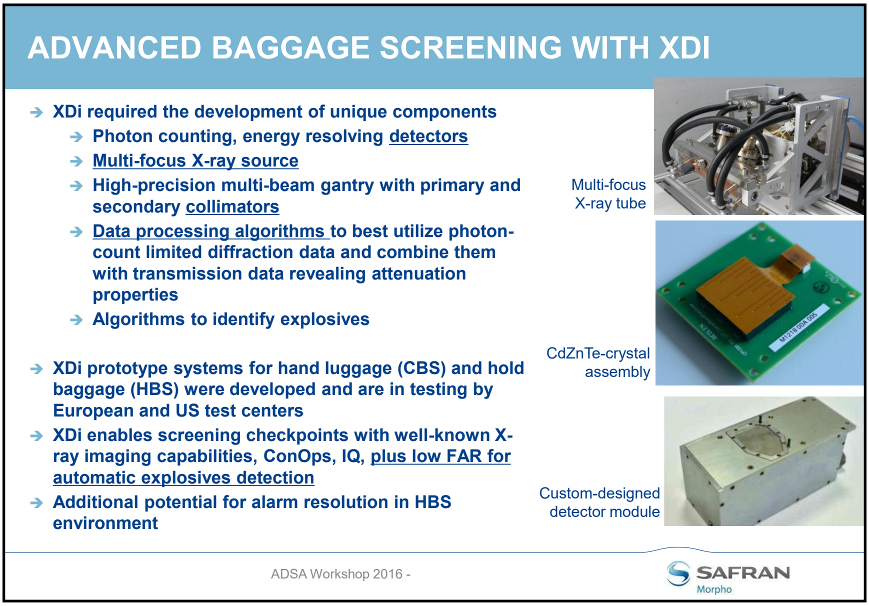

ADVANCED BAGGAGE SCREENING WITH XDI

- XDi required the development of unique components
  - Photon counting, energy resolving detectors
  - Multi-focus X-ray source
  - High-precision multi-beam gantry with primary and secondary collimators
  - Data processing algorithms to best utilize photon-count limited diffraction data and combine them with transmission data revealing attenuation properties
  - Algorithms to identify explosives
- XDi prototype systems for hand luggage (CBS) and hold baggage (HBS) were developed and are in testing by European and US test centers
- XDi enables screening checkpoints with well-known X-ray imaging capabilities, ConOps, IQ, plus low FAR for automatic explosives detection
- Additional potential for alarm resolution in HBS environment

Multi-focus
X-ray tube

CdZnTe-crystal
assembly

Custom-designed
detector module

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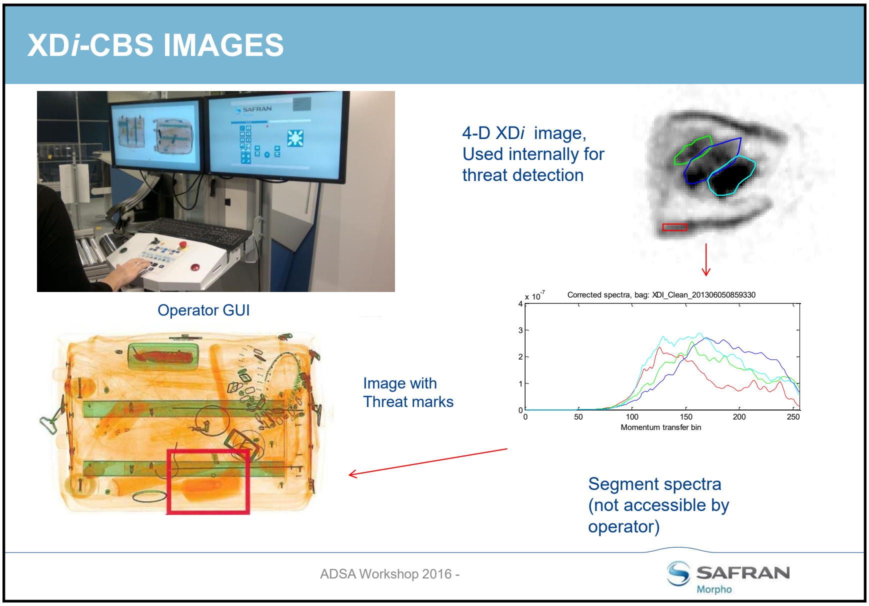

XD*i*-CBS IMAGES

Operator GUI

4-D XD*i* image,
Used internally for
threat detection

Image with
Threat marks

Segment spectra
(not accessible by
operator)

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THANK YOU FOR YOUR ATTENTION !!!

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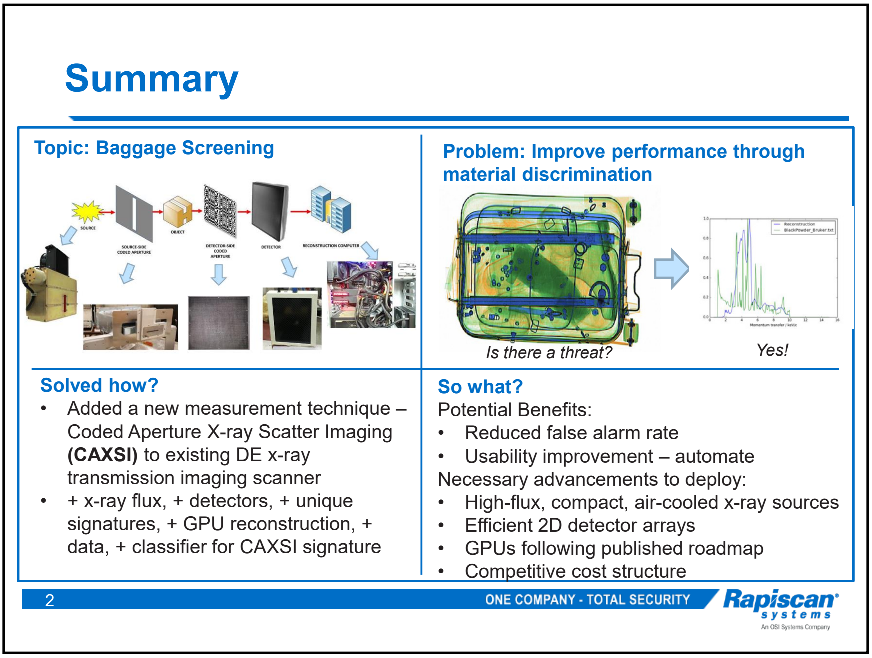
16.18 Dan Strellis: Prospects for Using Coherent X-Ray Scatter for Material Discrimination at a Checkpoint

Coherent x-ray scatter (CXS) for material discrimination at a checkpoint

Ed Franco and Dan Strellis
(dstrellis@rapiscansystems.com)

This work is supported by the US Department of Homeland Security, Science and Technology Directorate, Explosives Division, and the UK Home Office under HSARPA Contract # HSHQDC-14-C-B0044



Summary

Topic: Baggage Screening

Problem: Improve performance through material discrimination

Is there a threat?

Yes!

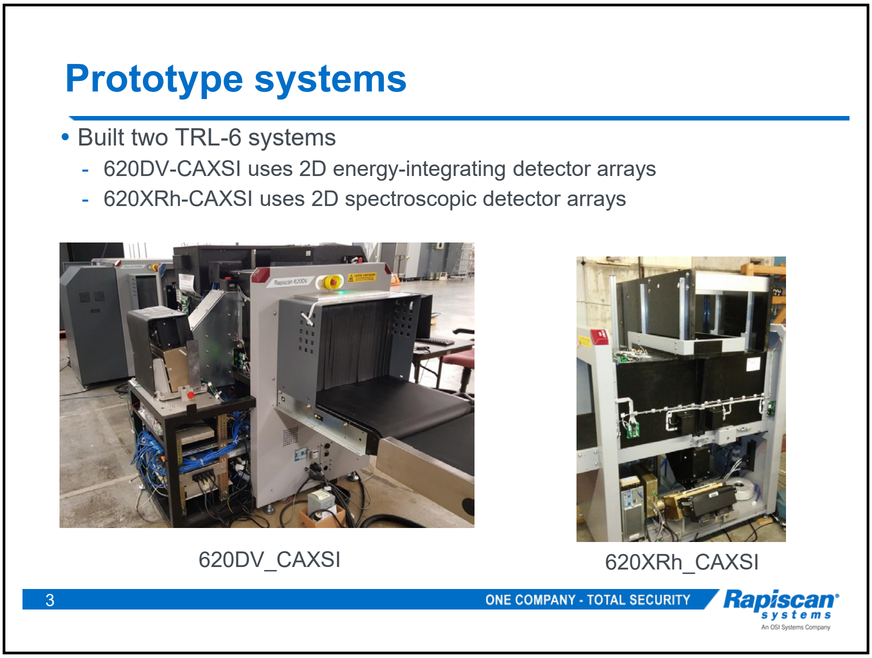
Solved how?

- Added a new measurement technique – Coded Aperture X-ray Scatter Imaging **(CAXSI)** to existing DE x-ray transmission imaging scanner
- + x-ray flux, + detectors, + unique signatures, + GPU reconstruction, + data, + classifier for CAXSI signature

So what?

Potential Benefits:
- Reduced false alarm rate
- Usability improvement – automate

Necessary advancements to deploy:
- High-flux, compact, air-cooled x-ray sources
- Efficient 2D detector arrays
- GPUs following published roadmap
- Competitive cost structure

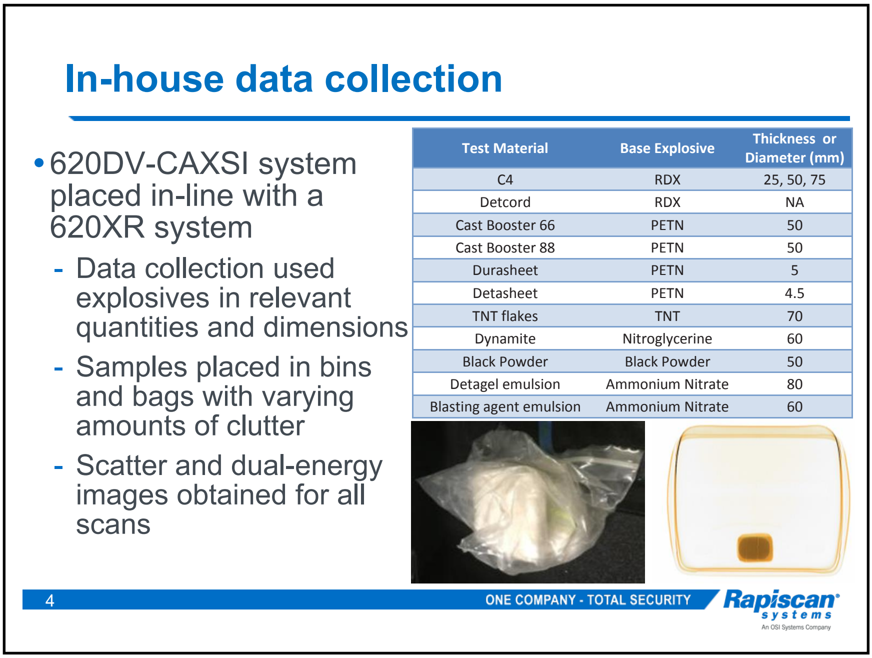


Prototype systems

- Built two TRL-6 systems
  - 620DV-CAXSI uses 2D energy-integrating detector arrays
  - 620XRh-CAXSI uses 2D spectroscopic detector arrays

620DV_CAXSI

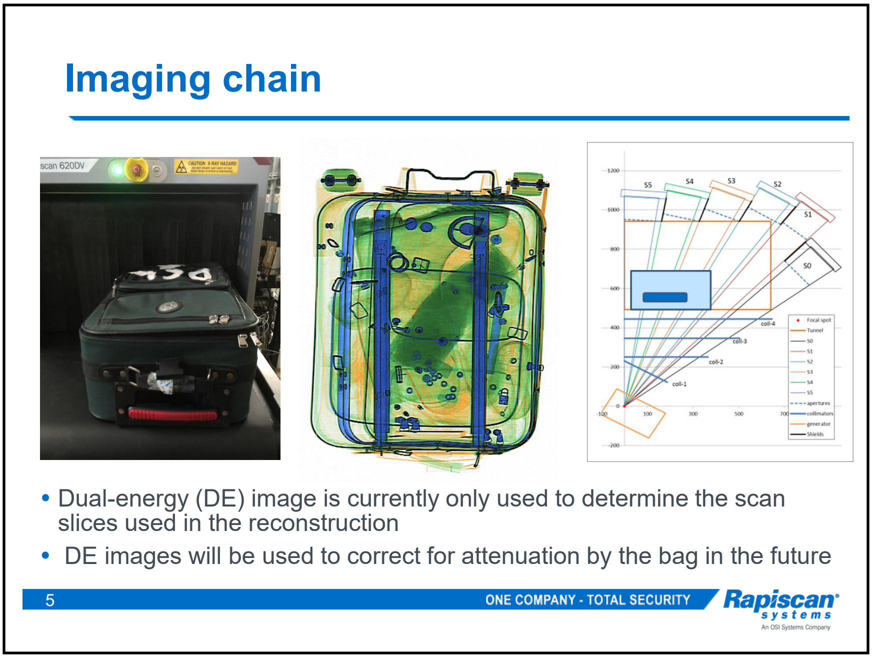
620XRh_CAXSI



In-house data collection

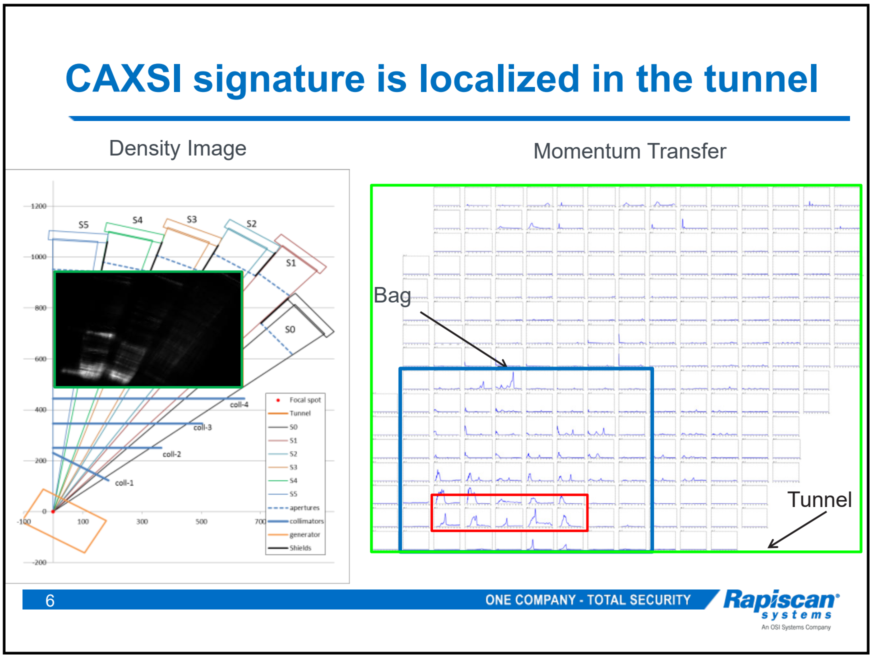
- 620DV-CAXSI system placed in-line with a 620XR system
  - Data collection used explosives in relevant quantities and dimensions
  - Samples placed in bins and bags with varying amounts of clutter
  - Scatter and dual-energy images obtained for all scans

Test Material	Base Explosive	Thickness or Diameter (mm)
C4	RDX	25, 50, 75
Detcord	RDX	NA
Cast Booster 66	PETN	50
Cast Booster 88	PETN	50
Durasheet	PETN	5
Detasheet	PETN	4.5
TNT flakes	TNT	70
Dynamite	Nitroglycerine	60
Black Powder	Black Powder	50
Detagel emulsion	Ammonium Nitrate	80
Blasting agent emulsion	Ammonium Nitrate	60



Imaging chain

- Dual-energy (DE) image is currently only used to determine the scan slices used in the reconstruction
- DE images will be used to correct for attenuation by the bag in the future



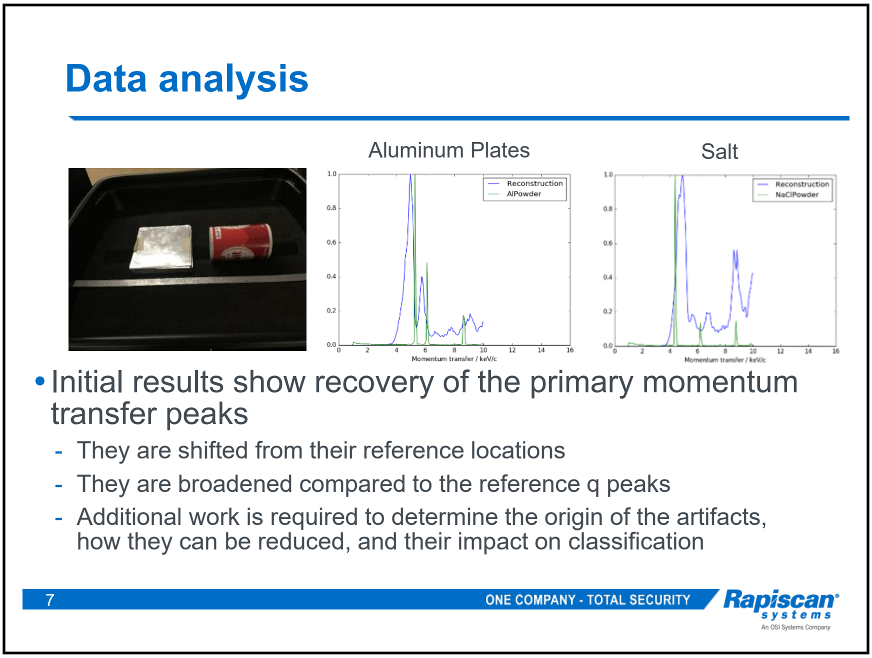
CAXSI signature is localized in the tunnel

Density Image

Momentum Transfer

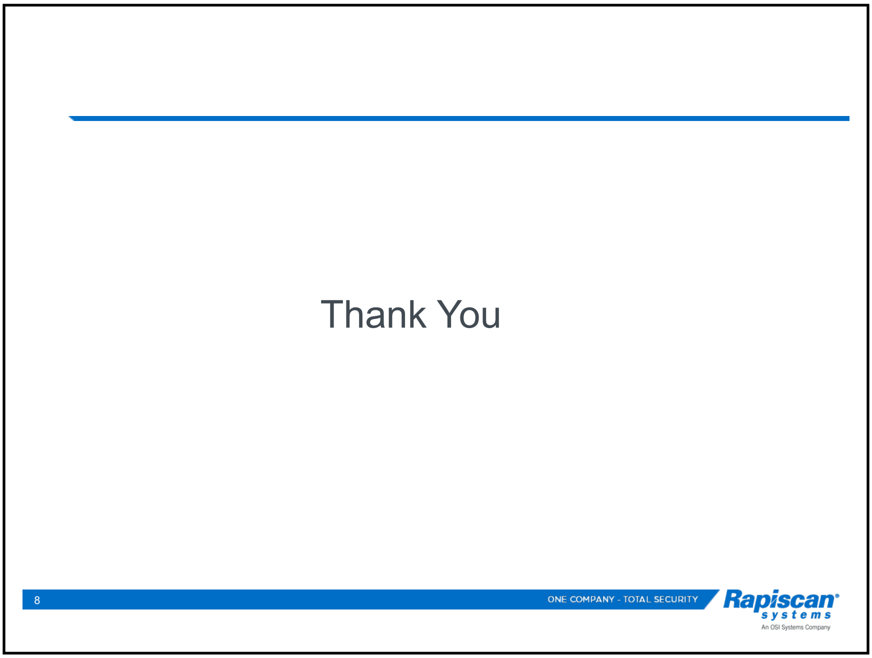
Bag

Tunnel



Data analysis

- Initial results show recovery of the primary momentum transfer peaks
  - They are shifted from their reference locations
  - They are broadened compared to the reference q peaks
  - Additional work is required to determine the origin of the artifacts, how they can be reduced, and their impact on classification



Thank You

16.19 Mircea Tudor: Fast & Reliable Bomb Threat Clearing of Civil Airplanes

AIRCRAFT SCANNING - INNOVATIVE SECURITY SOLUTION for BOMB THREAT CLEARING
„AVIATION SECURITY” – BOSTON – November, 2016

I have for you as many questions you might have for me, but I have also few answers! Mircea TUDOR, CEO of:

Who we are? TUDOR Scan Tech Products Range

- TUDOR Scan AERIA Innovative & unique solution for security screening of aircraft
- TUDOR Scan ML64 Robotic trucks scanners based on dual energy LINAC technology
- TUDOR Scan 1MC Robotic trucks scanners based on dual energy Gamma technology
- TUDOR Scan OCV Low dose X-ray solutions for scanning of occupied cars and vans
- Integrated Security Systems for airports, seaports, borders, homeland protection

International Recognition of our technologies

- The Grand Prix of the 37th International Exhibition of Inventions of Geneva 2009
- Gold Medal 37th International Exhibition of Inventions Geneva 2009
- WIPO AWARD World Intellectual Property Organization Award for Best Inventor 2009
- Gold Medal International Warsaw Invention Show 2009
- Gold Medal – The International Invention Fair of the Middle East – Kuwait 2008
- The Grand Prix of the 41st International Exhibition of Inventions of Geneva 2013

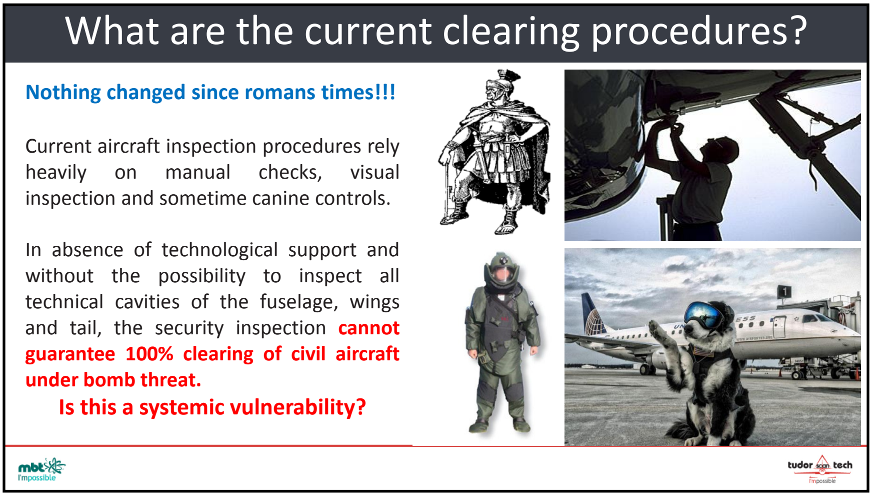
What are the THREATS we can solve?

- Global Civil Aviation is facing exponential increasing number of bomb threats in average of one per day, at least one per week being related to aircrafts;
- Real bombs can pass over the current security procedures, being placed in the aircraft, usually inside technical cavities that ***are not accessible to be inspected according to current aircraft clearing procedures.*** ***Is this a systemic vulnerability?***
- *Video source: http://www.bbc.com/news/world-middle-east-36961913*

- YES, the Civil Aviation is subject of a ***Systemic Vulnerability*** that terrorist groups are using to transform the safest mode of transportation into a weapon of fear and terror.

Insider threats are a reality today as per NEWSWEEK - March 06, 2016

http://globalincidentmap.com/incidents.php?typeid=1



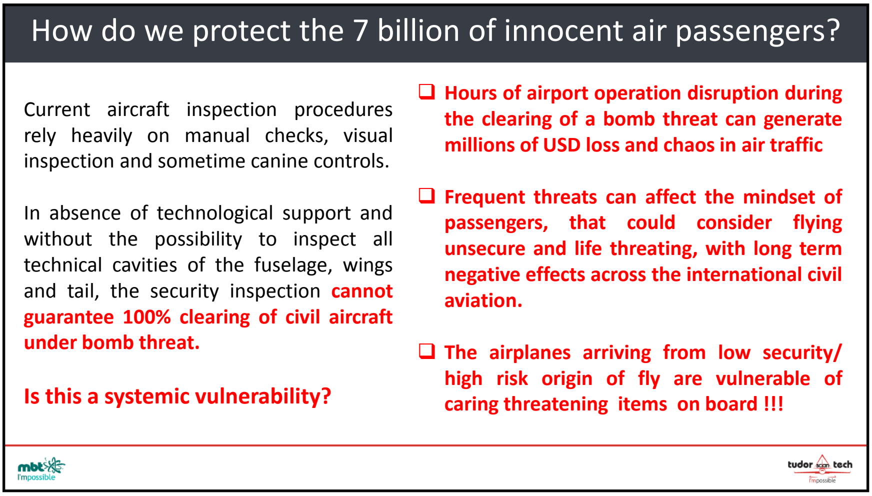
What are the current clearing procedures?

Nothing changed since romans times!!!

Current aircraft inspection procedures rely heavily on manual checks, visual inspection and sometime canine controls.

In absence of technological support and without the possibility to inspect all technical cavities of the fuselage, wings and tail, the security inspection **cannot guarantee 100% clearing of civil aircraft under bomb threat.**

Is this a systemic vulnerability?



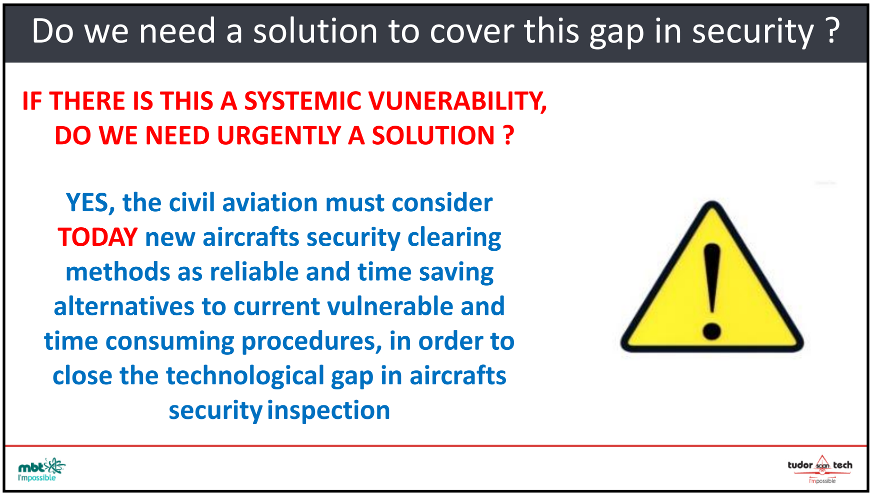
How do we protect the 7 billion of innocent air passengers?

Current aircraft inspection procedures rely heavily on manual checks, visual inspection and sometime canine controls.

In absence of technological support and without the possibility to inspect all technical cavities of the fuselage, wings and tail, the security inspection **cannot guarantee 100% clearing of civil aircraft under bomb threat.**

Is this a systemic vulnerability?

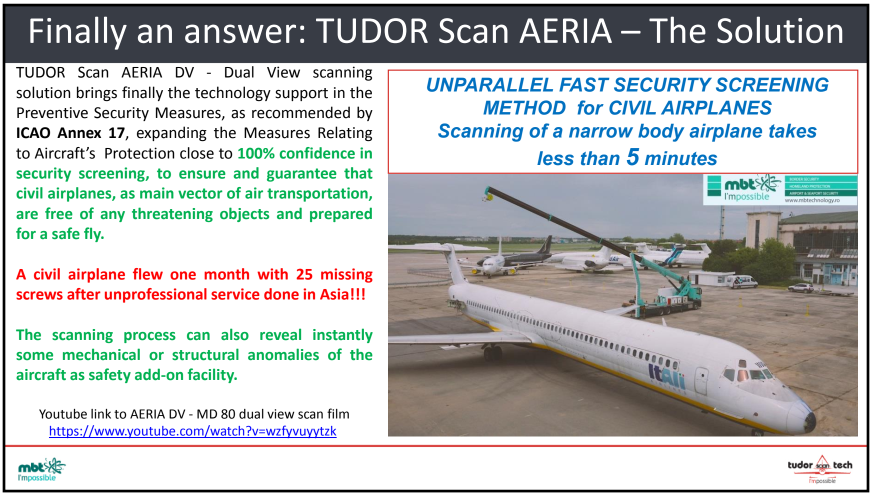
- ☐ **Hours of airport operation disruption during the clearing of a bomb threat can generate millions of USD loss and chaos in air traffic**
- ☐ **Frequent threats can affect the mindset of passengers, that could consider flying unsecure and life threating, with long term negative effects across the international civil aviation.**
- ☐ **The airplanes arriving from low security/ high risk origin of fly are vulnerable of caring threatening items on board !!!**



Do we need a solution to cover this gap in security ?

**IF THERE IS THIS A SYSTEMIC VUNERABILITY,
DO WE NEED URGENTLY A SOLUTION ?**

YES, the civil aviation must consider TODAY new aircrafts security clearing methods as reliable and time saving alternatives to current vulnerable and time consuming procedures, in order to close the technological gap in aircrafts security inspection



Finally an answer: TUDOR Scan AERIA – The Solution

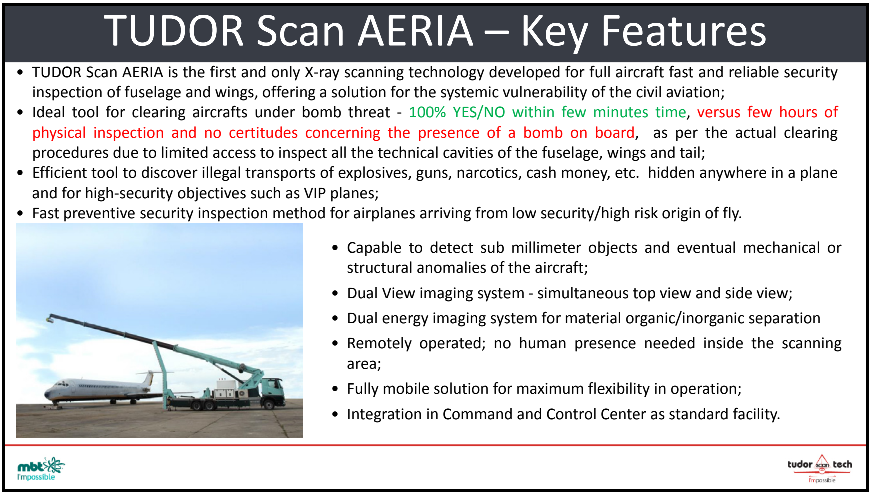
TUDOR Scan AERIA DV - Dual View scanning solution brings finally the technology support in the Preventive Security Measures, as recommended by **ICAO Annex 17**, expanding the Measures Relating to Aircraft's Protection close to **100% confidence in security screening, to ensure and guarantee that civil airplanes, as main vector of air transportation, are free of any threatening objects and prepared for a safe fly.**

A civil airplane flew one month with 25 missing screws after unprofessional service done in Asia!!!

The scanning process can also reveal instantly some mechanical or structural anomalies of the aircraft as safety add-on facility.

Youtube link to AERIA DV - MD 80 dual view scan film
https://www.youtube.com/watch?v=wzfyvuyytzk

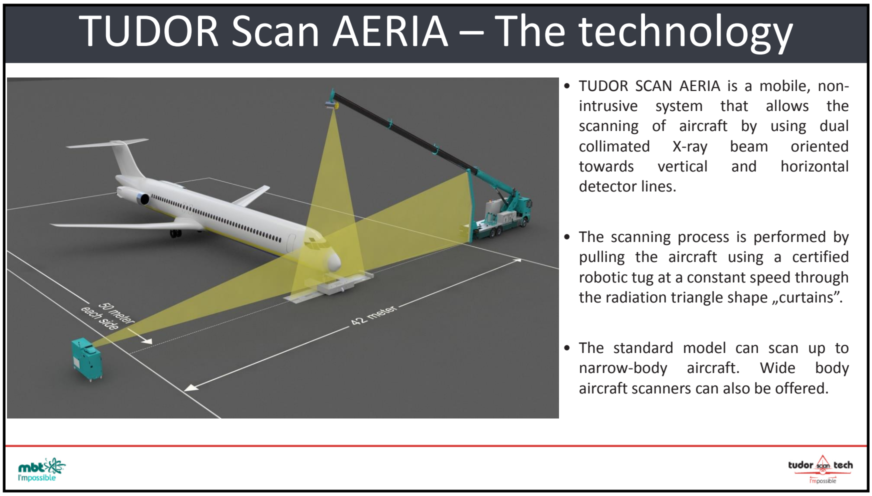
UNPARALLEL FAST SECURITY SCREENING METHOD for CIVIL AIRPLANES
Scanning of a narrow body airplane takes less than 5 minutes



TUDOR Scan AERIA – Key Features

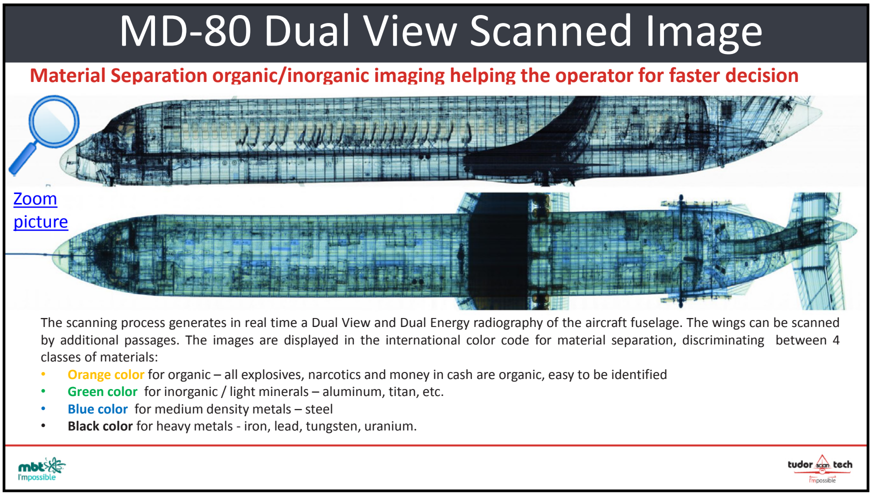
- TUDOR Scan AERIA is the first and only X-ray scanning technology developed for full aircraft fast and reliable security inspection of fuselage and wings, offering a solution for the systemic vulnerability of the civil aviation;
- Ideal tool for clearing aircrafts under bomb threat - 100% YES/NO within few minutes time, versus few hours of physical inspection and no certitudes concerning the presence of a bomb on board, as per the actual clearing procedures due to limited access to inspect all the technical cavities of the fuselage, wings and tail;
- Efficient tool to discover illegal transports of explosives, guns, narcotics, cash money, etc. hidden anywhere in a plane and for high-security objectives such as VIP planes;
- Fast preventive security inspection method for airplanes arriving from low security/high risk origin of fly.

- Capable to detect sub millimeter objects and eventual mechanical or structural anomalies of the aircraft;
- Dual View imaging system - simultaneous top view and side view;
- Dual energy imaging system for material organic/inorganic separation
- Remotely operated; no human presence needed inside the scanning area;
- Fully mobile solution for maximum flexibility in operation;
- Integration in Command and Control Center as standard facility.



TUDOR Scan AERIA – The technology

- TUDOR SCAN AERIA is a mobile, non-intrusive system that allows the scanning of aircraft by using dual collimated X-ray beam oriented towards vertical and horizontal detector lines.
- The scanning process is performed by pulling the aircraft using a certified robotic tug at a constant speed through the radiation triangle shape „curtains”.
- The standard model can scan up to narrow-body aircraft. Wide body aircraft scanners can also be offered.



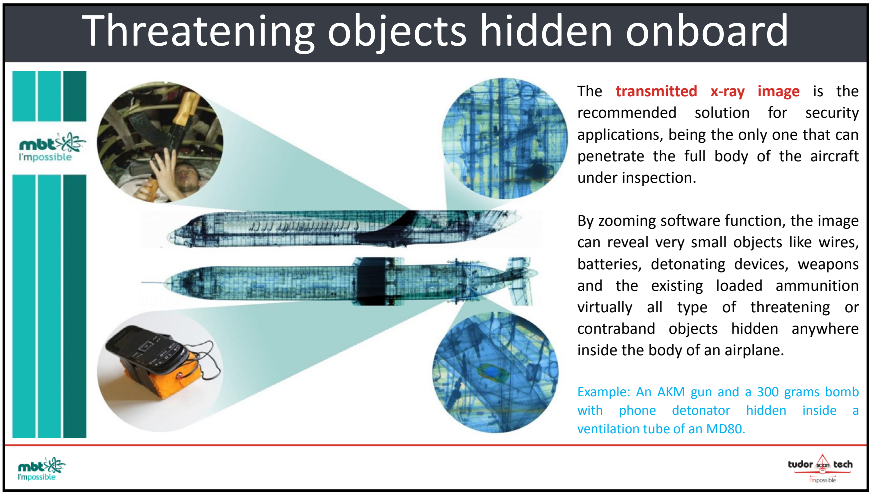
MD-80 Dual View Scanned Image

Material Separation organic/inorganic imaging helping the operator for faster decision

Zoom
picture

The scanning process generates in real time a Dual View and Dual Energy radiography of the aircraft fuselage. The wings can be scanned by additional passages. The images are displayed in the international color code for material separation, discriminating between 4 classes of materials:

- **Orange color** for organic – all explosives, narcotics and money in cash are organic, easy to be identified
- **Green color** for inorganic / light minerals – aluminum, titan, etc.
- **Blue color** for medium density metals – steel
- **Black color** for heavy metals - iron, lead, tungsten, uranium.

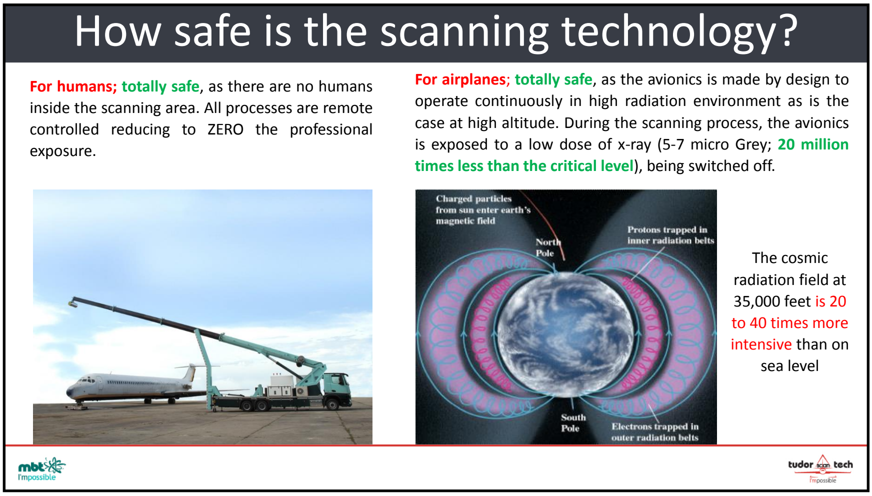


Threatening objects hidden onboard

The **transmitted x-ray image** is the recommended solution for security applications, being the only one that can penetrate the full body of the aircraft under inspection.

By zooming software function, the image can reveal very small objects like wires, batteries, detonating devices, weapons and the existing loaded ammunition virtually all type of threatening or contraband objects hidden anywhere inside the body of an airplane.

Example: An AKM gun and a 300 grams bomb with phone detonator hidden inside a ventilation tube of an MD80.

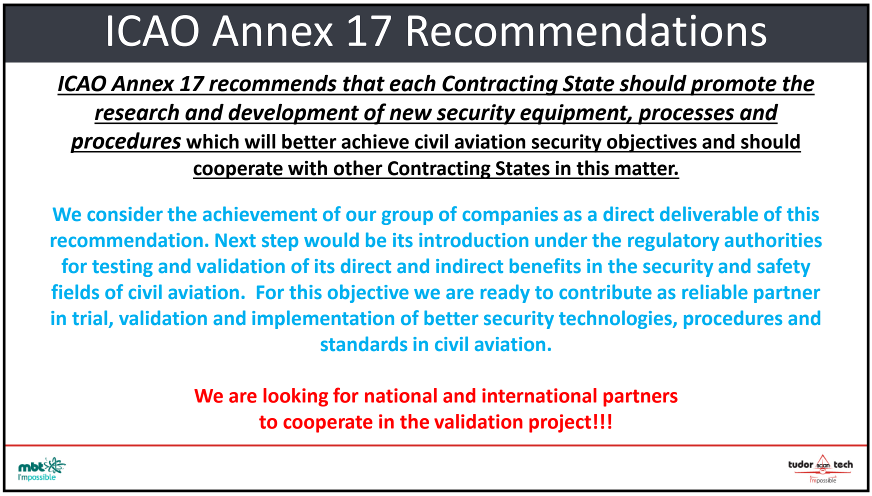


How safe is the scanning technology?

For humans; totally safe, as there are no humans inside the scanning area. All processes are remote controlled reducing to ZERO the professional exposure.

For airplanes; totally safe, as the avionics is made by design to operate continuously in high radiation environment as is the case at high altitude. During the scanning process, the avionics is exposed to a low dose of x-ray (5-7 micro Grey; **20 million times less than the critical level**), being switched off.

The cosmic radiation field at 35,000 feet is 20 to 40 times more intensive than on sea level

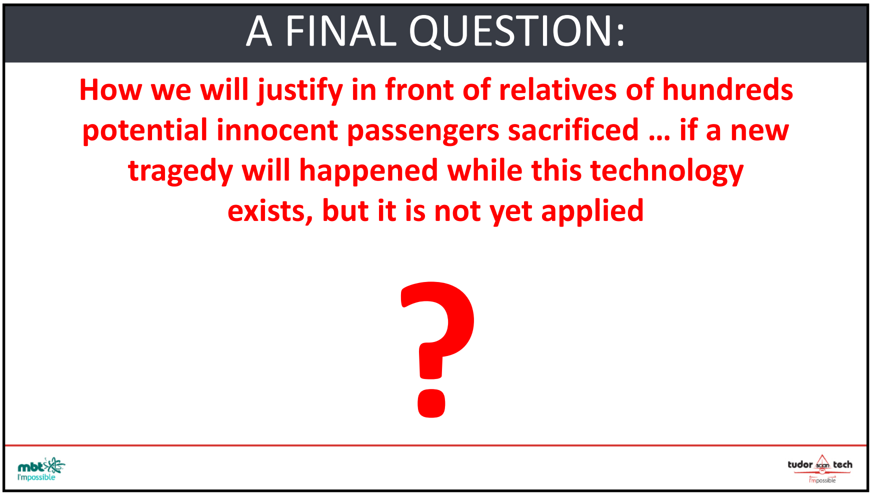


ICAO Annex 17 Recommendations

ICAO Annex 17 recommends that each Contracting State should promote the research and development of new security equipment, processes and procedures **which will better achieve civil aviation security objectives and should cooperate with other Contracting States in this matter.**

We consider the achievement of our group of companies as a direct deliverable of this recommendation. Next step would be its introduction under the regulatory authorities for testing and validation of its direct and indirect benefits in the security and safety fields of civil aviation. For this objective we are ready to contribute as reliable partner in trial, validation and implementation of better security technologies, procedures and standards in civil aviation.

We are looking for national and international partners
to cooperate in the validation project!!!



A FINAL QUESTION:

How we will justify in front of relatives of hundreds potential innocent passengers sacrificed … if a new tragedy will happened while this technology exists, but it is not yet applied

?

THANK YOU! ANY QUESTIONS?

TUDOR Scan Tech S.A.
Technologic Park
6, Rue de la Clef
CH-2610, St.- Imier
Switzerland
mircea.tudor@tudor-tech.ch
+41 799 068 014

MEDIA LINKS: **CTV News AERIA**: http://www.ctvnews.ca/video?clipId=462744

National Geographic documentary; minute 23:00 to 27:00:
https://www.youtube.com/watch?v=_mklT45zzC8&t=23m48s

Daily mail article: http://www.dailymail.co.uk/sciencetech/article-3052031/The-scanner-scour-entire-PLANE-Mobile-device-weapons-drugs-hidden-onboard

London Times article: http://www.thetimes.co.uk/tto/technology/article4419752.ece

Financial Times: http://www.ft.com/intl/cms/s/2/6501ff82-f95f-11e4-ae65-00144feab7de.html#axzz3ogPMeXTv

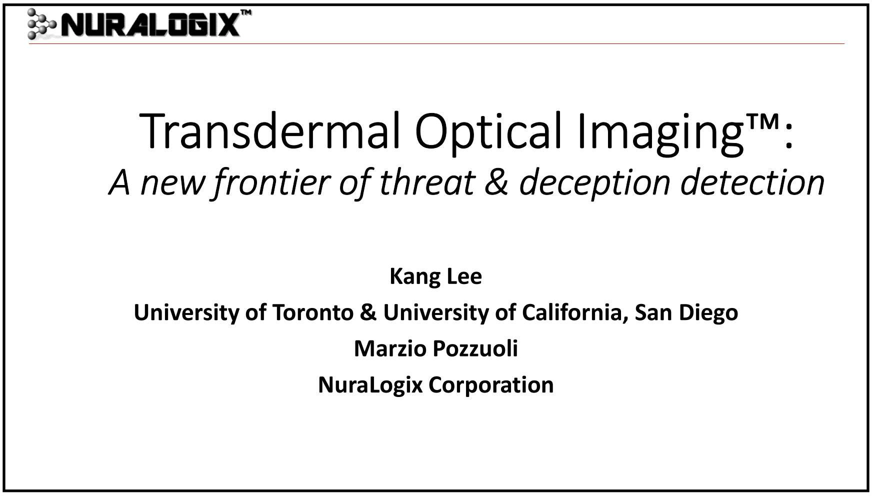
http://www.libertaddigital.com/ciencia-tecnologia/tecnologia/2015-05-13/desarrollan-un-escaner-para-aviones-que-detecta-bombas-en-segundos-1276547900/

http://www.rts.ch/info/economie/7759877-une-societe-roumaine-delocalise-en-suisse-et-confirme-vouloir-creer-130-emplois.html

L'IMPARTIAL July 08, 2016: «si l'avion israélien qui a dű ętre récemment escorté par nos avions de chasse, en raison d'une alerte de bombe, avait été scanné par un tel appareil, (o.n.TUDOR Scan AERIA) cette intervention n'aurait pas été nécessaire.»

Guy Parmelin – Defense Minister of Switzerland

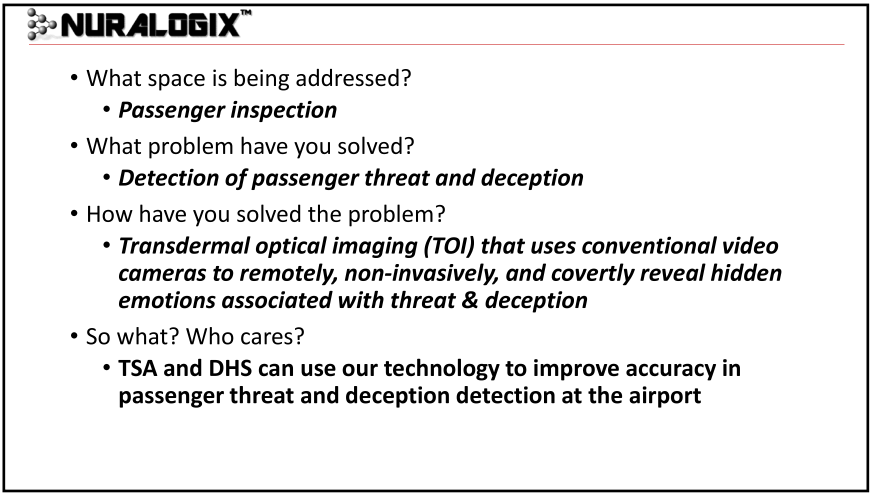
16.20 Kang Lee: Transdermal Optic Imaging: A New Frontier of Lie Detection



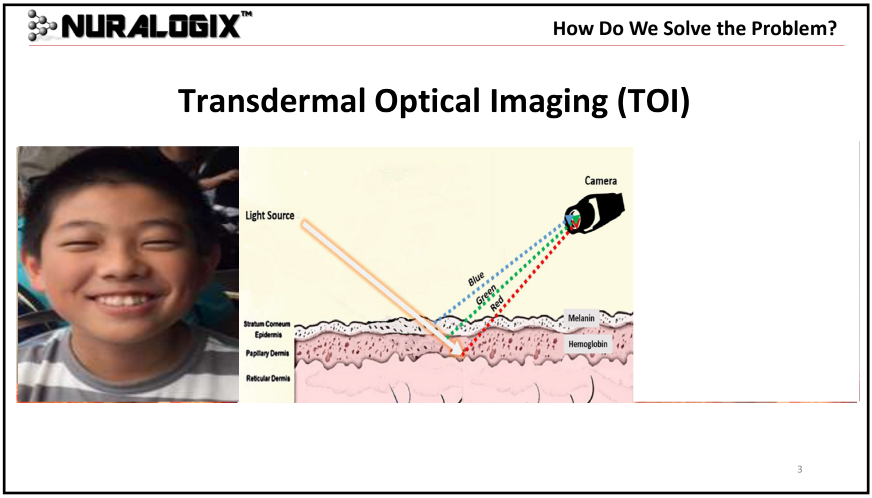
Transdermal Optical Imaging™:

A new frontier of threat & deception detection

Kang Lee
University of Toronto & University of California, San Diego
Marzio Pozzuoli
NuraLogix Corporation



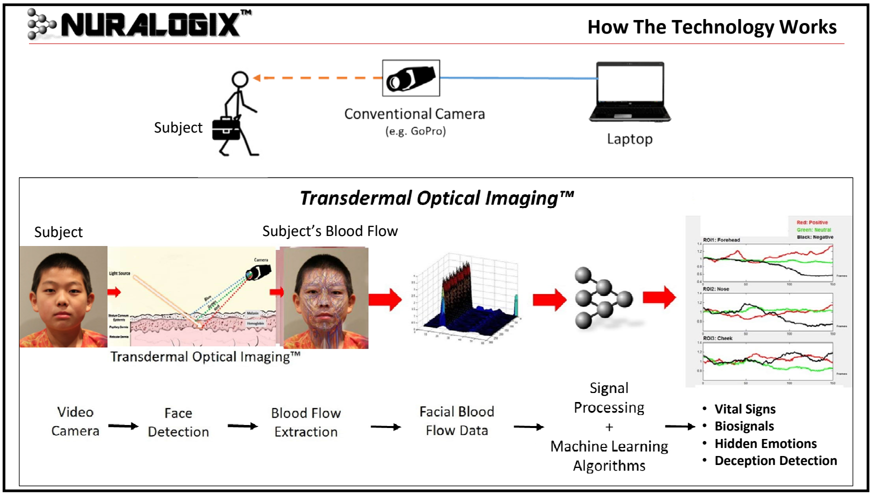
- What space is being addressed?
  - ***Passenger inspection***
- What problem have you solved?
  - ***Detection of passenger threat and deception***
- How have you solved the problem?
  - ***Transdermal optical imaging (TOI) that uses conventional video cameras to remotely, non-invasively, and covertly reveal hidden emotions associated with threat & deception***
- So what? Who cares?
  - **TSA and DHS can use our technology to improve accuracy in passenger threat and deception detection at the airport**



NURALOGIX™

How Do We Solve the Problem?

Transdermal Optical Imaging (TOI)



NURALOGIX™

How The Technology Works

Subject

Conventional Camera
(e.g. GoPro)

Laptop

Transdermal Optical Imaging™

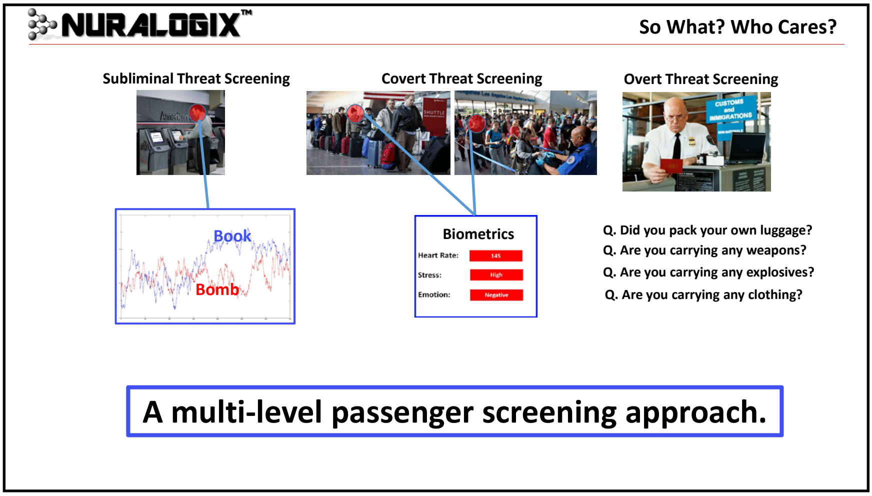
Subject

Subject's Blood Flow

Transdermal Optical Imaging™

Video Camera → Face Detection → Blood Flow Extraction → Facial Blood Flow Data → Signal Processing + Machine Learning Algorithms →

- **Vital Signs**
- **Biosignals**
- **Hidden Emotions**
- **Deception Detection**



NURALOGIX™

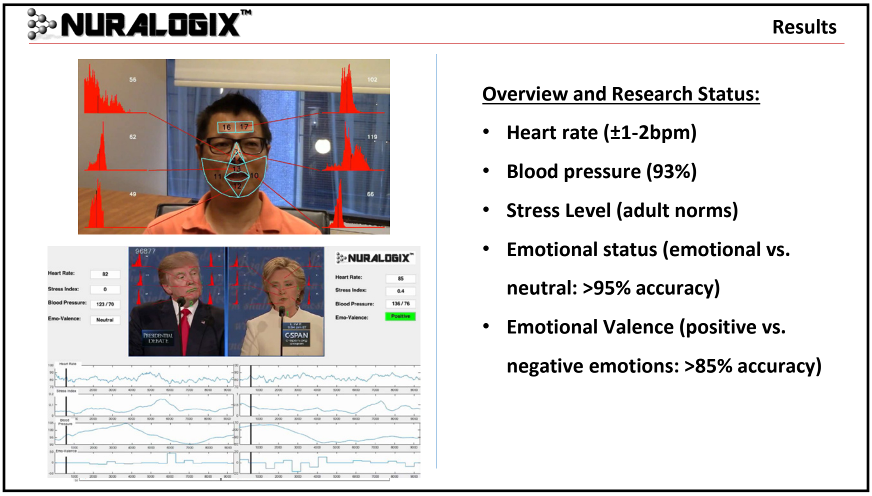
So What? Who Cares?

Biometrics

Heart Rate: 145
Stress: High
Emotion: Negative

Q. Did you pack your own luggage?
Q. Are you carrying any weapons?
Q. Are you carrying any explosives?
Q. Are you carrying any clothing?

A multi-level passenger screening approach.



NURALOGIX™

Results

Heart Rate: 82
Stress Index: 0
Blood Pressure: 123 / 70
Emo-Valence: Neutral

Heart Rate: 85
Stress Index: 0.4
Blood Pressure: 136 / 76
Emo-Valence: Positive

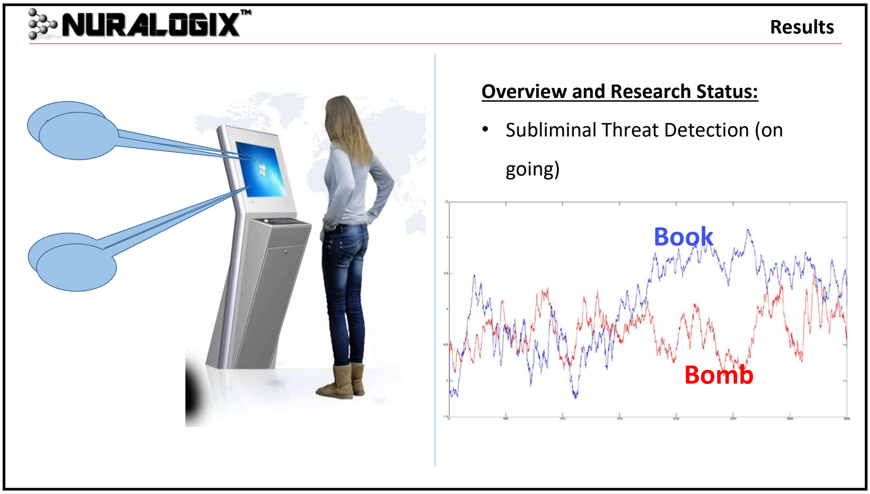
Overview and Research Status:

- Heart rate (±1-2bpm)
- Blood pressure (93%)
- Stress Level (adult norms)
- Emotional status (emotional vs. neutral: >95% accuracy)
- Emotional Valence (positive vs. negative emotions: >85% accuracy)

Results

Overview and Research Status:

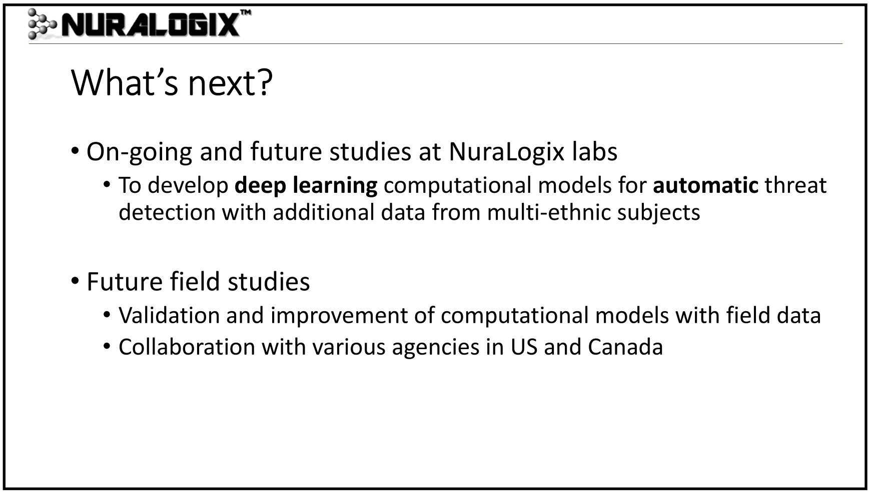
- Overt Threat Detection
    - Guilty Knowledge Question Method(on going study)



Results

Overview and Research Status:

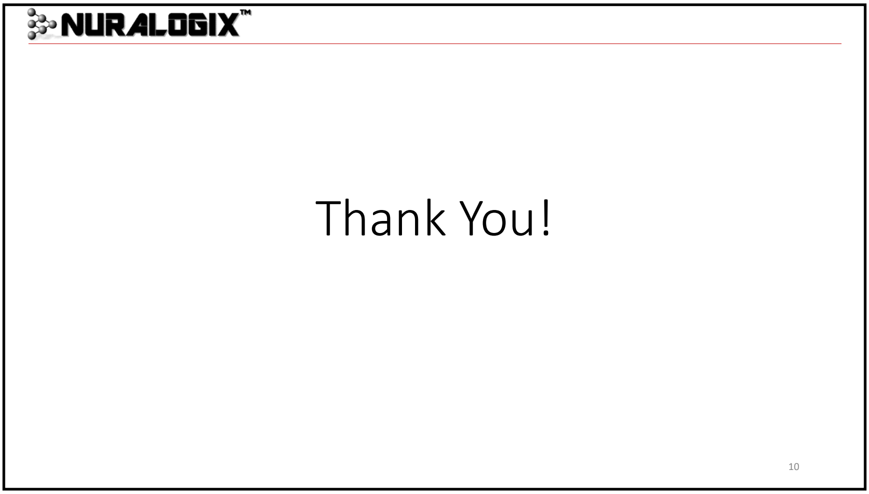
- Subliminal Threat Detection (on going)



NURALOGIX™

What's next?

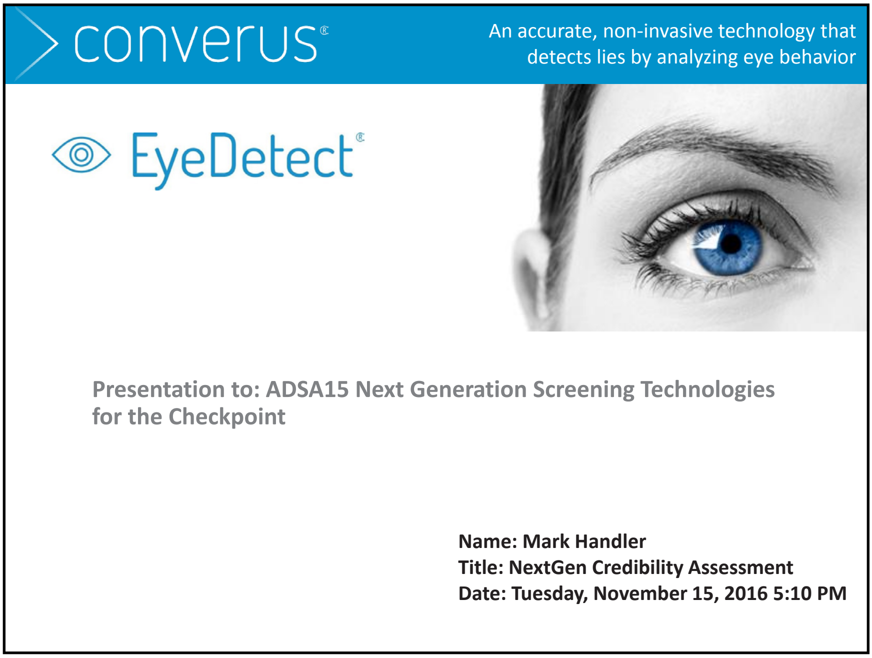
- On-going and future studies at NuraLogix labs
  - To develop **deep learning** computational models for **automatic** threat detection with additional data from multi-ethnic subjects
- Future field studies
  - Validation and improvement of computational models with field data
  - Collaboration with various agencies in US and Canada



NURALOGIX™

Thank You!

16.21 Mark Handler: Next Generation Screening Starts with the Eyes



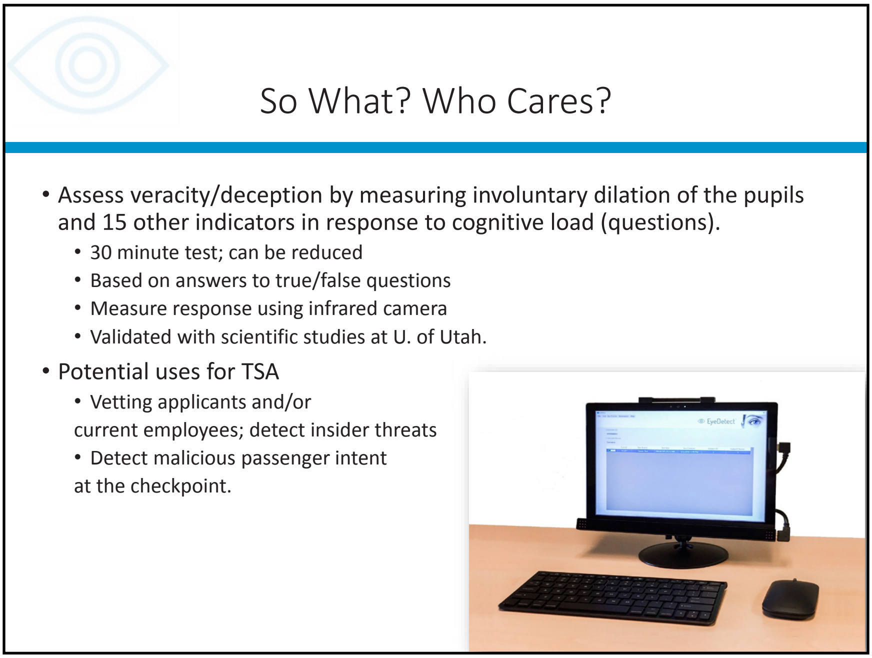
converus®

An accurate, non-invasive technology that detects lies by analyzing eye behavior

EyeDetect®

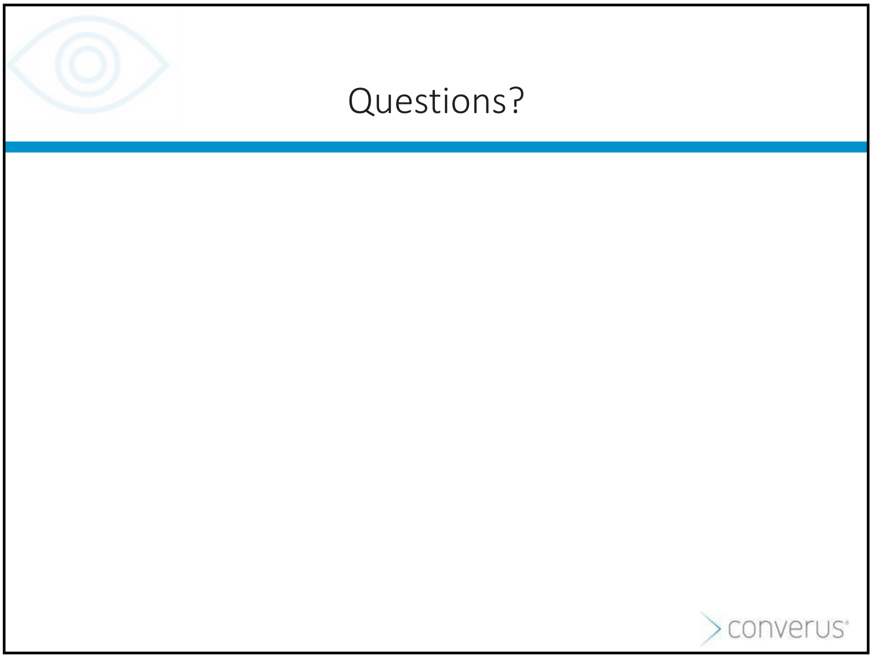
Presentation to: ADSA15 Next Generation Screening Technologies for the Checkpoint

Name: Mark Handler
Title: NextGen Credibility Assessment
Date: Tuesday, November 15, 2016 5:10 PM



So What? Who Cares?

- Assess veracity/deception by measuring involuntary dilation of the pupils and 15 other indicators in response to cognitive load (questions).
  - 30 minute test; can be reduced
  - Based on answers to true/false questions
  - Measure response using infrared camera
  - Validated with scientific studies at U. of Utah.
- Potential uses for TSA
  - Vetting applicants and/or current employees; detect insider threats
  - Detect malicious passenger intent at the checkpoint.



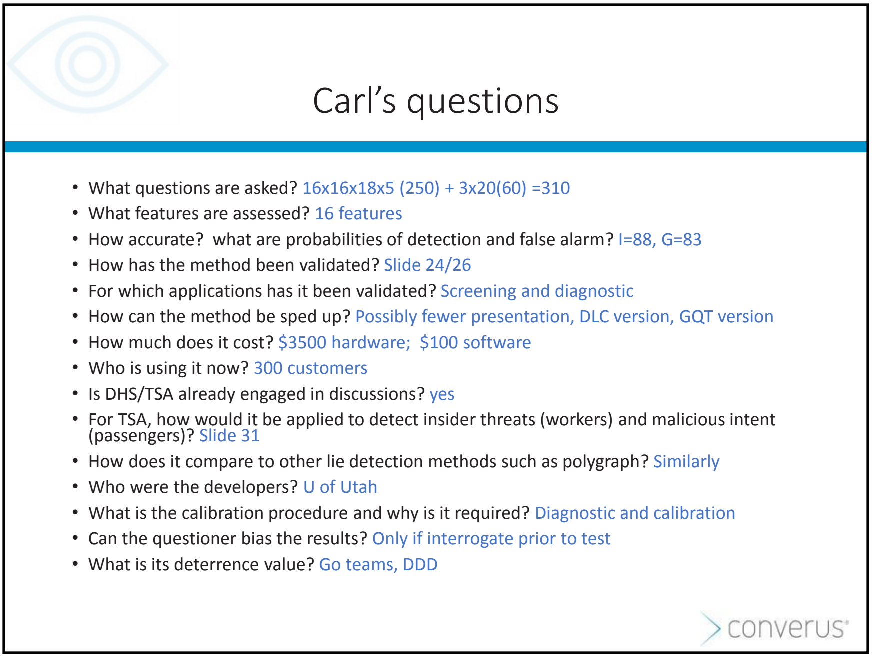
Questions?

converus®

EyeDetect®
The eyes don't lie.

converus®

Thank You!



Carl’s questions

- What questions are asked? 16x16x18x5 (250) + 3x20(60) =310
- What features are assessed? 16 features
- How accurate? what are probabilities of detection and false alarm? I=88, G=83
- How has the method been validated? Slide 24/26
- For which applications has it been validated? Screening and diagnostic
- How can the method be sped up? Possibly fewer presentation, DLC version, GQT version
- How much does it cost? $3500 hardware; $100 software
- Who is using it now? 300 customers
- Is DHS/TSA already engaged in discussions? yes
- For TSA, how would it be applied to detect insider threats (workers) and malicious intent (passengers)? Slide 31
- How does it compare to other lie detection methods such as polygraph? Similarly
- Who were the developers? U of Utah
- What is the calibration procedure and why is it required? Diagnostic and calibration
- Can the questioner bias the results? Only if interrogate prior to test
- What is its deterrence value? Go teams, DDD

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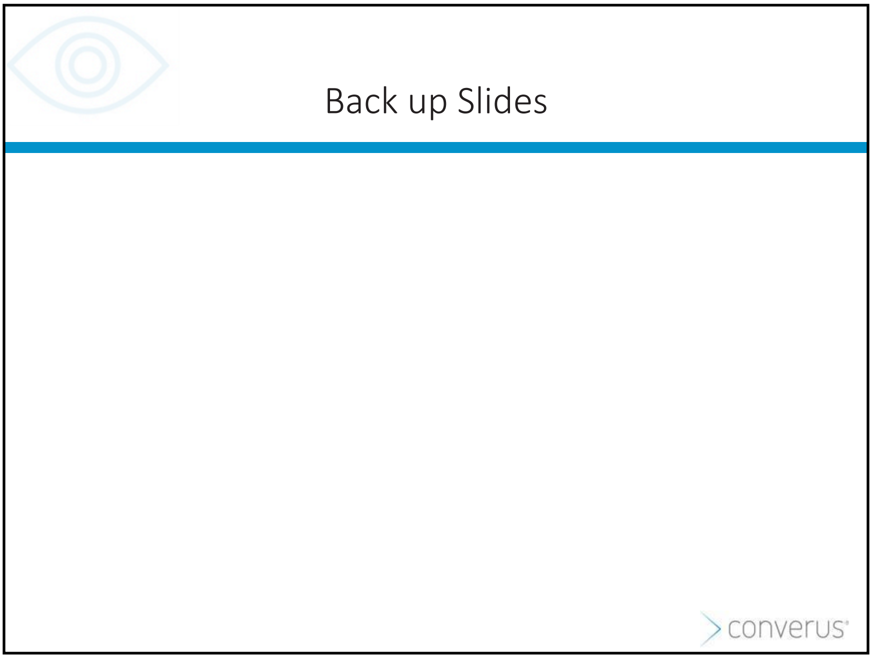
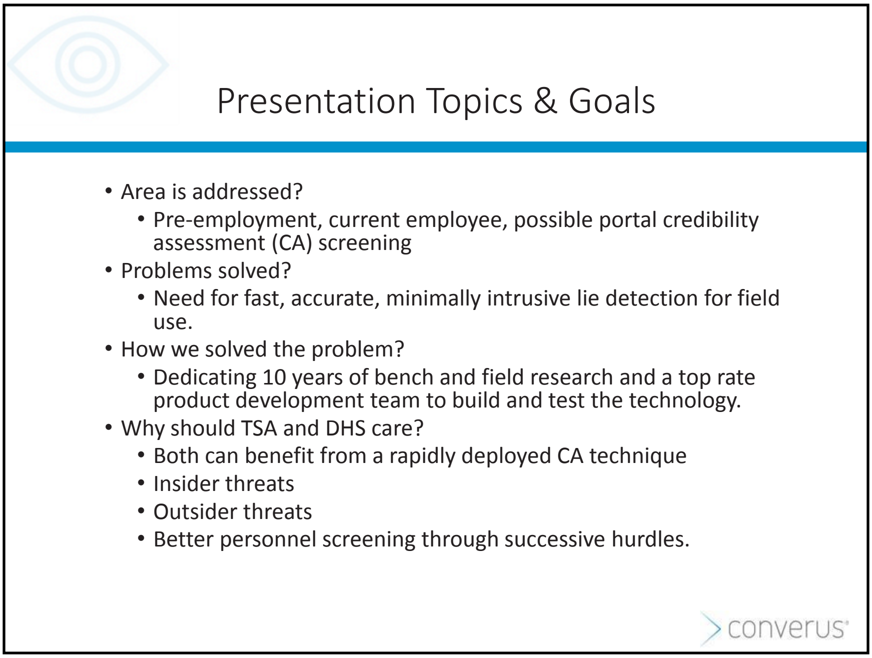


Back up Slides

converus



Presentation Topics & Goals

- Area is addressed?
  - Pre-employment, current employee, possible portal credibility assessment (CA) screening
- Problems solved?
  - Need for fast, accurate, minimally intrusive lie detection for field use.
- How we solved the problem?
  - Dedicating 10 years of bench and field research and a top rate product development team to build and test the technology.
- Why should TSA and DHS care?
  - Both can benefit from a rapidly deployed CA technique
  - Insider threats
  - Outsider threats
  - Better personnel screening through successive hurdles.

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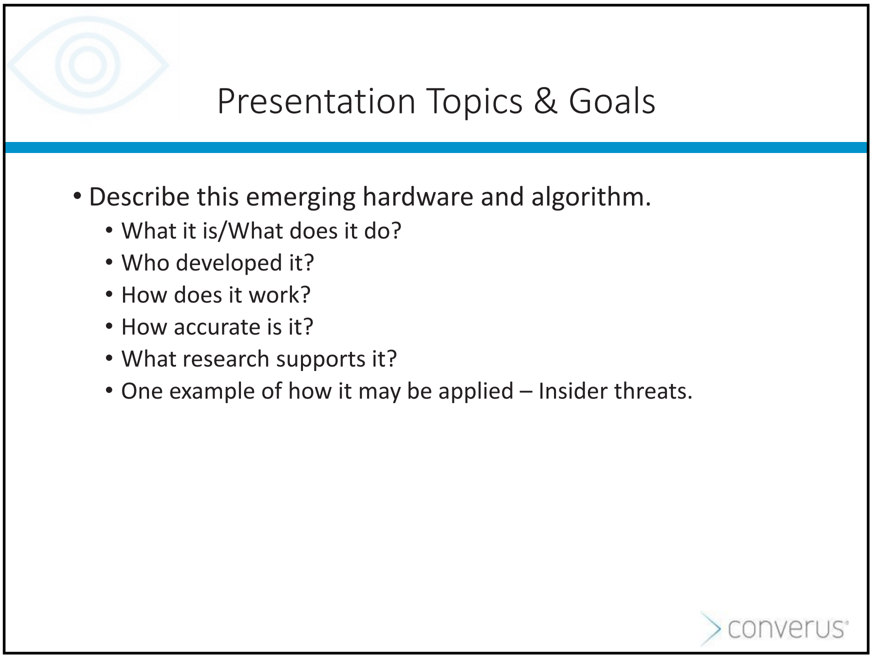

Presentation Topics & Goals

- Describe this emerging hardware and algorithm.
  - What it is/What does it do?
  - Who developed it?
  - How does it work?
  - How accurate is it?
  - What research supports it?
  - One example of how it may be applied – Insider threats.

converus

Describe this emerging hardware and algorithm.

- What is it/What does it do?

converus

Meet EyeDetect

An accurate, non-intrusive technology that detects lies by analyzing eye behavior during a 30-minute test.

converus

Describe this emerging hardware and algorithm.

- Who are the developers?

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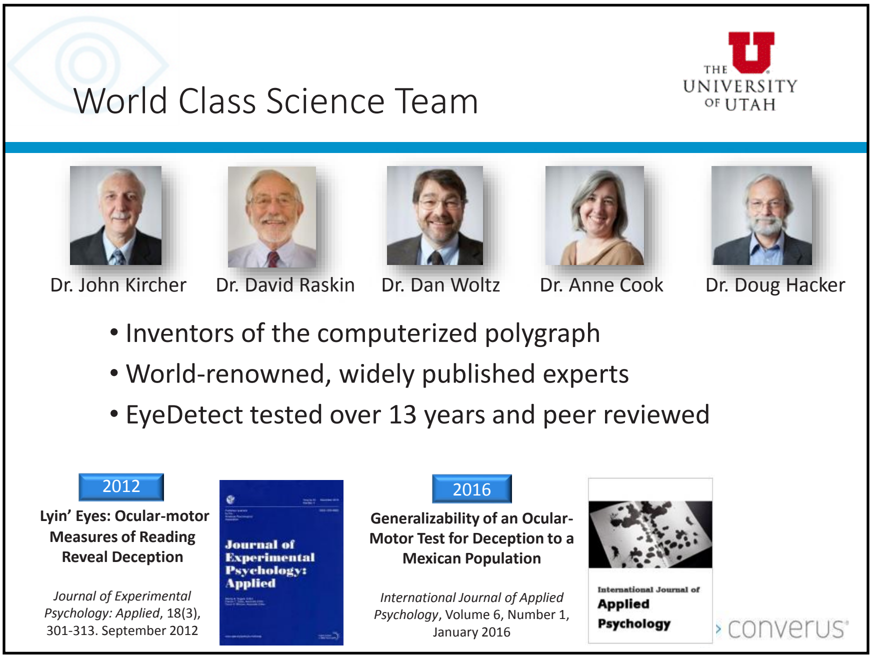

World Class Science Team

Dr. John Kircher
Dr. David Raskin
Dr. Dan Woltz
Dr. Anne Cook
Dr. Doug Hacker

- Inventors of the computerized polygraph
- World-renowned, widely published experts
- EyeDetect tested over 13 years and peer reviewed

2012

Lyin' Eyes: Ocular-motor Measures of Reading Reveal Deception

Journal of Experimental Psychology: Applied, 18(3), 301-313. September 2012

2016

Generalizability of an Ocular-Motor Test for Deception to a Mexican Population

International Journal of Applied Psychology, Volume 6, Number 1, January 2016

converus

Describe this emerging hardware and algorithm.

- How does it work?

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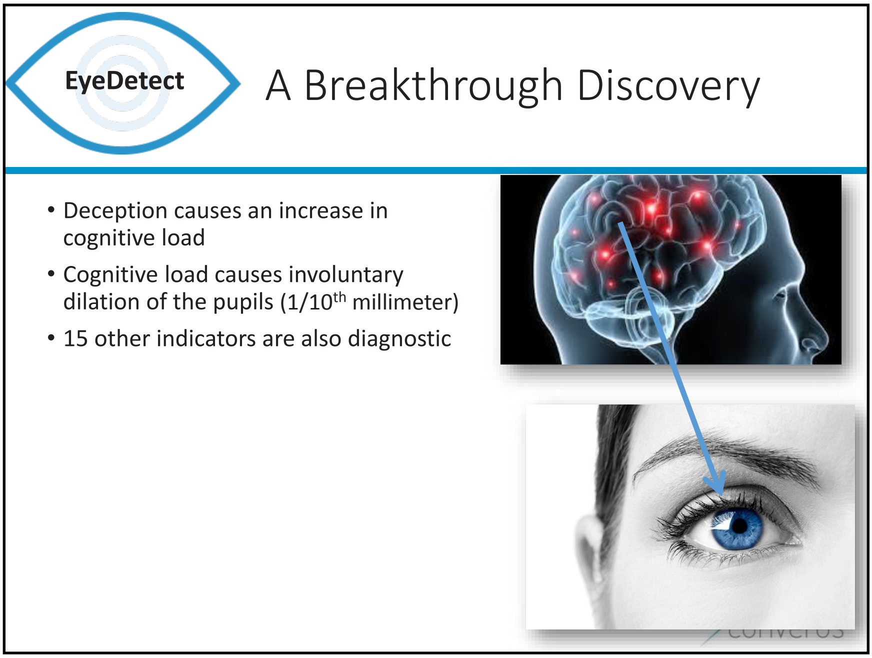
Introducing EyeDetect®

converus®

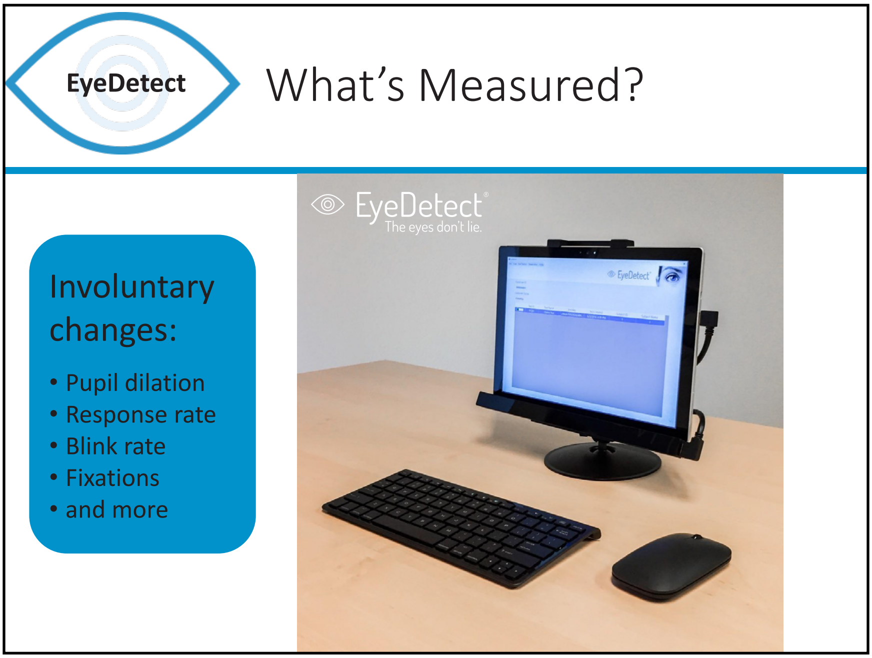


EyeDetect

A Breakthrough Discovery

- Deception causes an increase in cognitive load
- Cognitive load causes involuntary dilation of the pupils (1/10th millimeter)
- 15 other indicators are also diagnostic

converus

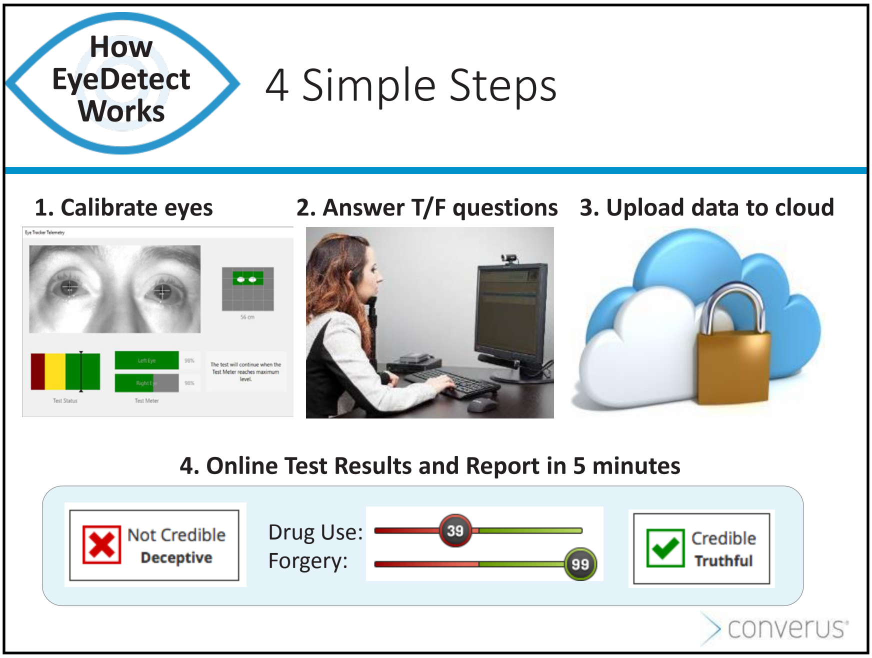


EyeDetect

What’s Measured?

Involuntary changes:

- Pupil dilation
- Response rate
- Blink rate
- Fixations
- and more



How EyeDetect Works

4 Simple Steps

1. Calibrate eyes
2. Answer T/F questions
3. Upload data to cloud
4. Online Test Results and Report in 5 minutes

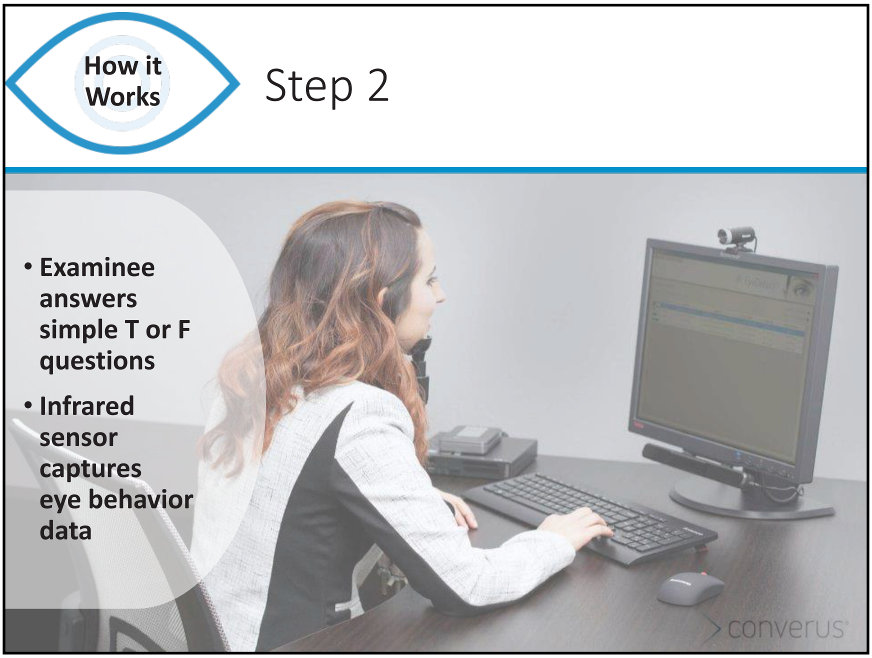
☒ Not Credible **Deceptive**

Drug Use: 39

Forgery: 99

✓ Credible **Truthful**

converus



How it Works

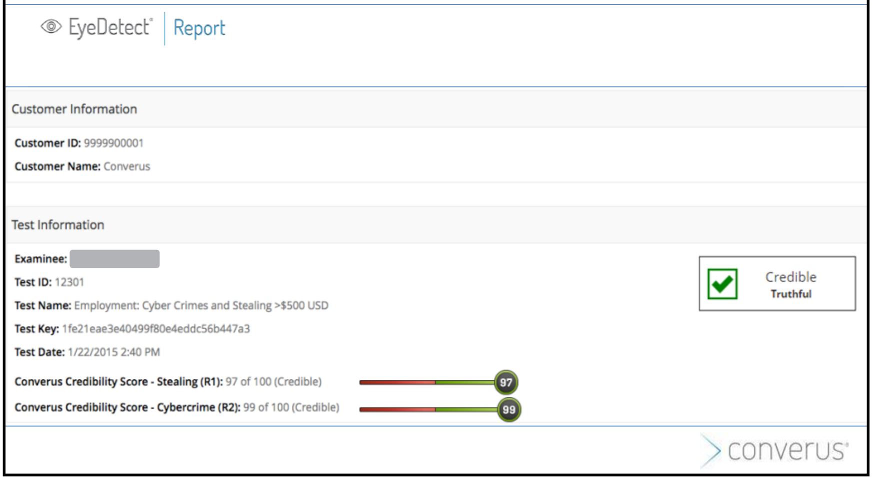
Step 2

- Examinee answers simple T or F questions
- Infrared sensor captures eye behavior data

converus

Report

Individual Summary



Customer Information

Customer ID: 9999900001

Customer Name: Converus

Test Information

Examinee: [redacted]

Test ID: 12301

Test Name: Employment: Cyber Crimes and Stealing >$500 USD

Test Key: 1fe21eae3e40499f80e4eddc56b447a3

Test Date: 1/22/2015 2:40 PM

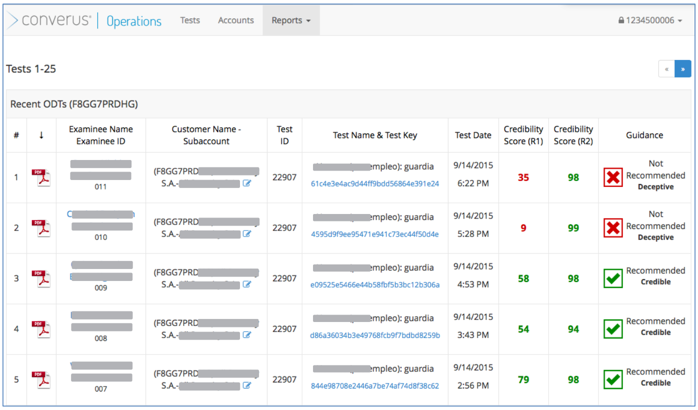
Conversus Credibility Score - Stealing (R1): 97 of 100 (Credible)

Conversus Credibility Score - Cybercrime (R2): 99 of 100 (Credible)

☑ Credible **Truthful**

Dashboard

Results in 5 minutes!



Tests 1-25

Recent ODTs (F8GG7PRDHG)

#	↓	Examinee Name Examinee ID	Customer Name - Subaccount	Test ID	Test Name & Test Key	Test Date	Credibility Score (R1)	Credibility Score (R2)	Guidance
1	PDF	[redacted] 011	(F8GG7PRD[redacted] S.A.-[redacted]	22907	[redacted]mpleo): guardia 61c4e3e4ac9d44ff9bdd56864e391e24	9/14/2015 6:22 PM	35	98	☒ Not Recommended **Deceptive**
2	PDF	[redacted] 010	(F8GG7PRD[redacted] S.A.-[redacted]	22907	[redacted]mpleo): guardia 4595d9f9ee95471e941c73ec44f50d4e	9/14/2015 5:28 PM	9	99	☒ Not Recommended **Deceptive**
3	PDF	[redacted] 009	(F8GG7PRD[redacted] S.A.-[redacted]	22907	[redacted]mpleo): guardia e09525e5466e44b58fbf5b3bc12b306a	9/14/2015 4:53 PM	58	98	☑ Recommended **Credible**
4	PDF	[redacted] 008	(F8GG7PRD[redacted] S.A.-[redacted]	22907	[redacted]mpleo): guardia d86a36034b3e49768fcb9f7bdbd8259b	9/14/2015 3:43 PM	54	94	☑ Recommended **Credible**
5	PDF	[redacted] 007	(F8GG7PRD[redacted] S.A.-[redacted]	22907	[redacted]mpleo): guardia 844e98708e2446a7be74af74d8f38c62	9/14/2015 2:56 PM	79	98	☑ Recommended **Credible**

conversus

Dashboard

Analysis

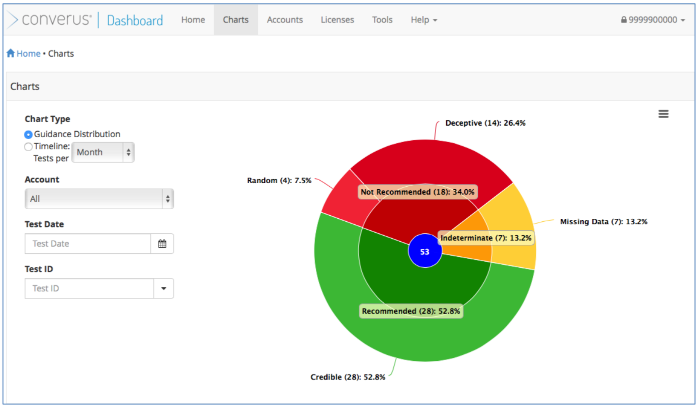


Chart Type
● Guidance Distribution
○ Timeline: Tests per Month

Account: All

Test Date: Test Date

Test ID: Test ID

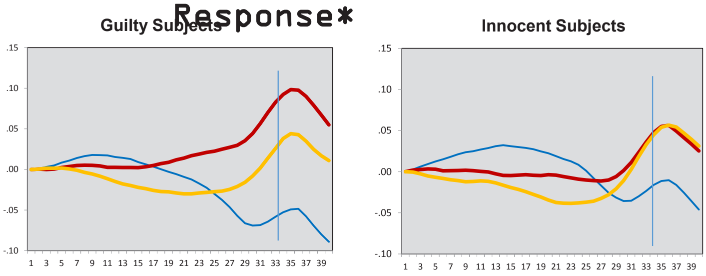
converus

EyeDetect is 85% accurate

Pupil Diameter Response*

Tec, 2013

N=200



🟥 **Relevant Declarations**
🟧 **Secondary Declarations**
🟦 Neutral Declarations

* just one of various measurements

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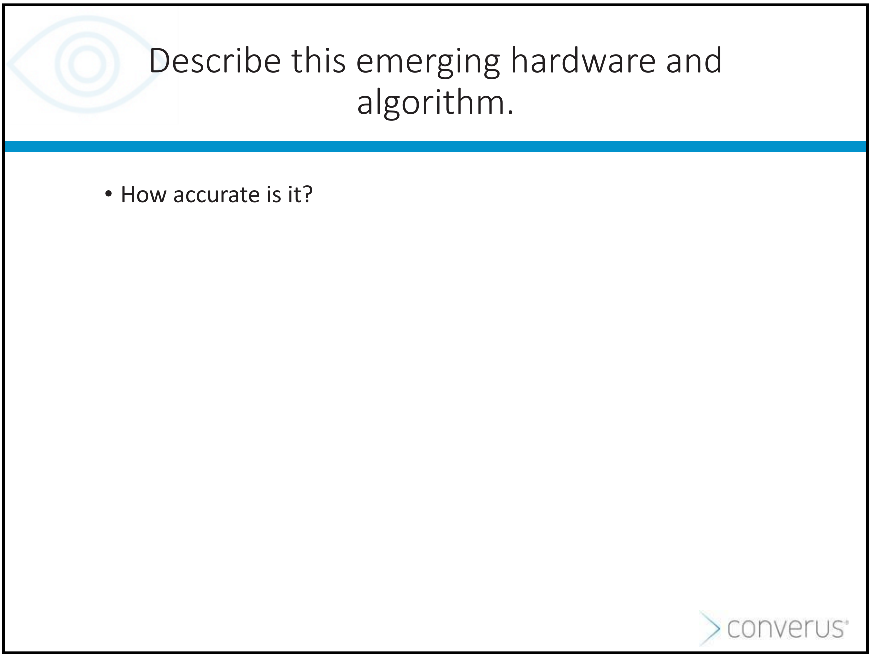
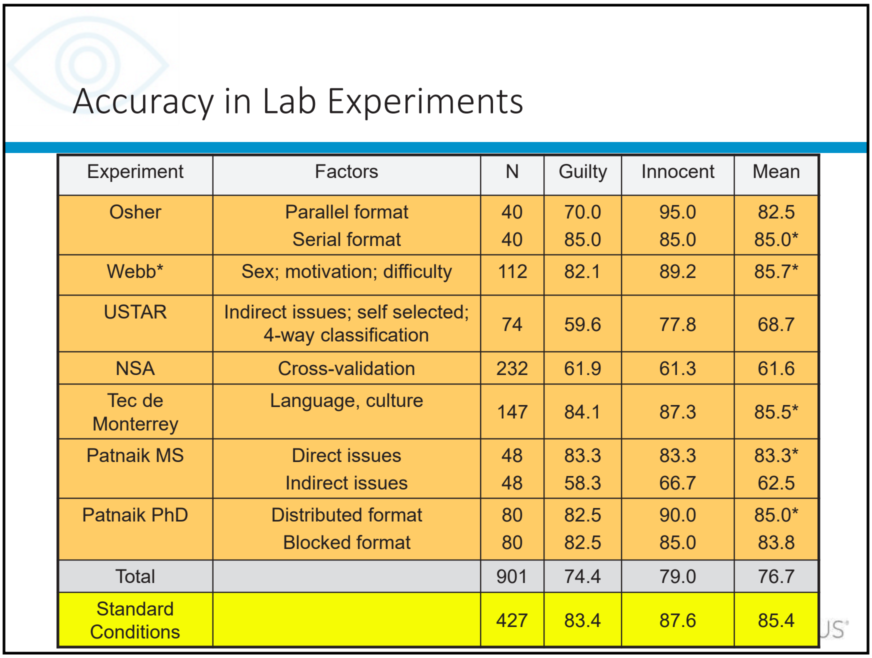


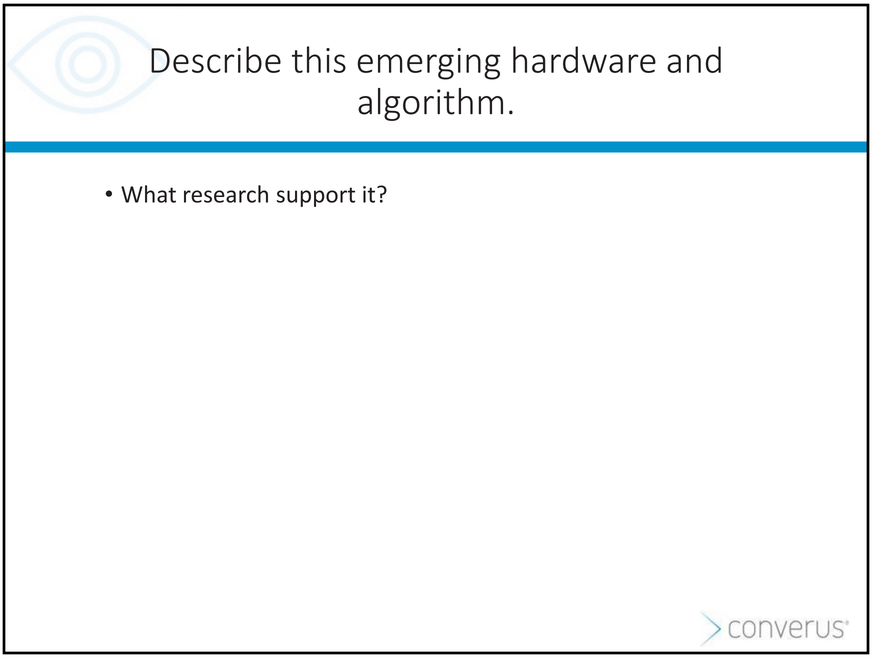
Describe this emerging hardware and algorithm.

- How accurate is it?



Accuracy in Lab Experiments

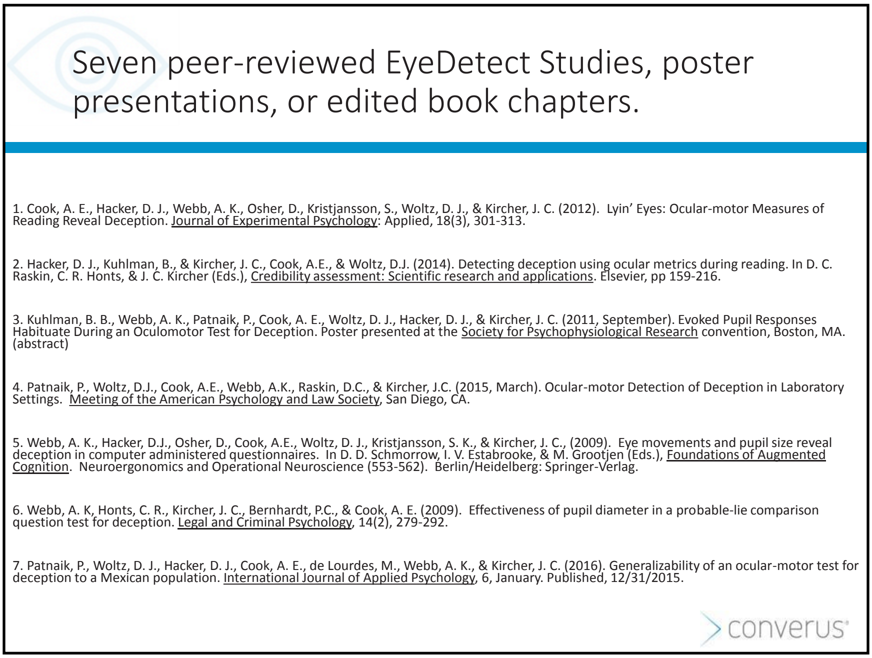
Experiment	Factors	N	Guilty	Innocent	Mean
Osher	Parallel format Serial format	40 40	70.0 85.0	95.0 85.0	82.5 85.0*
Webb*	Sex; motivation; difficulty	112	82.1	89.2	85.7*
USTAR	Indirect issues; self selected; 4-way classification	74	59.6	77.8	68.7
NSA	Cross-validation	232	61.9	61.3	61.6
Tec de Monterrey	Language, culture	147	84.1	87.3	85.5*
Patnaik MS	Direct issues Indirect issues	48 48	83.3 58.3	83.3 66.7	83.3* 62.5
Patnaik PhD	Distributed format Blocked format	80 80	82.5 82.5	90.0 85.0	85.0* 83.8
Total		901	74.4	79.0	76.7
Standard Conditions		427	83.4	87.6	85.4



Describe this emerging hardware and algorithm.

- What research support it?

converus



Seven peer-reviewed EyeDetect Studies, poster presentations, or edited book chapters.

1. Cook, A. E., Hacker, D. J., Webb, A. K., Osher, D., Kristjansson, S., Woltz, D. J., & Kircher, J. C. (2012). Lyin' Eyes: Ocular-motor Measures of Reading Reveal Deception. Journal of Experimental Psychology: Applied, 18(3), 301-313.

2. Hacker, D. J., Kuhlman, B., & Kircher, J. C., Cook, A.E., & Woltz, D.J. (2014). Detecting deception using ocular metrics during reading. In D. C. Raskin, C. R. Honts, & J. C. Kircher (Eds.), Credibility assessment: Scientific research and applications. Elsevier, pp 159-216.

3. Kuhlman, B. B., Webb, A. K., Patnaik, P., Cook, A. E., Woltz, D. J., Hacker, D. J., & Kircher, J. C. (2011, September). Evoked Pupil Responses Habituate During an Oculomotor Test for Deception. Poster presented at the Society for Psychophysiological Research convention, Boston, MA. (abstract)

4. Patnaik, P., Woltz, D.J., Cook, A.E., Webb, A.K., Raskin, D.C., & Kircher, J.C. (2015, March). Ocular-motor Detection of Deception in Laboratory Settings. Meeting of the American Psychology and Law Society, San Diego, CA.

5. Webb, A. K., Hacker, D.J., Osher, D., Cook, A.E., Woltz, D. J., Kristjansson, S. K., & Kircher, J. C., (2009). Eye movements and pupil size reveal deception in computer administered questionnaires. In D. D. Schmorrow, I. V. Estabrooke, & M. Grootjen (Eds.), Foundations of Augmented Cognition. Neuroergonomics and Operational Neuroscience (553-562). Berlin/Heidelberg: Springer-Verlag.

6. Webb, A. K, Honts, C. R., Kircher, J. C., Bernhardt, P.C., & Cook, A. E. (2009). Effectiveness of pupil diameter in a probable-lie comparison question test for deception. Legal and Criminal Psychology, 14(2), 279-292.

7. Patnaik, P., Woltz, D. J., Hacker, D. J., Cook, A. E., de Lourdes, M., Webb, A. K., & Kircher, J. C. (2016). Generalizability of an ocular-motor test for deception to a Mexican population. International Journal of Applied Psychology, 6, January. Published, 12/31/2015.

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Describe this emerging hardware and algorithm.

- How does it compare to polygraph?

converus

EyeDetect + Polygraph (PDD) Accuracies

Accuracy estimates from the multiple EyeDetect studies as presented by Dr. David Raskin at the 2015 APA seminar and for PDD from the APA Meta-Analytic Review (APA 2012).

Accuracy Rates for EyeDetect (Raskin, 2015) and PDD (APA 2012 table 2)		
Ground Truth	Pass Test	Fail Test
EyeDetect		
Innocent	0.88 (TN)	0.12 (FP)
Guilt	0.17 (FN)	0.83 (TP)
PDD		
Innocent	0.72 (TN)	0.14 (FP)
Guilt	0.08 (FN)	0.81 (TP)

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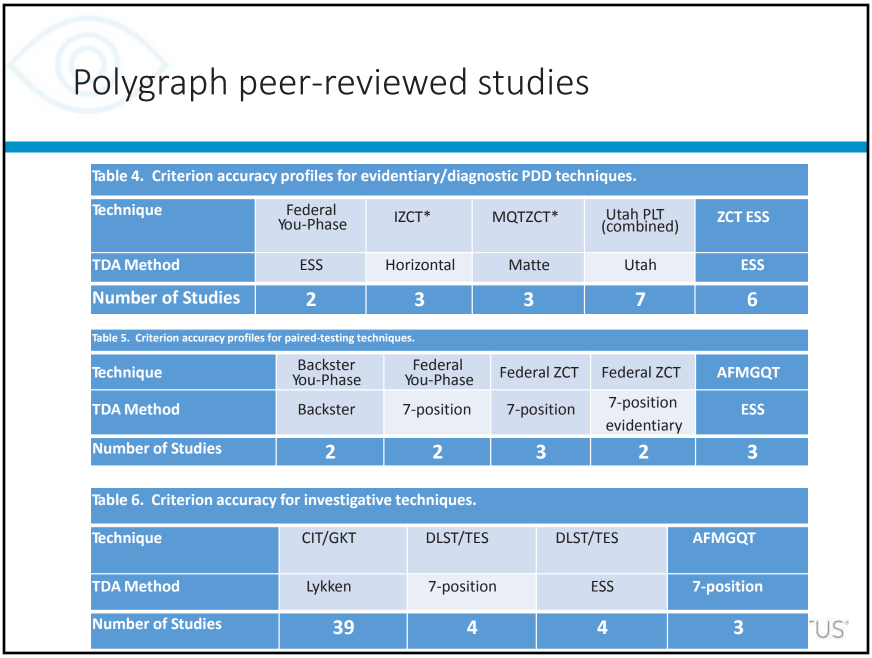


Polygraph peer-reviewed studies

Table 4. Criterion accuracy profiles for evidentiary/diagnostic PDD techniques.

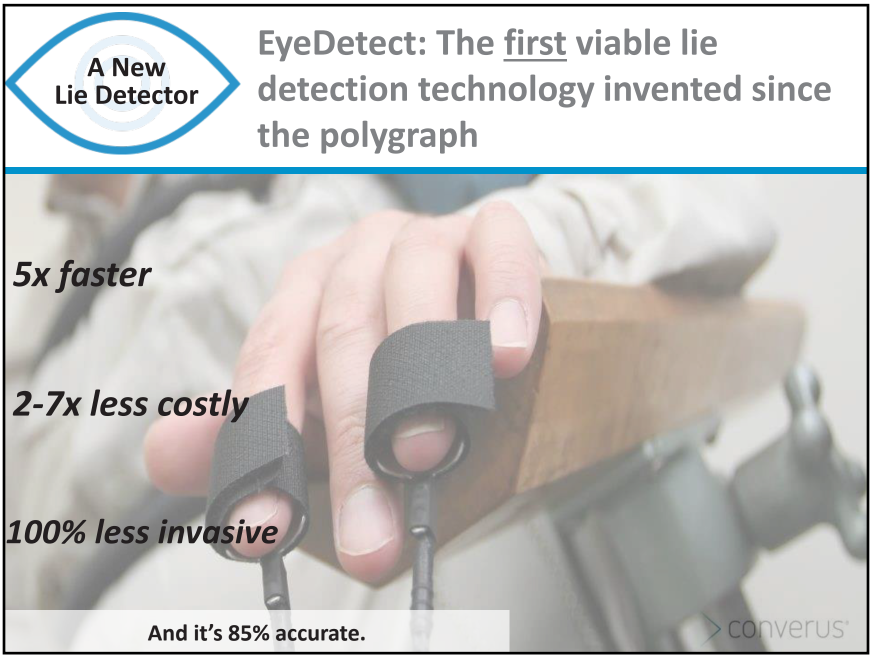
Technique	Federal You-Phase	IZCT*	MQTZCT*	Utah PLT (combined)	**ZCT ESS**
TDA Method	ESS	Horizontal	Matte	Utah	**ESS**
Number of Studies	**2**	**3**	**3**	**7**	**6**

Table 5. Criterion accuracy profiles for paired-testing techniques.

Technique	Backster You-Phase	Federal You-Phase	Federal ZCT	Federal ZCT	**AFMGQT**
TDA Method	Backster	7-position	7-position	7-position evidentiary	**ESS**
Number of Studies	**2**	**2**	**3**	**2**	**3**

Table 6. Criterion accuracy for investigative techniques.

Technique	CIT/GKT	DLST/TES	DLST/TES	**AFMGQT**
TDA Method	Lykken	7-position	ESS	**7-position**
Number of Studies	**39**	**4**	**4**	**3**



A New Lie Detector

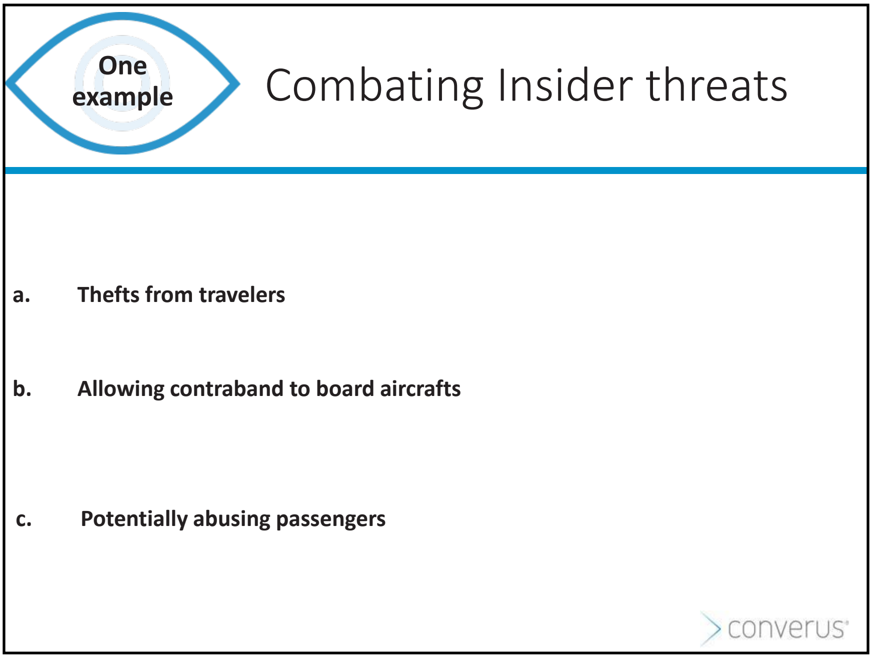
EyeDetect: The <u>first</u> viable lie detection technology invented since the polygraph

5x faster

2-7x less costly

100% less invasive

And it's 85% accurate.



One example

Combating Insider threats

a. **Thefts from travelers**

b. **Allowing contraband to board aircrafts**

c. **Potentially abusing passengers**

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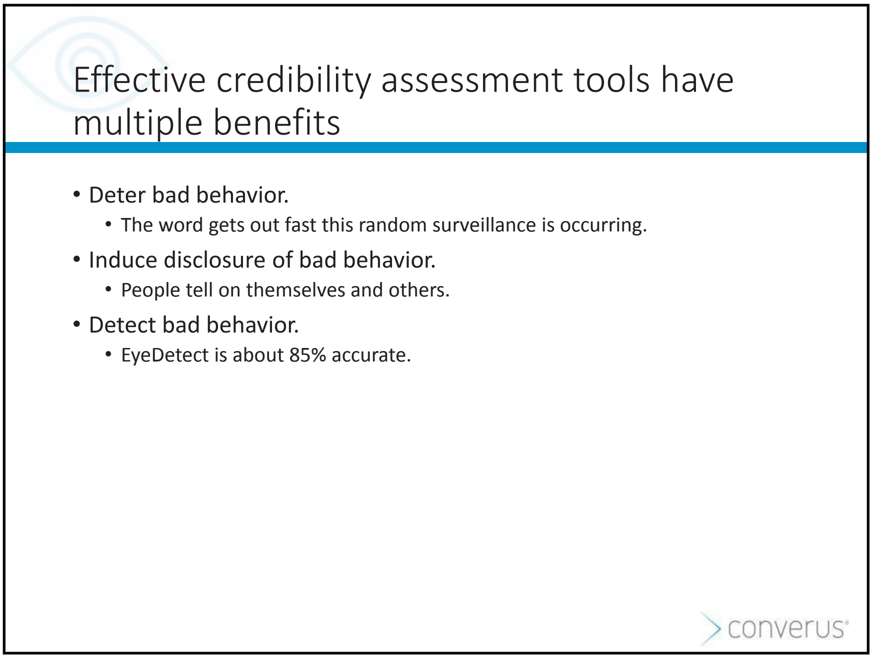

Effective credibility assessment tools have multiple benefits

- Deter bad behavior.
  - The word gets out fast this random surveillance is occurring.
- Induce disclosure of bad behavior.
  - People tell on themselves and others.
- Detect bad behavior.
  - EyeDetect is about 85% accurate.

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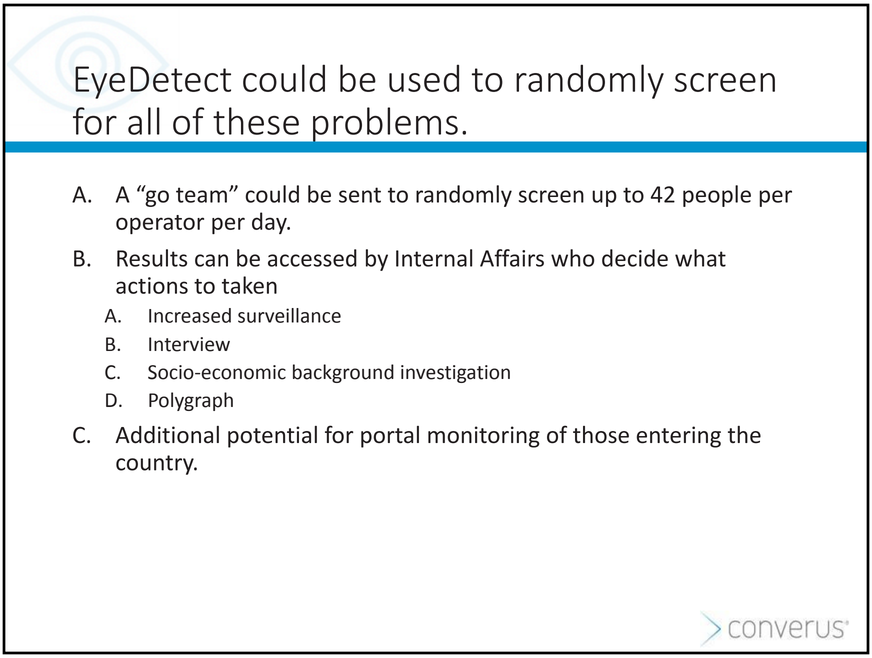

EyeDetect could be used to randomly screen for all of these problems.

A. A “go team” could be sent to randomly screen up to 42 people per operator per day.
B. Results can be accessed by Internal Affairs who decide what actions to taken
  A. Increased surveillance
  B. Interview
  C. Socio-economic background investigation
  D. Polygraph
C. Additional potential for portal monitoring of those entering the country.

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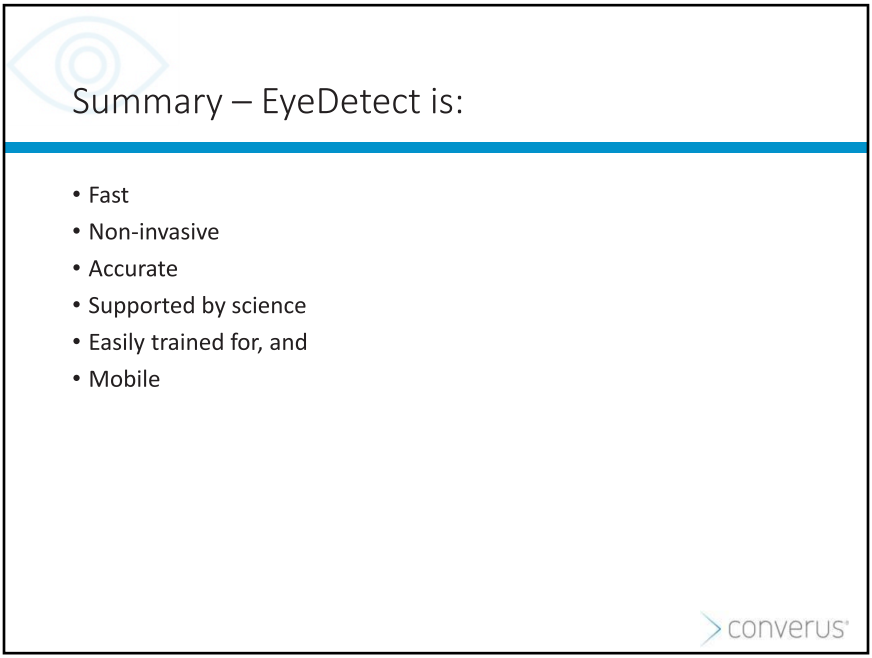
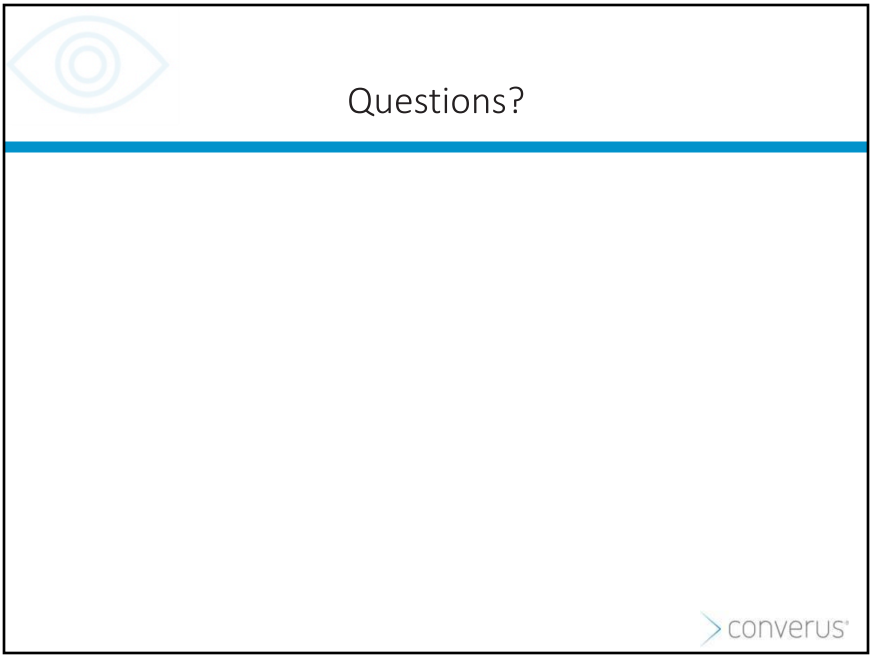


Summary – EyeDetect is:

- Fast
- Non-invasive
- Accurate
- Supported by science
- Easily trained for, and
- Mobile

converus



Questions?

converus

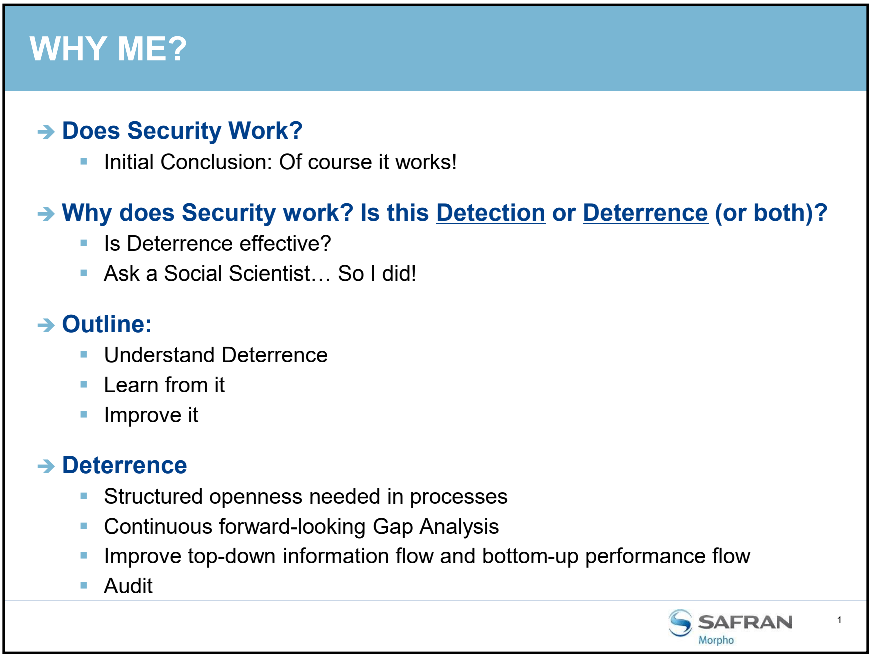
16.22 Matthew Merzbacher: Deterrence: Is It Effective and How to Make it Better

Deterrence

Is it effective and how to make it better

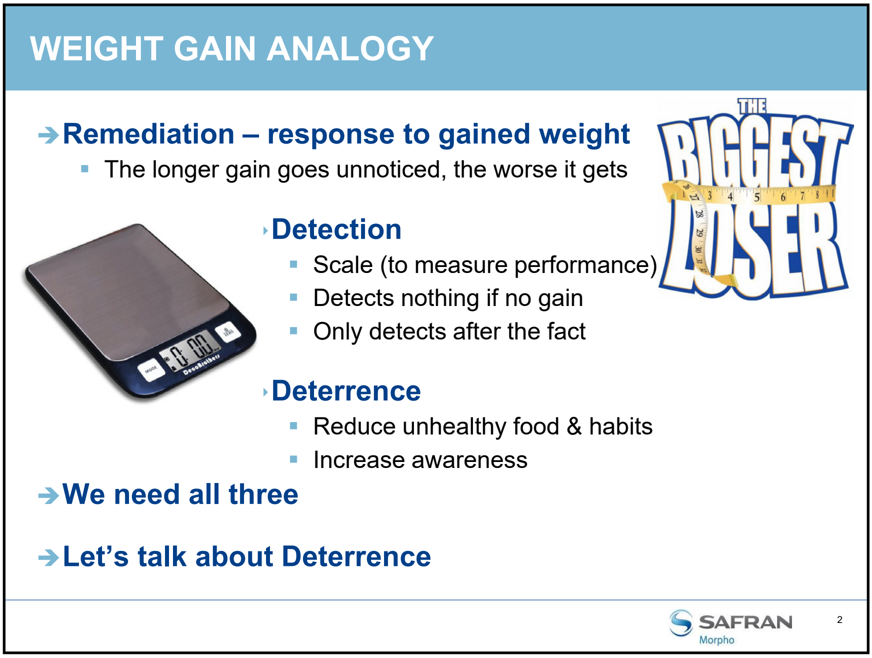
Matthew Merzbacher

/ November 15, 2016 /



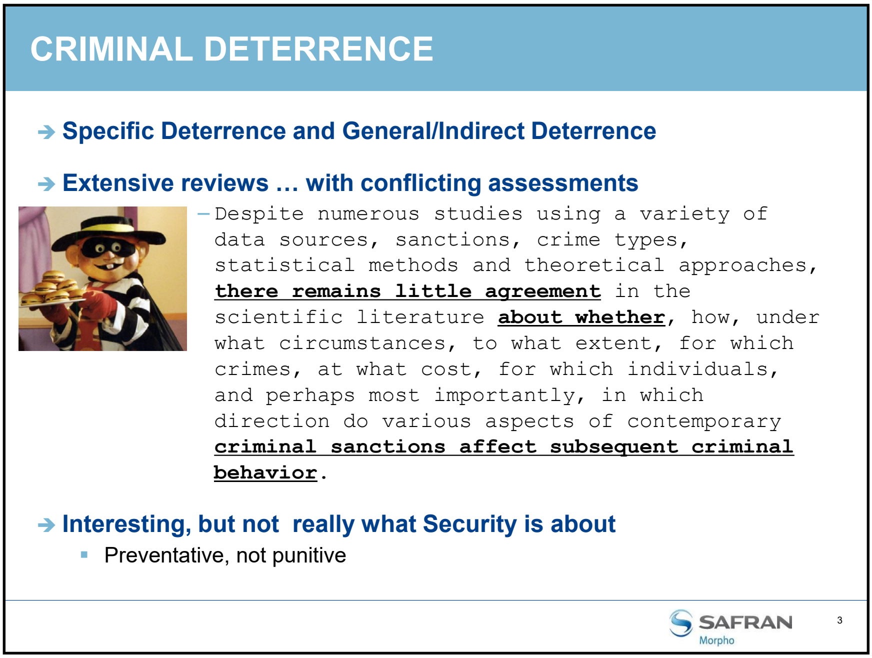
WHY ME?

- **Does Security Work?**
  - Initial Conclusion: Of course it works!
- **Why does Security work? Is this Detection or Deterrence (or both)?**
  - Is Deterrence effective?
  - Ask a Social Scientist… So I did!
- **Outline:**
  - Understand Deterrence
  - Learn from it
  - Improve it
- **Deterrence**
  - Structured openness needed in processes
  - Continuous forward-looking Gap Analysis
  - Improve top-down information flow and bottom-up performance flow
  - Audit



WEIGHT GAIN ANALOGY

- **Remediation – response to gained weight**
  - The longer gain goes unnoticed, the worse it gets
- **Detection**
  - Scale (to measure performance)
  - Detects nothing if no gain
  - Only detects after the fact
- **Deterrence**
  - Reduce unhealthy food & habits
  - Increase awareness
- **We need all three**
- **Let's talk about Deterrence**

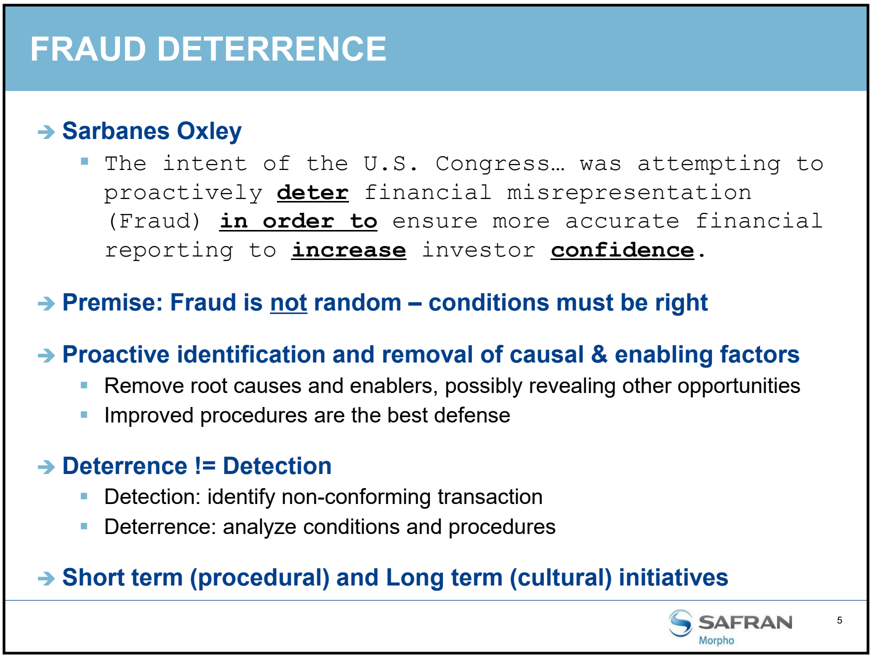


CRIMINAL DETERRENCE

- **Specific Deterrence and General/Indirect Deterrence**
- **Extensive reviews … with conflicting assessments**
  - Despite numerous studies using a variety of data sources, sanctions, crime types, statistical methods and theoretical approaches, **there remains little agreement** in the scientific literature **about whether**, how, under what circumstances, to what extent, for which crimes, at what cost, for which individuals, and perhaps most importantly, in which direction do various aspects of contemporary **criminal sanctions affect subsequent criminal behavior**.
- **Interesting, but not really what Security is about**
  - Preventative, not punitive

NUCLEAR DETERRENCE

- Game Theory (Schelling)
- Strategy intended to dissuade an adversary from taking an action not yet started
  - An inferior nuclear force, by virtue of its extreme destructive power, could deter a more powerful adversary
- Kissinger, Perry, Shultz, Nunn (WSJ '07)
  - **Reversed** their previous position and asserted that far from making the world safer, nuclear weapons had become a source of extreme risk.
    - Nuclear deterrence is a **far less persuasive strategic response to a world** of potential regional nuclear arms races and nuclear **terrorism** than it was to the cold war.
- Closer, but…



FRAUD DETERRENCE

- Sarbanes Oxley
  - The intent of the U.S. Congress… was attempting to proactively **deter** financial misrepresentation (Fraud) **in order to** ensure more accurate financial reporting to **increase** investor **confidence**.
- Premise: Fraud is not random – conditions must be right
- Proactive identification and removal of causal & enabling factors
  - Remove root causes and enablers, possibly revealing other opportunities
  - Improved procedures are the best defense
- Deterrence != Detection
  - Detection: identify non-conforming transaction
  - Deterrence: analyze conditions and procedures
- Short term (procedural) and Long term (cultural) initiatives

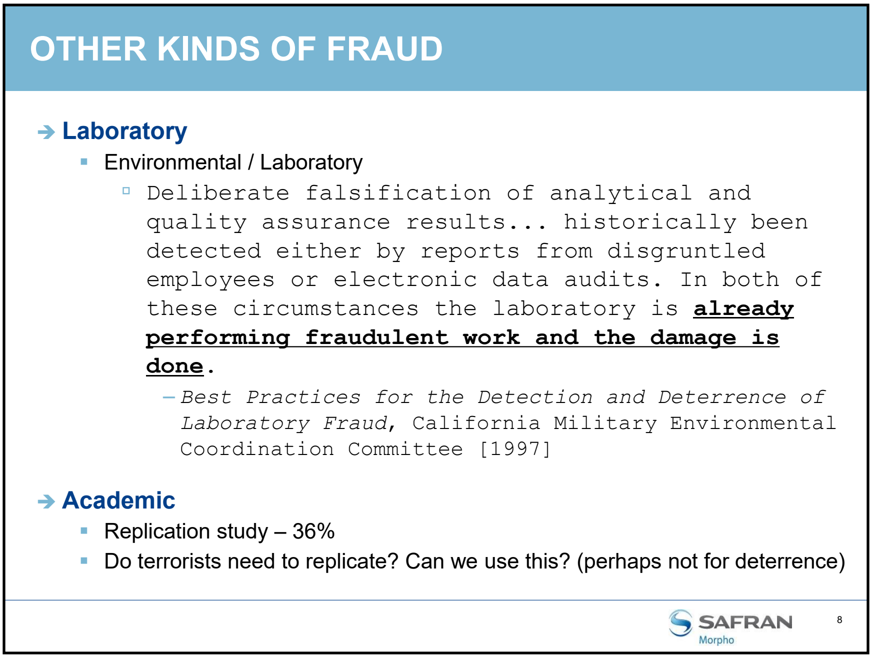
HOW DOES IT WORK? COSO MODEL

- **Control Environment**
  - Top-Down culture of ethics in Management
- **Risk Assessment**
  - Look forward to identify gaps
- **Control Activities**
  - Do (only) what you intend – no more, no less
- **Information & Communication**
  - Information flows Down to line
  - Performance flows Up (informally & formally) – Objective Feedback
- **Monitoring**
  - Audit

WILL/DOES COSO WORK FOR SECURITY?

- **Control Environment**
  - How do we control society from top-down?
- **Risk Assessment**
  - Opportunity for improvement: Gap analysis

- **Control Activities**
  - Strict ConOps in place
  - Danger: Impediment to innovation
- **Information & Communication**
  - Information flows Down,
    Performance flows Up
- **Monitoring**
  - Audit, Audit, Audit!



OTHER KINDS OF FRAUD

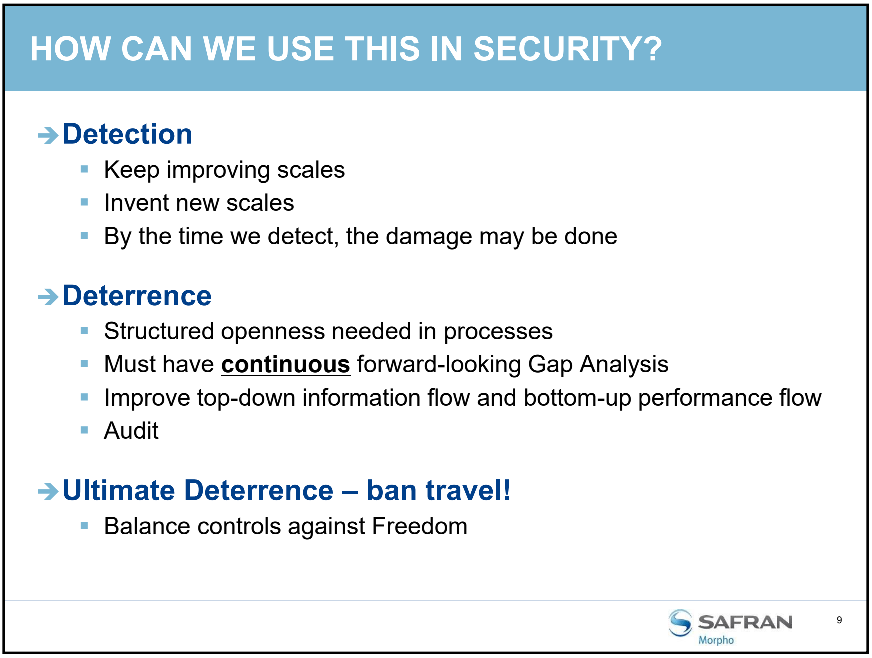
Laboratory

- Environmental / Laboratory
  - Deliberate falsification of analytical and quality assurance results... historically been detected either by reports from disgruntled employees or electronic data audits. In both of these circumstances the laboratory is **already performing fraudulent work and the damage is done**.
    - *Best Practices for the Detection and Deterrence of Laboratory Fraud*, California Military Environmental Coordination Committee [1997]

Academic

- Replication study – 36%
- Do terrorists need to replicate? Can we use this? (perhaps not for deterrence)

SAFRAN
Morpho



HOW CAN WE USE THIS IN SECURITY?

Detection

- Keep improving scales
- Invent new scales
- By the time we detect, the damage may be done

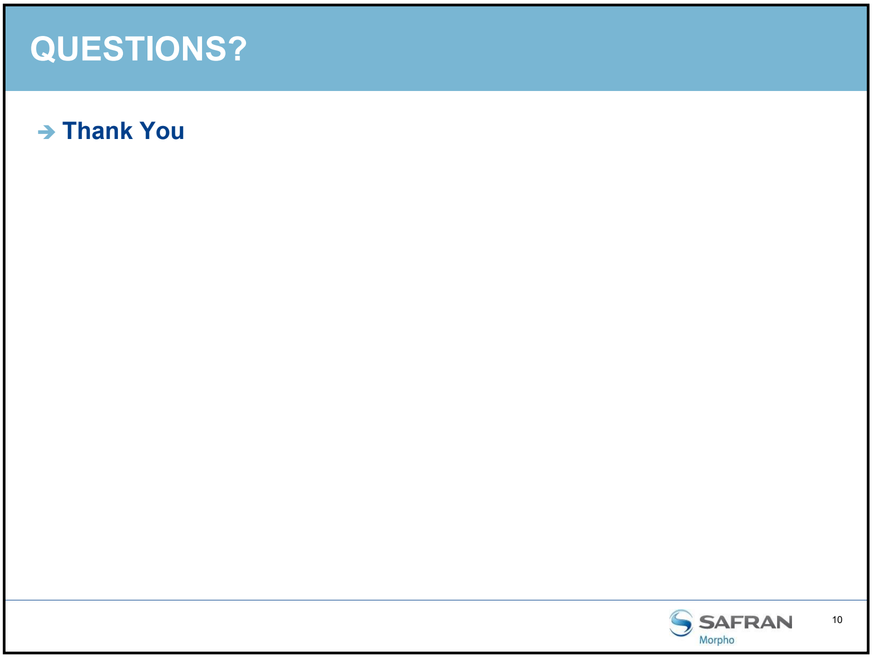
Deterrence

- Structured openness needed in processes
- Must have **continuous** forward-looking Gap Analysis
- Improve top-down information flow and bottom-up performance flow
- Audit

Ultimate Deterrence – ban travel!

- Balance controls against Freedom

SAFRAN
Morpho



QUESTIONS?

- Thank You

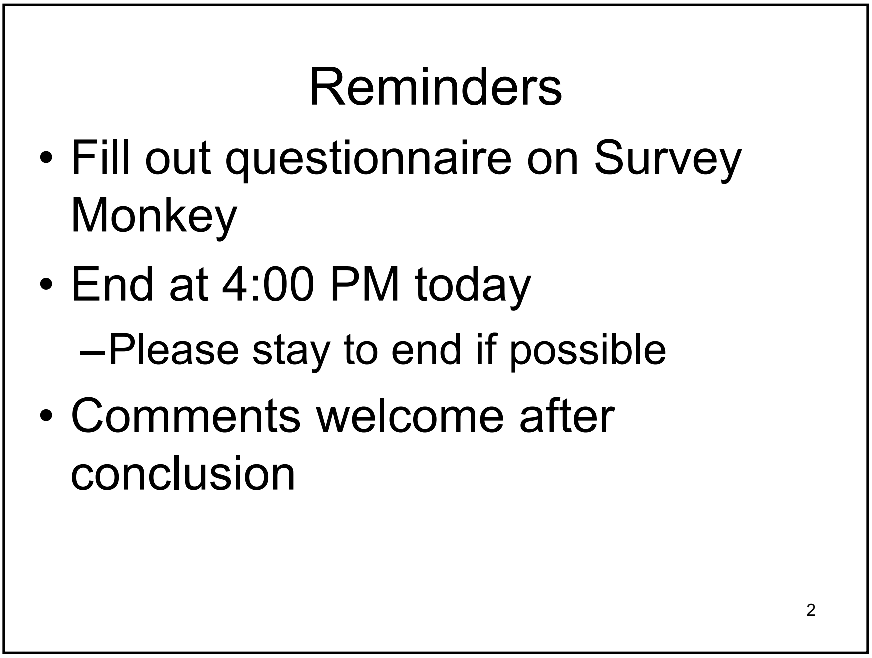
16.23 Carl Crawford: Call to Order

Fifteenth Advanced Development for Security Applications
Workshop (ADSA15):

Next Generation Screening Technologies
and Processes for the Checkpoint

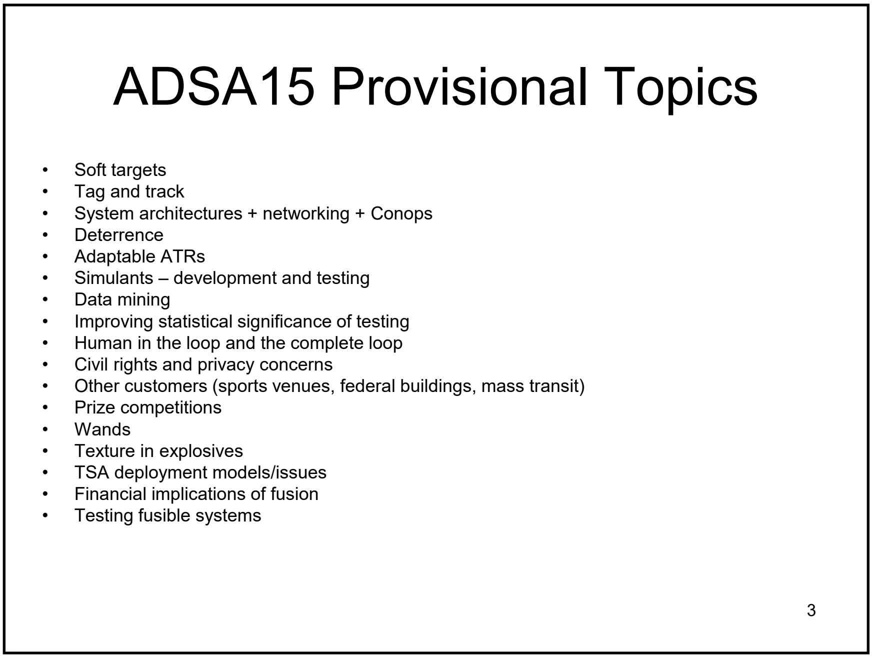
Call To Order
Day 2

Carl R. Crawford
Csuptwo, LLC



Reminders

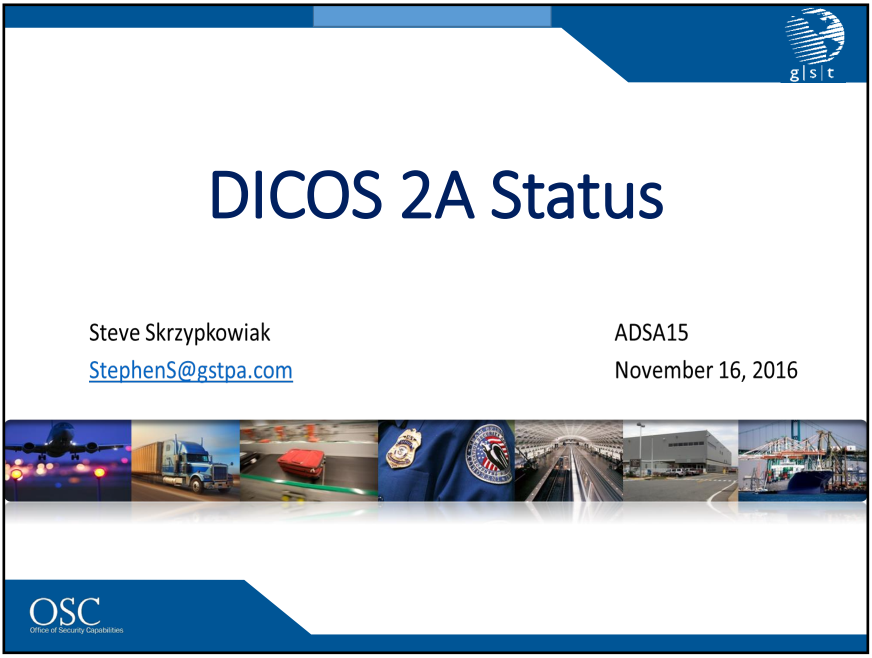
- Fill out questionnaire on Survey Monkey
- End at 4:00 PM today
  - Please stay to end if possible
- Comments welcome after conclusion



ADSA15 Provisional Topics

- Soft targets
- Tag and track
- System architectures + networking + Conops
- Deterrence
- Adaptable ATRs
- Simulants – development and testing
- Data mining
- Improving statistical significance of testing
- Human in the loop and the complete loop
- Civil rights and privacy concerns
- Other customers (sports venues, federal buildings, mass transit)
- Prize competitions
- Wands
- Texture in explosives
- TSA deployment models/issues
- Financial implications of fusion
- Testing fusible systems

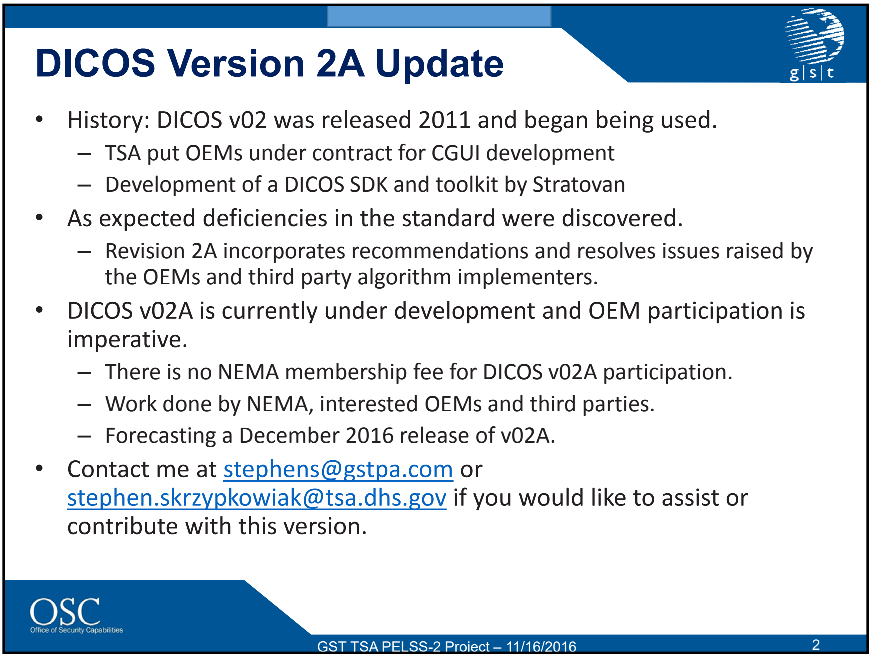
16.24 Steve Skrzypkowiak: DICOS 2A Status



DICOS 2A Status

Steve Skrzypkowiak
StephenS@gstpa.com

ADSA15
November 16, 2016



DICOS Version 2A Update

- History: DICOS v02 was released 2011 and began being used.
  - TSA put OEMs under contract for CGUI development
  - Development of a DICOS SDK and toolkit by Stratovan
- As expected deficiencies in the standard were discovered.
  - Revision 2A incorporates recommendations and resolves issues raised by the OEMs and third party algorithm implementers.
- DICOS v02A is currently under development and OEM participation is imperative.
  - There is no NEMA membership fee for DICOS v02A participation.
  - Work done by NEMA, interested OEMs and third parties.
  - Forecasting a December 2016 release of v02A.
- Contact me at stephens@gstpa.com or stephen.skrzypkowiak@tsa.dhs.gov if you would like to assist or contribute with this version.

GST TSA PELSS-2 Project – 11/16/2016 2

Backup

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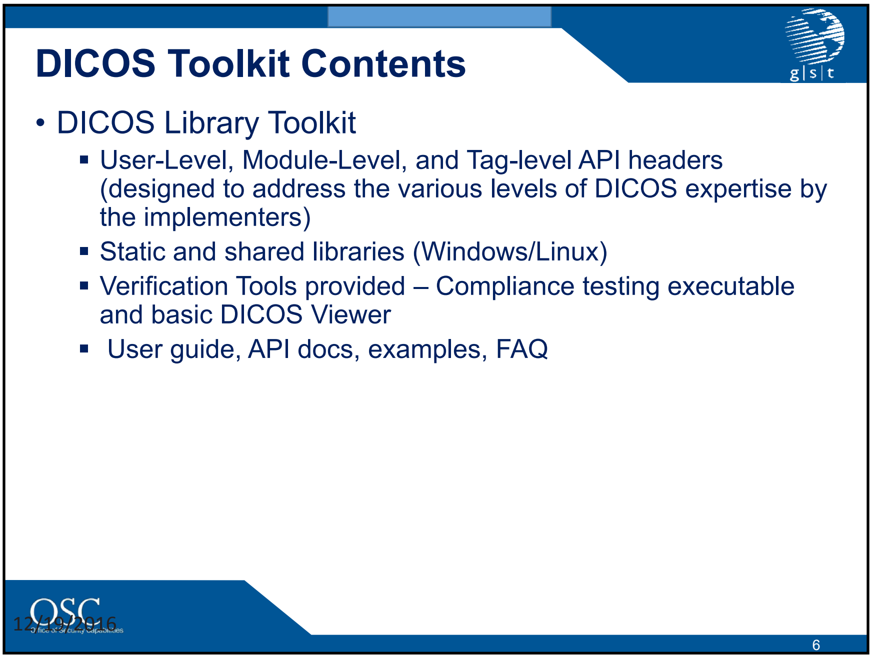
DICOS SDK Overview

STRATOVAN™
Saving lives through software

OSC
Office of Security Capabilities

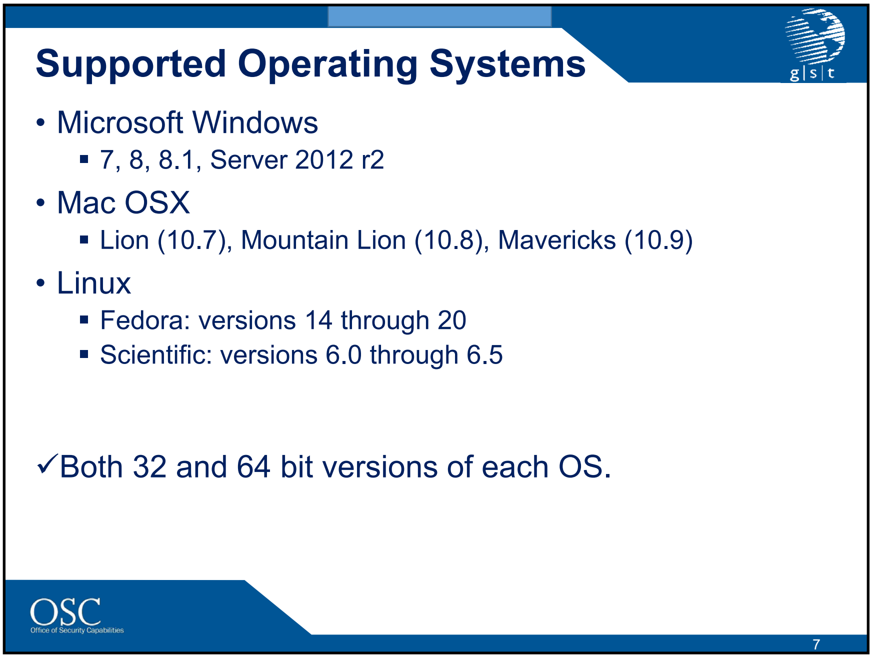
DICOS Toolkit/SDK Architecture and Design Quick Overview



DICOS Toolkit Contents

- DICOS Library Toolkit
  - User-Level, Module-Level, and Tag-level API headers (designed to address the various levels of DICOS expertise by the implementers)
  - Static and shared libraries (Windows/Linux)
  - Verification Tools provided – Compliance testing executable and basic DICOS Viewer
  - User guide, API docs, examples, FAQ

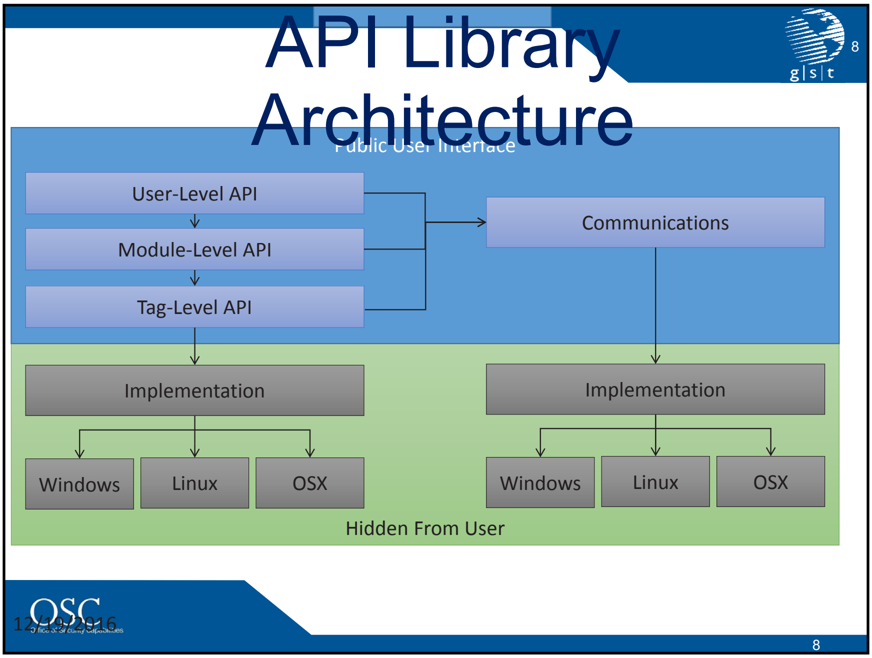
12/19/2016



Supported Operating Systems

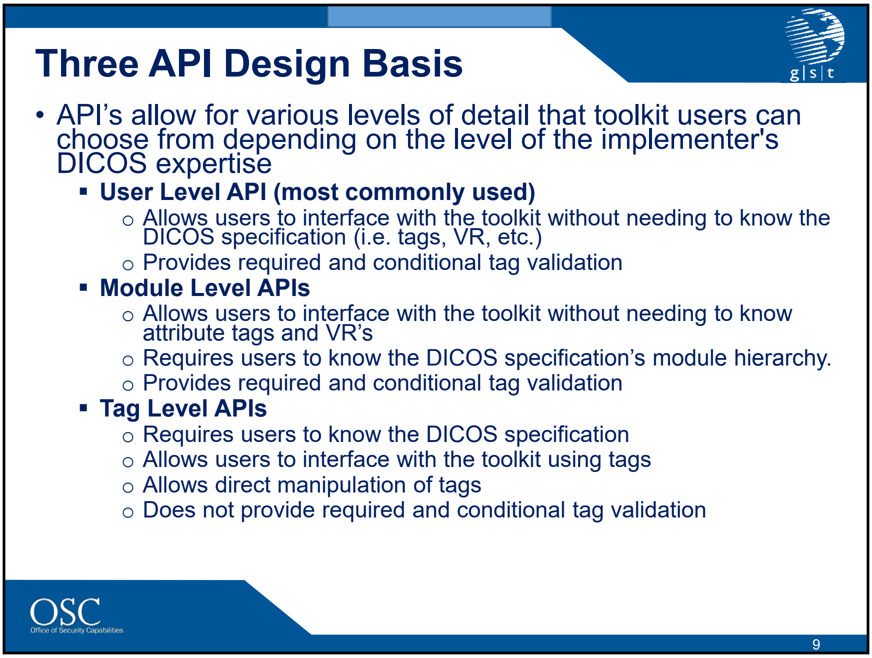
- Microsoft Windows
    - 7, 8, 8.1, Server 2012 r2
- Mac OSX
    - Lion (10.7), Mountain Lion (10.8), Mavericks (10.9)
- Linux
    - Fedora: versions 14 through 20
    - Scientific: versions 6.0 through 6.5

✓Both 32 and 64 bit versions of each OS.



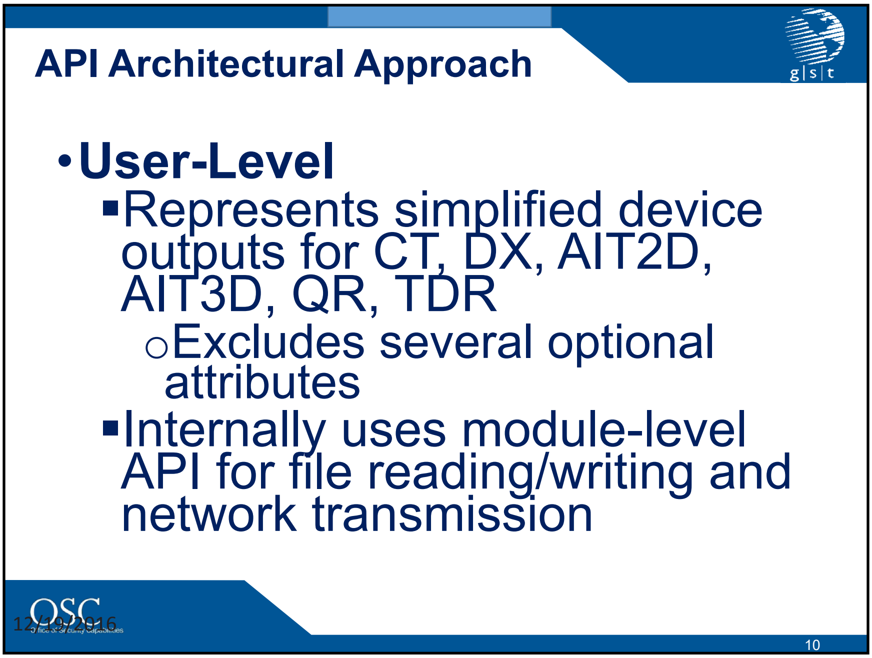
API Library Architecture

12/19/2016



Three API Design Basis

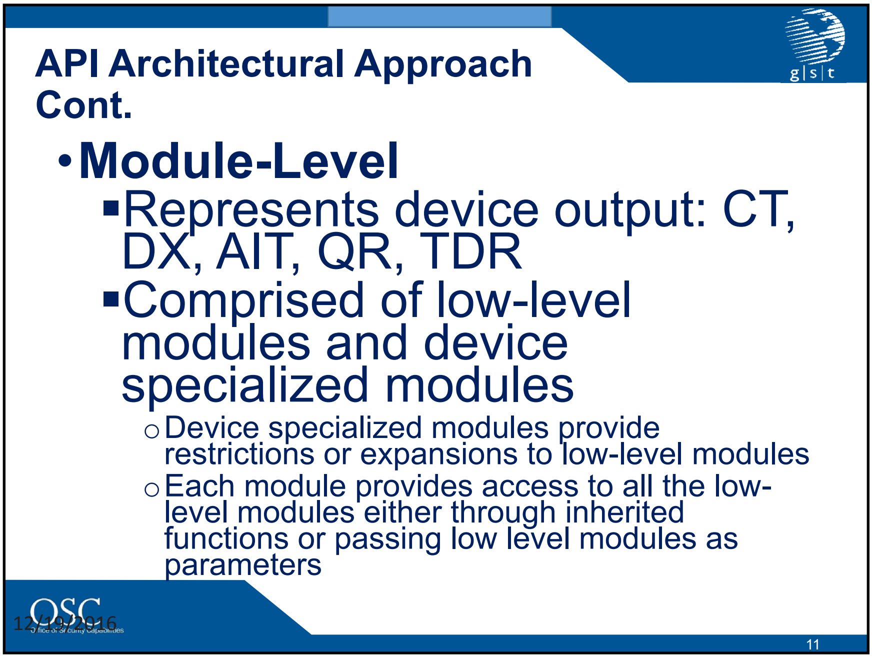
- API's allow for various levels of detail that toolkit users can choose from depending on the level of the implementer's DICOS expertise
  - **User Level API (most commonly used)**
    - Allows users to interface with the toolkit without needing to know the DICOS specification (i.e. tags, VR, etc.)
    - Provides required and conditional tag validation
  - **Module Level APIs**
    - Allows users to interface with the toolkit without needing to know attribute tags and VR's
    - Requires users to know the DICOS specification's module hierarchy.
    - Provides required and conditional tag validation
  - **Tag Level APIs**
    - Requires users to know the DICOS specification
    - Allows users to interface with the toolkit using tags
    - Allows direct manipulation of tags
    - Does not provide required and conditional tag validation



API Architectural Approach

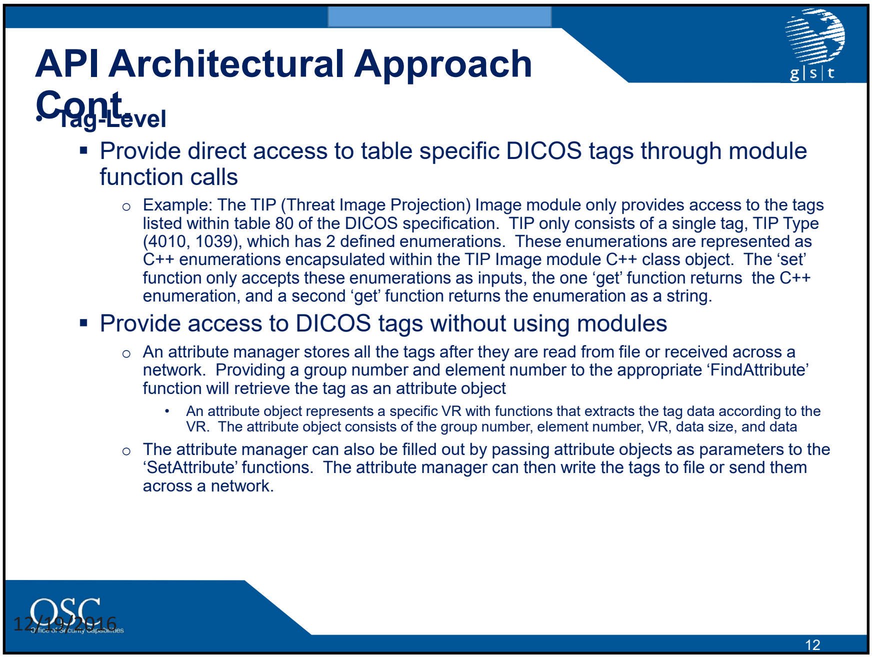
- **User-Level**
  - Represents simplified device outputs for CT, DX, AIT2D, AIT3D, QR, TDR
    - Excludes several optional attributes
  - Internally uses module-level API for file reading/writing and network transmission

12/19/2016



API Architectural Approach Cont.

- **Module-Level**
  - Represents device output: CT, DX, AIT, QR, TDR
  - Comprised of low-level modules and device specialized modules
    - Device specialized modules provide restrictions or expansions to low-level modules
    - Each module provides access to all the low-level modules either through inherited functions or passing low level modules as parameters



API Architectural Approach Cont.

- **Tag-Level**
  - Provide direct access to table specific DICOS tags through module function calls
    - Example: The TIP (Threat Image Projection) Image module only provides access to the tags listed within table 80 of the DICOS specification. TIP only consists of a single tag, TIP Type (4010, 1039), which has 2 defined enumerations. These enumerations are represented as C++ enumerations encapsulated within the TIP Image module C++ class object. The 'set' function only accepts these enumerations as inputs, the one 'get' function returns the C++ enumeration, and a second 'get' function returns the enumeration as a string.
  - Provide access to DICOS tags without using modules
    - An attribute manager stores all the tags after they are read from file or received across a network. Providing a group number and element number to the appropriate 'FindAttribute' function will retrieve the tag as an attribute object
      - An attribute object represents a specific VR with functions that extracts the tag data according to the VR. The attribute object consists of the group number, element number, VR, data size, and data
    - The attribute manager can also be filled out by passing attribute objects as parameters to the 'SetAttribute' functions. The attribute manager can then write the tags to file or send them across a network.

DICOS Compliance and Certification

Stratovan DICOS SDK Class Interfaces and Architecture

v0.1

Introduction

The **Digital Imaging and Communications in Security (DICOS)** standard is an adaptation of the **Digital Imaging and Communications in Medicine (DICOM)** standard for security screening applications.
The Stratovan DICOS Toolkit consists of a software library and tools that implements the NEMA DICOS Standard v02. The Toolkit is support on Windows, Linux and Mac operating systems.

Downloading the Stratovan DICOS Toolkit:

- The Stratovan DICOS Toolkit is available here https://www.stratovan.com/products/dicos-toolkit

Documentation

- **Stratovan DICOS Toolkit User Guide**

Conformance Testing

Conformance Testing is the process of verifying that DICOS files generated by Stratovan DICOS Toolkit users or other DICOS implementations adhere to the DICOS specification and to any additional sets of rules that a 3rd party may with to apply.
The Conformance Testing Suite included in the Stratovan DICOS Toolkit is a set of programs used to display the contents of DICOS files and to determine if DICOS files conform to the NEMA DICOS Specification.

- **DICOS Conformance Testing Suite**

Examples and Sample Code

- **Examples and Sample Code**

DICOS Integration Tutorial

- A detailed tutorial is available through Stratovan
- Stratovan can be reached at:
  - www.stratovan.com
  - (530)-746-7970
    - Contact: David Hinojosa (hinojosa@stratoan.com)

g|s|t

Thank You!

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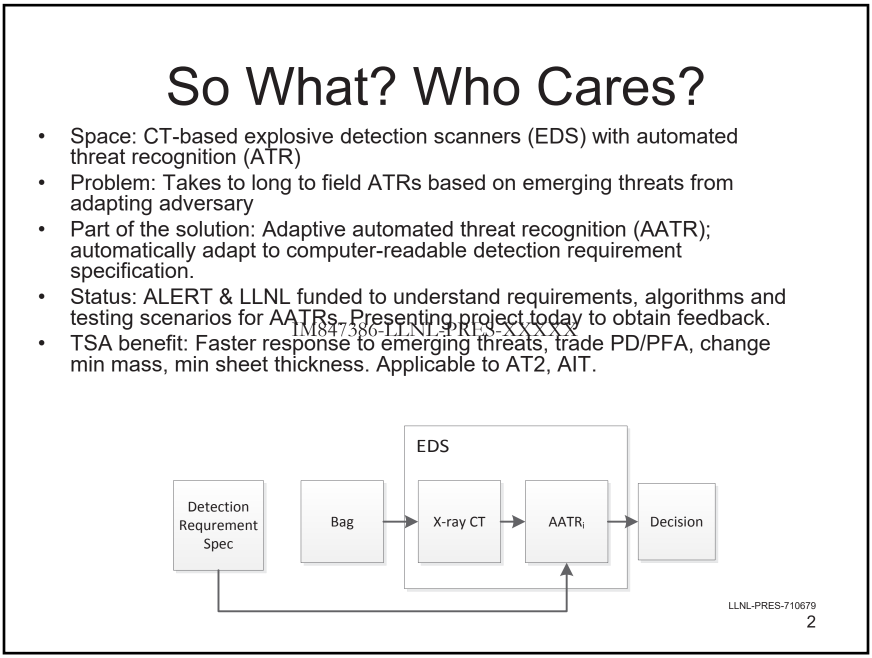
16.25 Harry Martz: Adaptive Automated Threat Recognition

Adaptive Automated Threat Recognition (AATR)

Harry Martz
Lawrence Livermore National Laboratory

This work was performed under the auspices of the U.S. Department of Energy by Lawrence Livermore National Laboratory under Contract DE-AC52-07NA27344



So What? Who Cares?

- Space: CT-based explosive detection scanners (EDS) with automated threat recognition (ATR)
- Problem: Takes to long to field ATRs based on emerging threats from adapting adversary
- Part of the solution: Adaptive automated threat recognition (AATR); automatically adapt to computer-readable detection requirement specification.
- Status: ALERT & LLNL funded to understand requirements, algorithms and testing scenarios for AATRs. Presenting project today to obtain feedback.
- TSA benefit: Faster response to emerging threats, trade PD/PFA, change min mass, min sheet thickness. Applicable to AT2, AIT.

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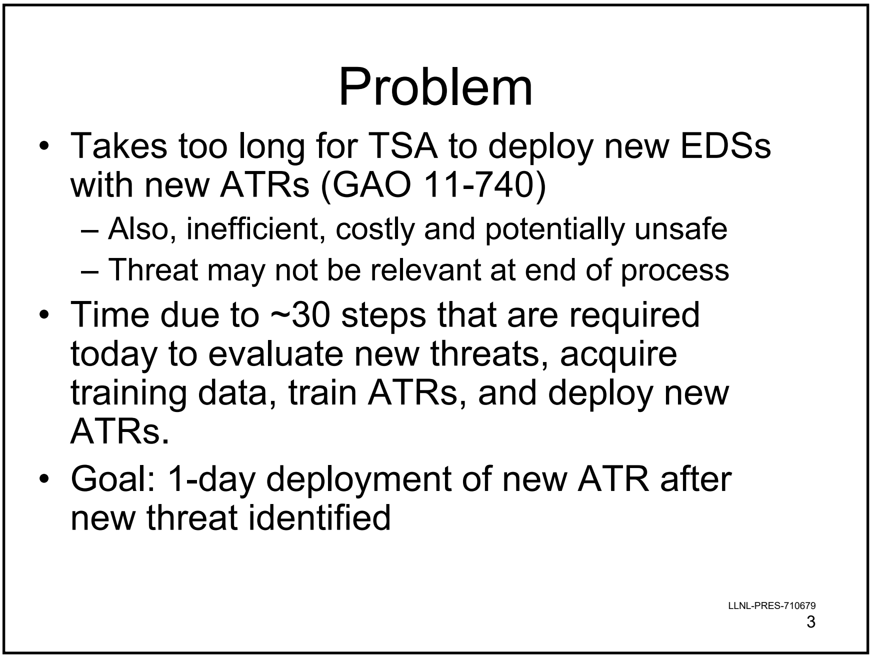
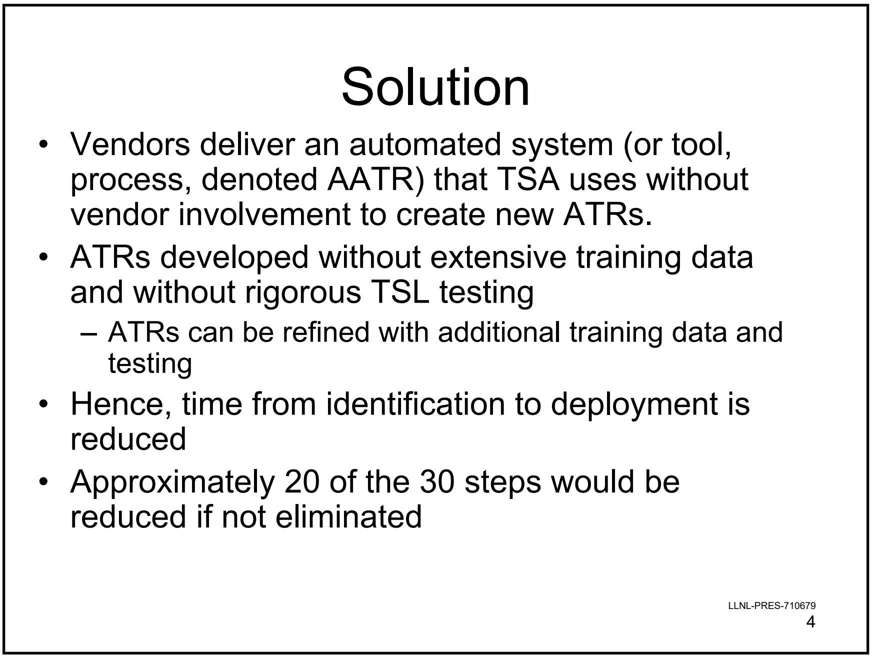


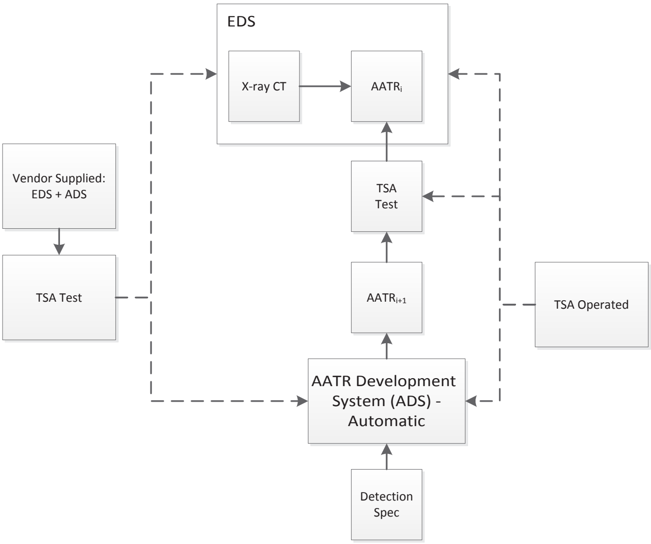
Problem

- Takes too long for TSA to deploy new EDSs with new ATRs (GAO 11-740)
  - Also, inefficient, costly and potentially unsafe
  - Threat may not be relevant at end of process
- Time due to ~30 steps that are required today to evaluate new threats, acquire training data, train ATRs, and deploy new ATRs.
- Goal: 1-day deployment of new ATR after new threat identified



Solution

- Vendors deliver an automated system (or tool, process, denoted AATR) that TSA uses without vendor involvement to create new ATRs.
- ATRs developed without extensive training data and without rigorous TSL testing
  - ATRs can be refined with additional training data and testing
- Hence, time from identification to deployment is reduced
- Approximately 20 of the 30 steps would be reduced if not eliminated



EDS

X-ray CT

AATR$_i$

Vendor Supplied:
EDS + ADS

TSA Test

TSA
Test

AATR$_{i+1}$

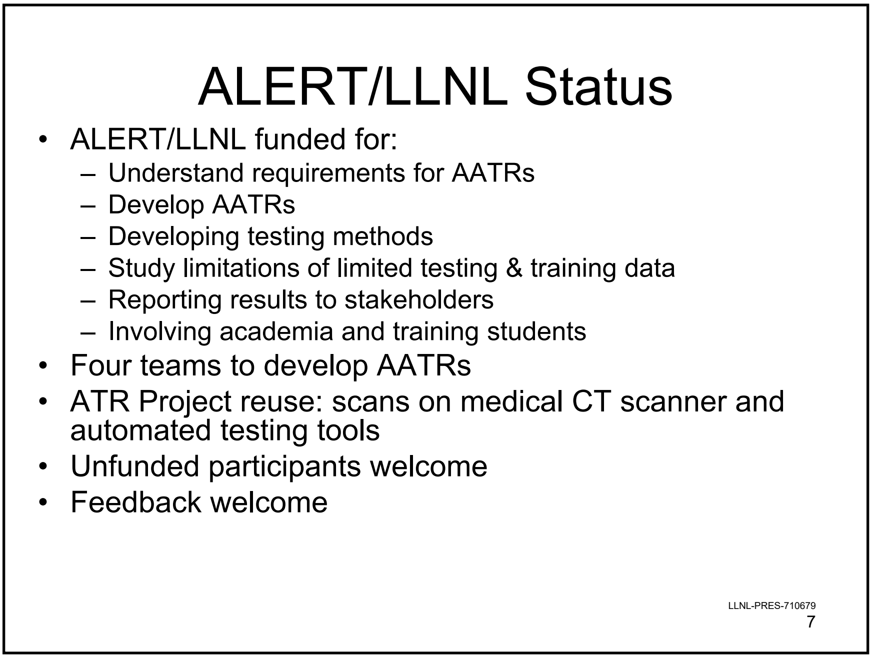
TSA Operated

AATR Development
System (ADS) -
Automatic

Detection
Spec

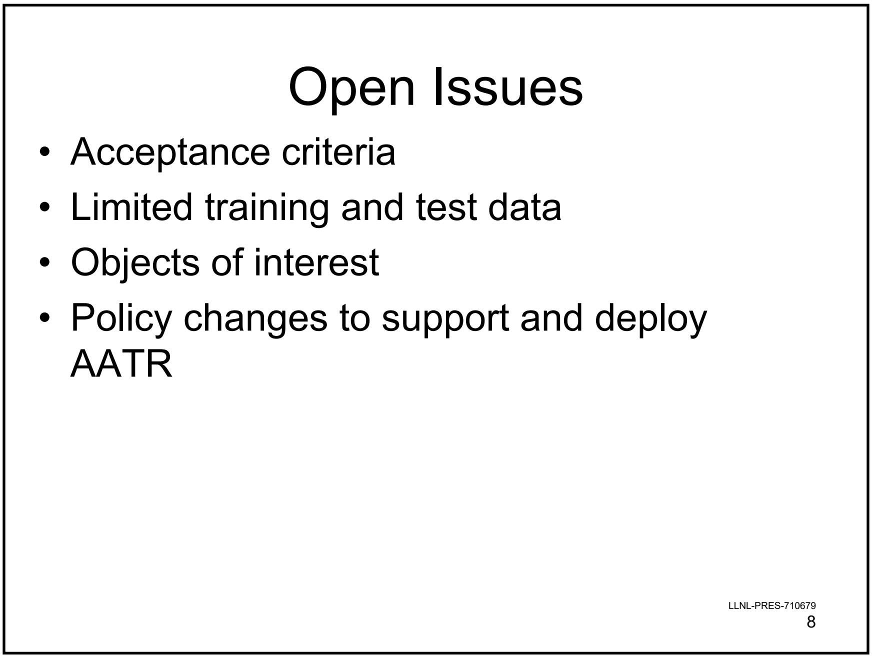
Detection Requirement Spec

- Types of threat classes
- For each class
  - Minimum mass
  - Minimum thickness (sheets only)
  - Density range
  - Coefficient for calculating weighted PD
  - PD per class
- Weighted PD
- PFA
- Computer readable



ALERT/LLNL Status

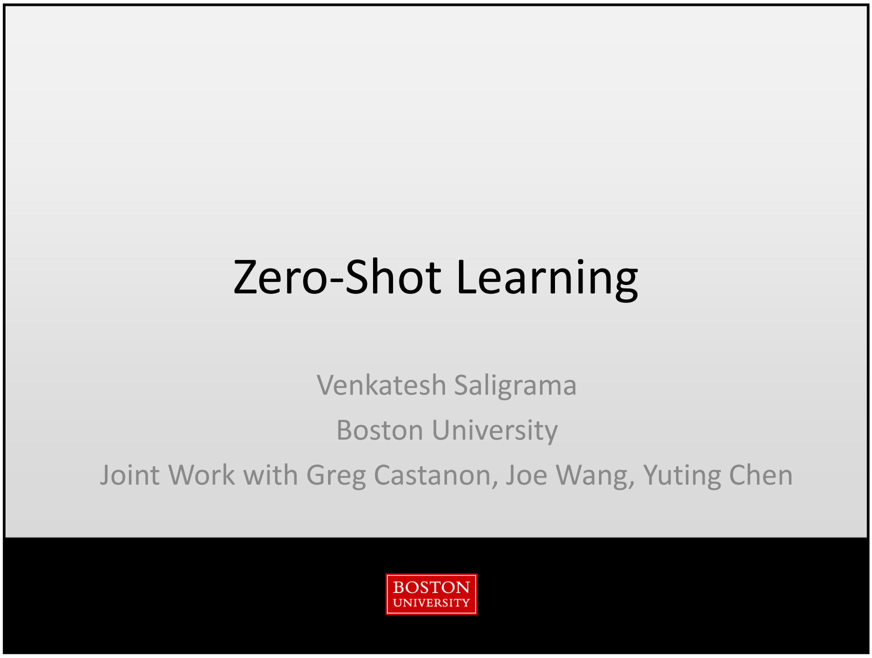
- ALERT/LLNL funded for:
  - Understand requirements for AATRs
  - Develop AATRs
  - Developing testing methods
  - Study limitations of limited testing & training data
  - Reporting results to stakeholders
  - Involving academia and training students
- Four teams to develop AATRs
- ATR Project reuse: scans on medical CT scanner and automated testing tools
- Unfunded participants welcome
- Feedback welcome



Open Issues

- Acceptance criteria
- Limited training and test data
- Objects of interest
- Policy changes to support and deploy AATR

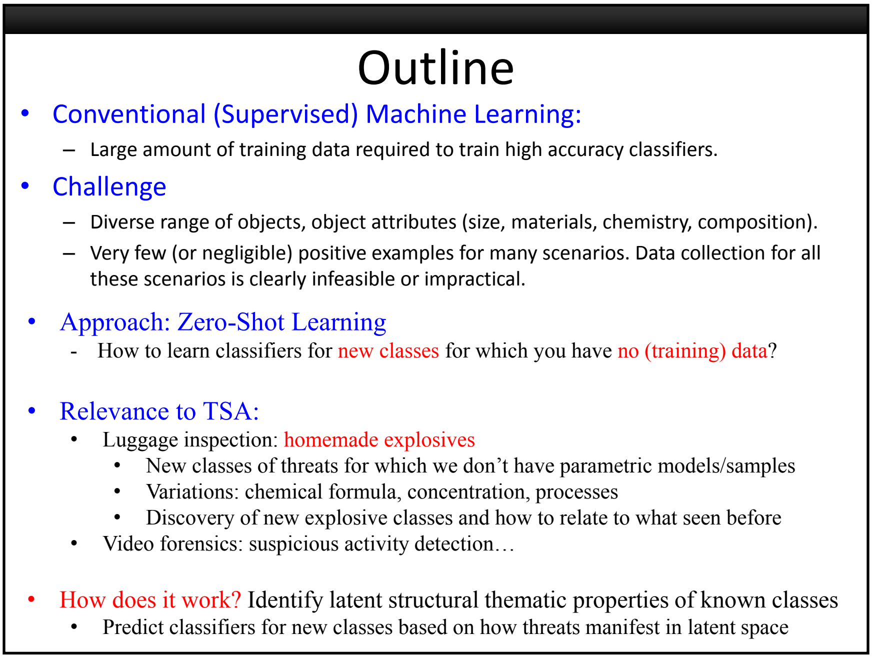
16.26 Venkatesh Saligrama: Zero Shot Learning



Zero-Shot Learning

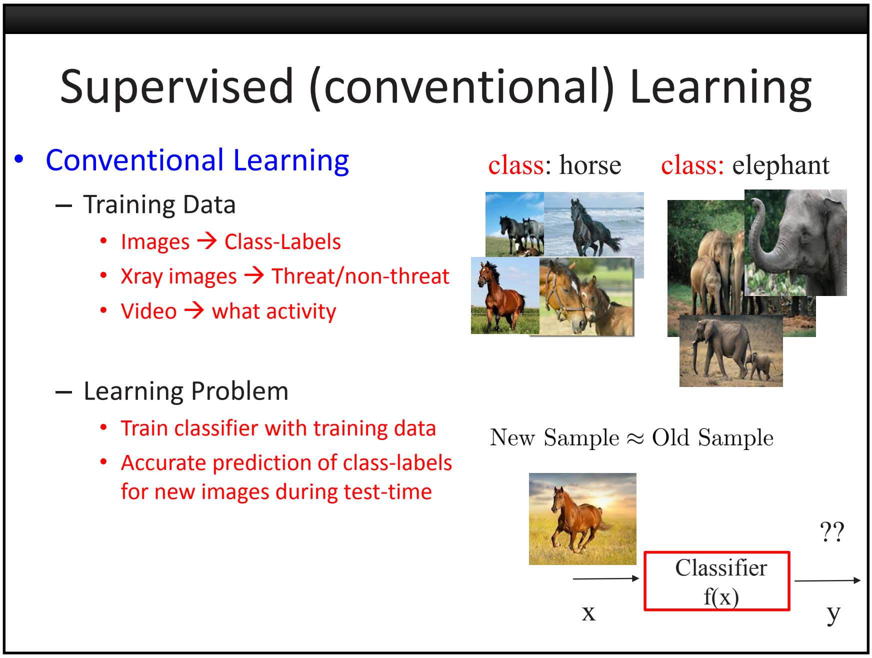
Venkatesh Saligrama
Boston University
Joint Work with Greg Castanon, Joe Wang, Yuting Chen

BOSTON UNIVERSITY



Outline

- Conventional (Supervised) Machine Learning:
  - Large amount of training data required to train high accuracy classifiers.
- Challenge
  - Diverse range of objects, object attributes (size, materials, chemistry, composition).
  - Very few (or negligible) positive examples for many scenarios. Data collection for all these scenarios is clearly infeasible or impractical.
- Approach: Zero-Shot Learning
  - How to learn classifiers for new classes for which you have no (training) data?
- Relevance to TSA:
  - Luggage inspection: homemade explosives
    - New classes of threats for which we don’t have parametric models/samples
    - Variations: chemical formula, concentration, processes
    - Discovery of new explosive classes and how to relate to what seen before
  - Video forensics: suspicious activity detection…
- How does it work? Identify latent structural thematic properties of known classes
  - Predict classifiers for new classes based on how threats manifest in latent space



Supervised (conventional) Learning

- Conventional Learning
  - Training Data
    - Images → Class-Labels
    - Xray images → Threat/non-threat
    - Video → what activity
  - Learning Problem
    - Train classifier with training data
    - Accurate prediction of class-labels for new images during test-time

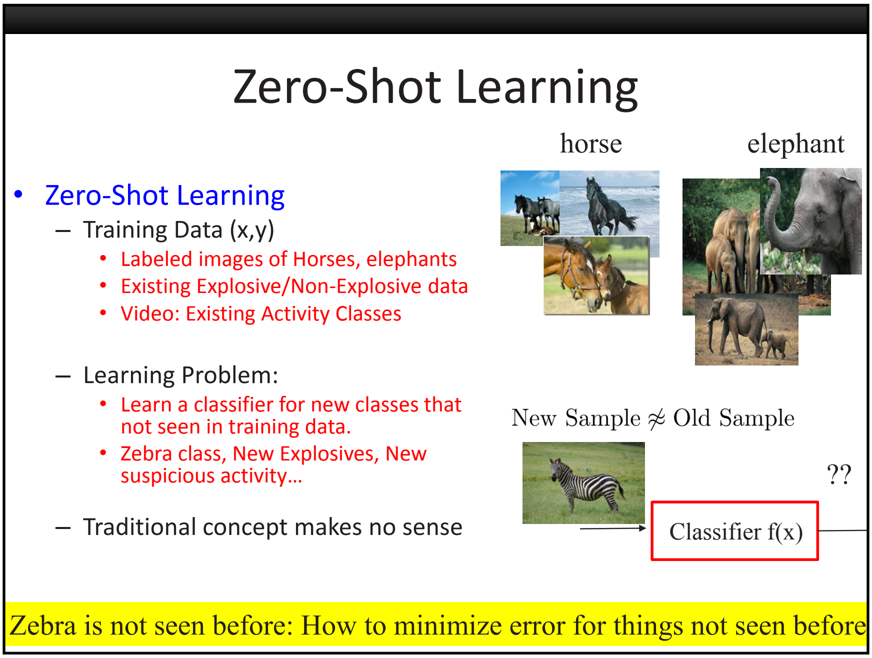
class: horse

class: elephant

New Sample ≈ Old Sample

x → Classifier f(x) → y

??



Zero-Shot Learning

- Zero-Shot Learning
  - Training Data (x,y)
    - Labeled images of Horses, elephants
    - Existing Explosive/Non-Explosive data
    - Video: Existing Activity Classes
  - Learning Problem:
    - Learn a classifier for new classes that not seen in training data.
    - Zebra class, New Explosives, New suspicious activity…
  - Traditional concept makes no sense

horse

elephant

New Sample ≉ Old Sample

→ Classifier f(x) —

??

Zebra is not seen before: How to minimize error for things not seen before

Airport Security Context

- Millions of types of homemade threats:
  - Fine grained classification
- Myriad Scanner Outputs

Key Idea: Leverage structure in descriptions

Source domain

Horse	
Kingdom:	Animalia
Phylum:	Chordata
Class:	Mammalia
Order:	Perissodactyla
Family:	Equidae
Genus:	*Equus*
Species:	*E. ferus*
Subspecies:	***E. f. caballus***

Elephants	
Kingdom:	Animalia
Phylum:	Chordata
Subphylum:	Vertebrata
Class:	Mammalia
Superorder:	Afrotheria
Order:	Proboscidea
Family:	Elephantidae
	Gray, 1821

Seen classes

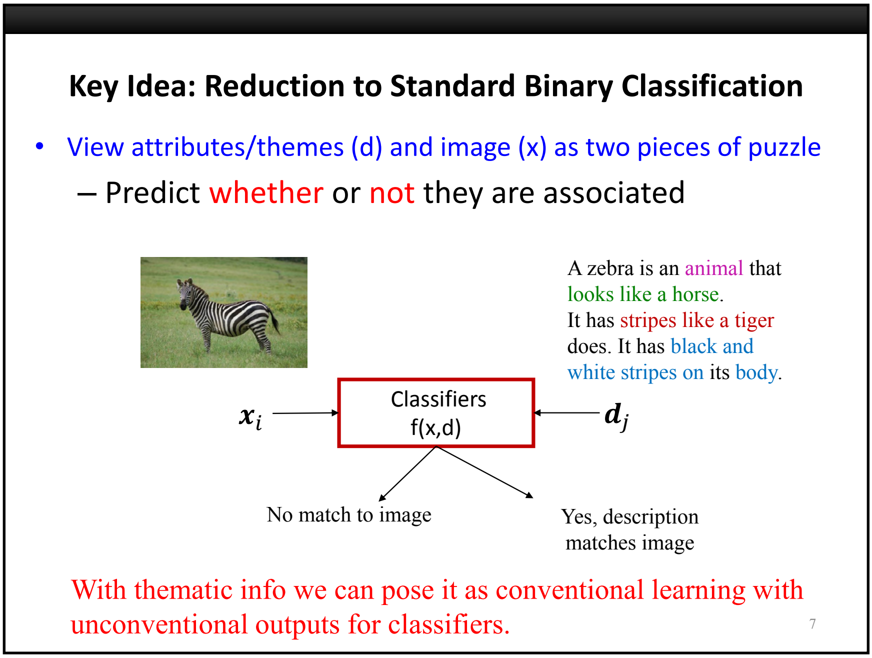
Target domain

Zebra	
Kingdom:	Animalia
Phylum:	Chordata
Class:	Mammalia
Order:	Perissodactyla
Family:	Equidae
Genus:	*Equus*
Subgenus:	***Hippotigris*** and ***Dolichohippus***

Domestic dog	
Kingdom:	Animalia
Phylum:	Chordata
Class:	Mammalia
Order:	Carnivora
Family:	Canidae
Genus:	*Canis*
Species:	*C. lupus*
Subspecies:	***C. l. familiaris***

Unseen classes

What if we are given thematic information during training?
Can we recognize new class from thematic information?



Key Idea: Reduction to Standard Binary Classification

- View attributes/themes (d) and image (x) as two pieces of puzzle
  – Predict whether or not they are associated

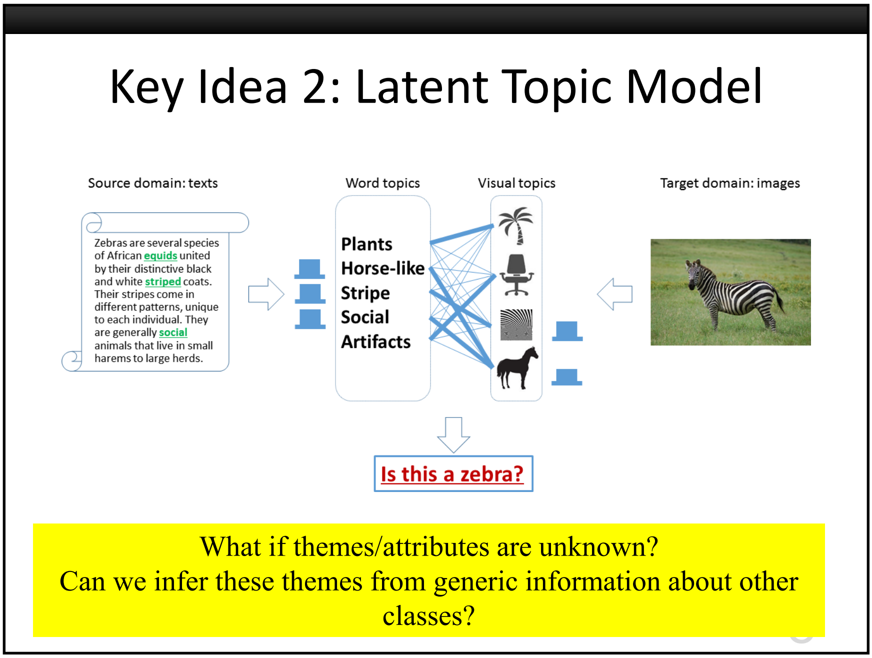
A zebra is an animal that looks like a horse. It has stripes like a tiger does. It has black and white stripes on its body.

x_i → Classifiers f(x,d) ← d_j

No match to image

Yes, description matches image

With thematic info we can pose it as conventional learning with unconventional outputs for classifiers.



Key Idea 2: Latent Topic Model

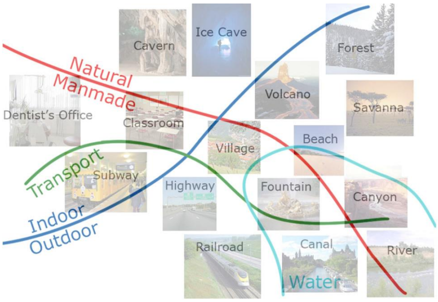
Zebras are several species of African equids united by their distinctive black and white striped coats. Their stripes come in different patterns, unique to each individual. They are generally social animals that live in small harems to large herds.

Is this a zebra?

What if themes/attributes are unknown?
Can we infer these themes from generic information about other classes?

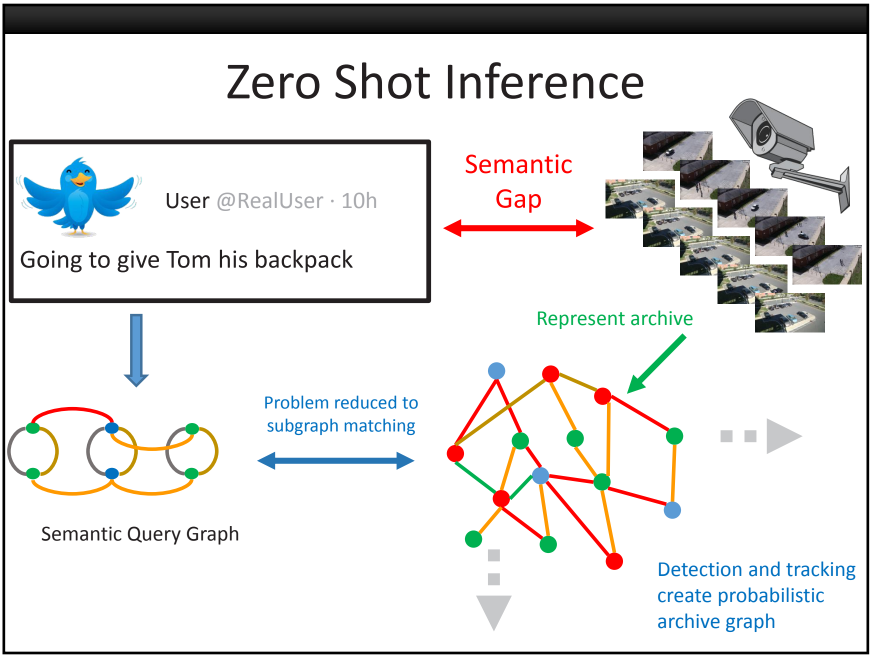
Experiments: Benchmark datasets

Dataset	# instances	# attributes	# seen/unseen classes
aP&Y	15,339	64 (continuous)	20 / 12
AwA	30,475	85 (continuous)	40 / 10
CUB-200-2011	11,788	312 (binary)	150 / 50
SUN Attribute	14,340	102 (binary)	707 / 10



Performance Comparison

Method	aP&Y	AwA	CUB-200-2011	SUN Attribute	Average
Akata et al. **CVPR'15**	-	61.9	40.3	-	-
Lampert et al. **PAMI'14**	38.16	57.23	-	72.00	-
R.-Paredes and Torr **ICML'15**	24.22±2.89	75.32±2.28	-	82.10±0.32	
SSE, **ICCV'15**	46.23±0.53	76.33±0.83	30.41±0.20	82.50±1.32	58.87
SDL, **arXiv'15**	***50.35±2.97***	***79.12±0.53***	***41.78±0.52***	***83.83±0.29***	***63.77***



Zero Shot Inference

User @RealUser · 10h

Going to give Tom his backpack

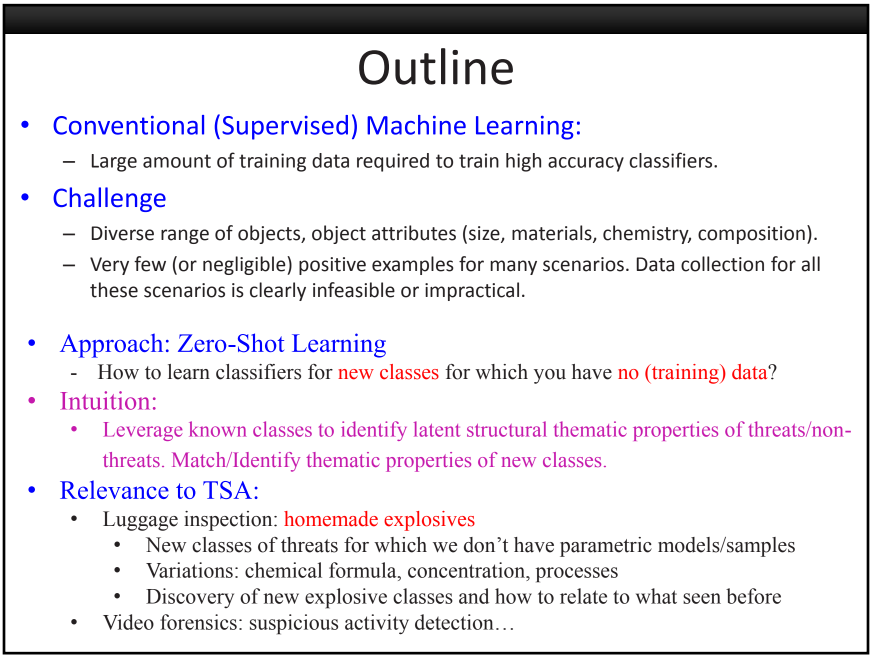
Semantic Gap

Represent archive

Problem reduced to subgraph matching

Semantic Query Graph

Detection and tracking create probabilistic archive graph



Outline

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  - Large amount of training data required to train high accuracy classifiers.
- Challenge
  - Diverse range of objects, object attributes (size, materials, chemistry, composition).
  - Very few (or negligible) positive examples for many scenarios. Data collection for all these scenarios is clearly infeasible or impractical.
- Approach: Zero-Shot Learning
  - How to learn classifiers for new classes for which you have no (training) data?
- Intuition:
  - Leverage known classes to identify latent structural thematic properties of threats/non-threats. Match/Identify thematic properties of new classes.
- Relevance to TSA:
  - Luggage inspection: homemade explosives
    - New classes of threats for which we don’t have parametric models/samples
    - Variations: chemical formula, concentration, processes
    - Discovery of new explosive classes and how to relate to what seen before
  - Video forensics: suspicious activity detection…

16.27 Lee Spanier: Accelerating Certification Testing by Creating an “Instrument Mode” Construct and by Avoiding Lorenz Attractors

TRANSPORTATION SECURITY LABORATORY

Accelerating AIT Certification Tests

Homeland Security
Science and Technology

LEE SPANIER
IT&E Division
16 NOVEMBER 2016

So What? Who Cares?

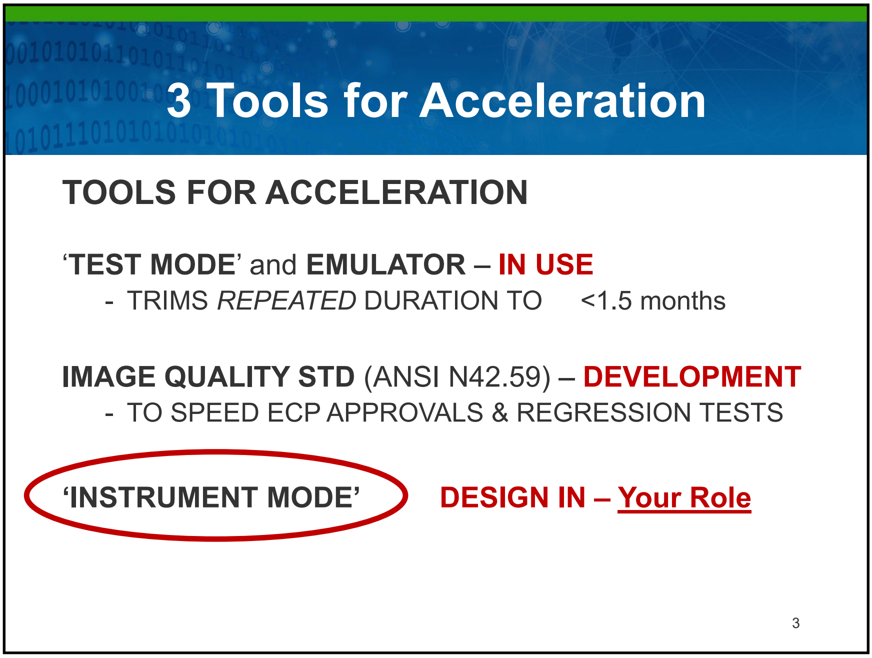
FOCUS: **PASSENGER SCREENING SYSTEMS (AIT)**
DETECTION CERTIFICATION @ 2 TIERS

1st TIME DURATION

- EXISTING Standard 4.5 months +/- 1 month
- NEW Standard 7.5 months +/- 1 month

SCHEDULE DRIVERS

- Simulant & Body Phantom Development &Validation
- Comprehensive Target Detection Test



3 Tools for Acceleration

TOOLS FOR ACCELERATION

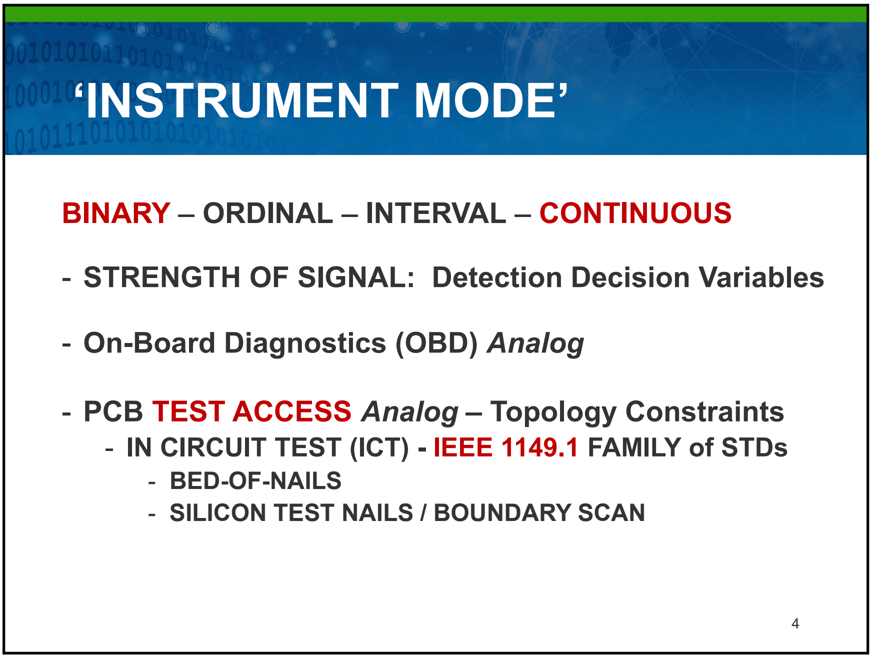
‘**TEST MODE**’ and **EMULATOR** – **IN USE**

- TRIMS *REPEATED* DURATION TO <1.5 months

IMAGE QUALITY STD (ANSI N42.59) – **DEVELOPMENT**

- TO SPEED ECP APPROVALS & REGRESSION TESTS

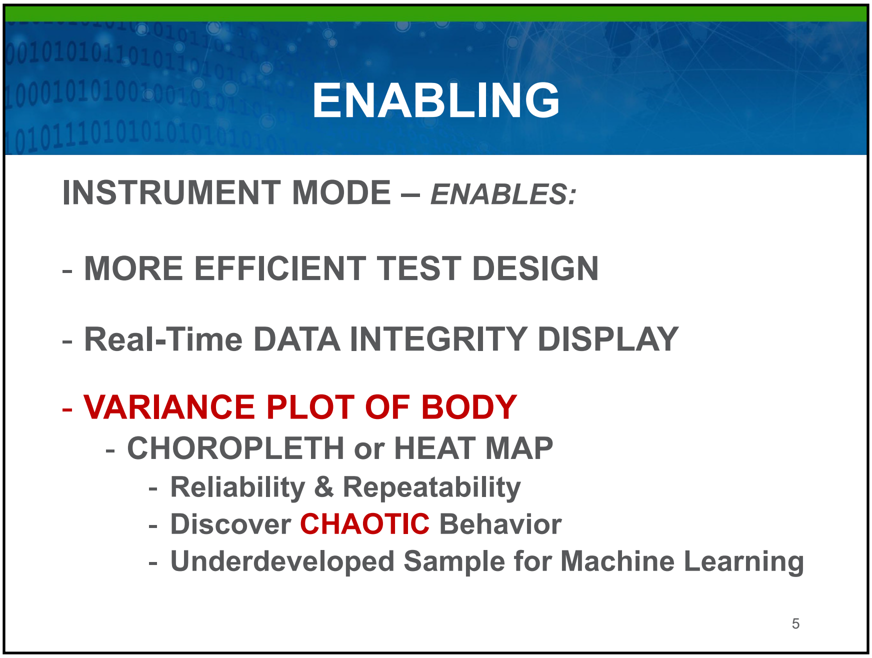
‘INSTRUMENT MODE’ **DESIGN IN – Your Role**



‘INSTRUMENT MODE’

BINARY – ORDINAL – INTERVAL – CONTINUOUS

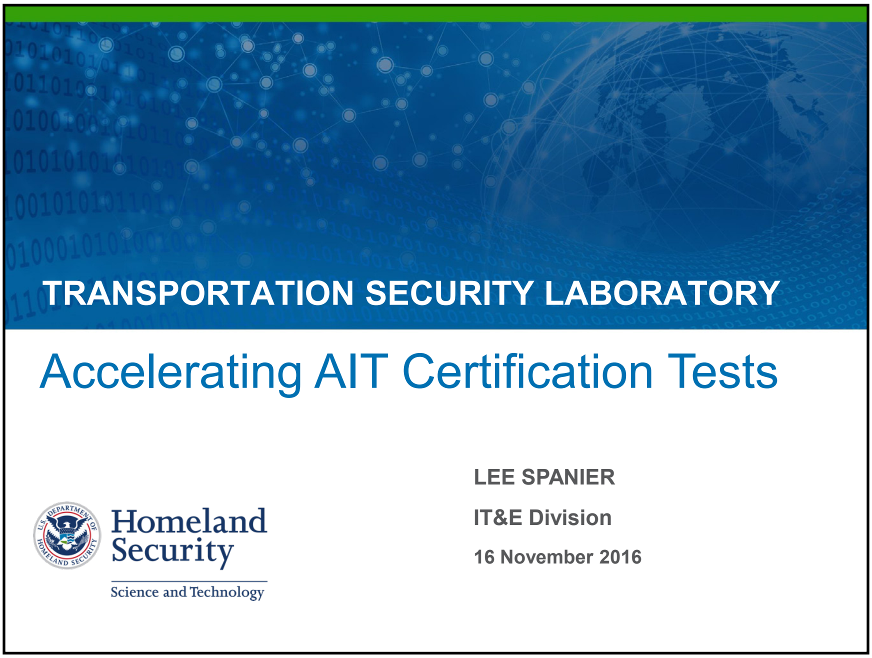
- **STRENGTH OF SIGNAL: Detection Decision Variables**
- **On-Board Diagnostics (OBD) *Analog***
- **PCB TEST ACCESS *Analog* – Topology Constraints**
  - **IN CIRCUIT TEST (ICT) - IEEE 1149.1 FAMILY of STDs**
    - **BED-OF-NAILS**
    - **SILICON TEST NAILS / BOUNDARY SCAN**



ENABLING

INSTRUMENT MODE – *ENABLES:*

- MORE EFFICIENT TEST DESIGN
- Real-Time DATA INTEGRITY DISPLAY
- VARIANCE PLOT OF BODY
  - CHOROPLETH or HEAT MAP
    - Reliability & Repeatability
    - Discover CHAOTIC Behavior
    - Underdeveloped Sample for Machine Learning



TRANSPORTATION SECURITY LABORATORY

Accelerating AIT Certification Tests

Homeland
Security
Science and Technology

LEE SPANIER
IT&E Division
16 November 2016

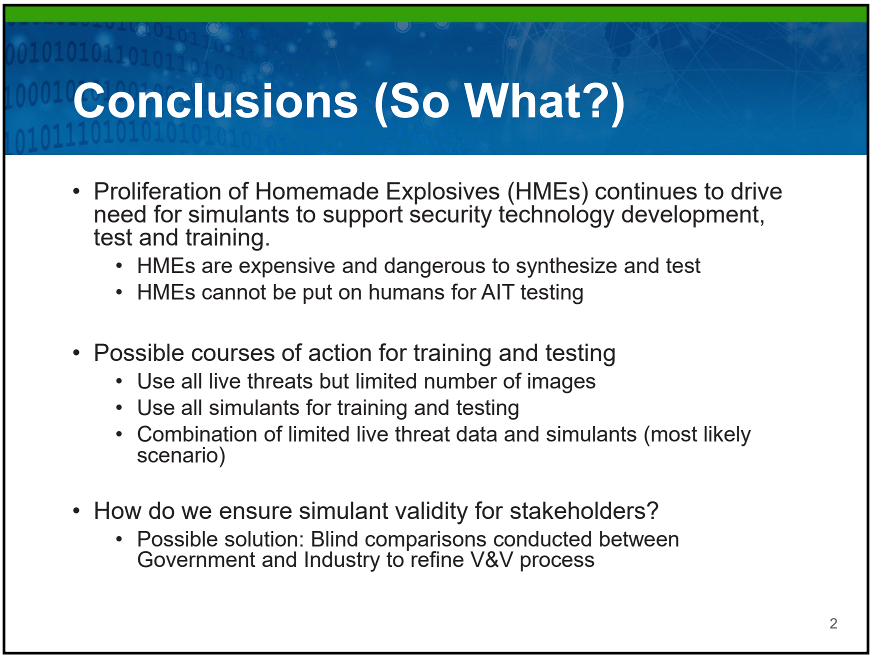
16.28 Robert Klueg: HME Stimulant Development and Validation

TRANSPORTATION SECURITY LABORATORY

Simulant Verification and Validation

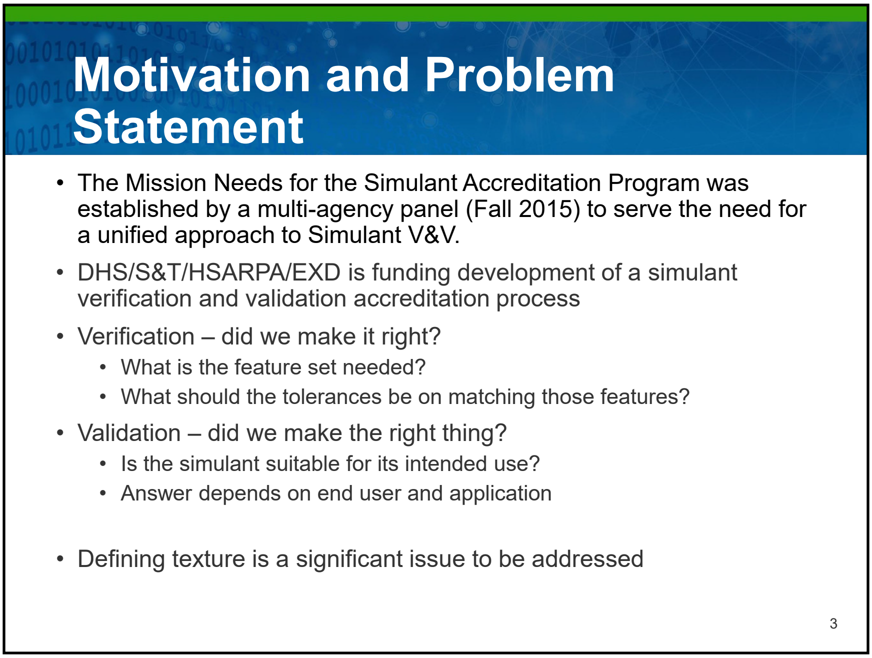
Homeland Security
Science and Technology

Robert Klueg
Spectroscopy DT&E Branch Chief
November 16, 2016
Transportation Security Laboratory
Science and Technology Directorate



Conclusions (So What?)

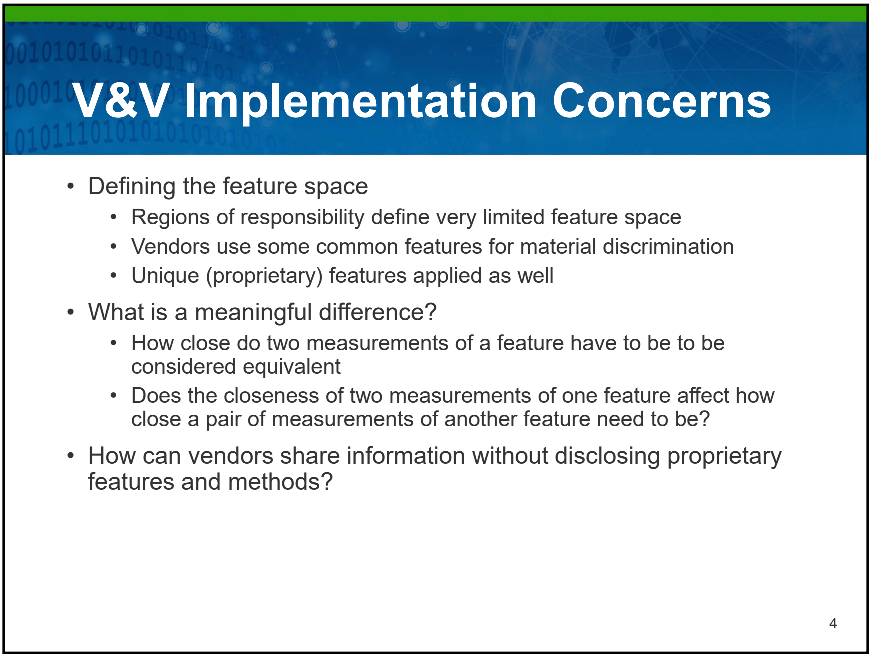
- Proliferation of Homemade Explosives (HMEs) continues to drive need for simulants to support security technology development, test and training.
    - HMEs are expensive and dangerous to synthesize and test
    - HMEs cannot be put on humans for AIT testing
- Possible courses of action for training and testing
    - Use all live threats but limited number of images
    - Use all simulants for training and testing
    - Combination of limited live threat data and simulants (most likely scenario)
- How do we ensure simulant validity for stakeholders?
    - Possible solution: Blind comparisons conducted between Government and Industry to refine V&V process



Motivation and Problem Statement

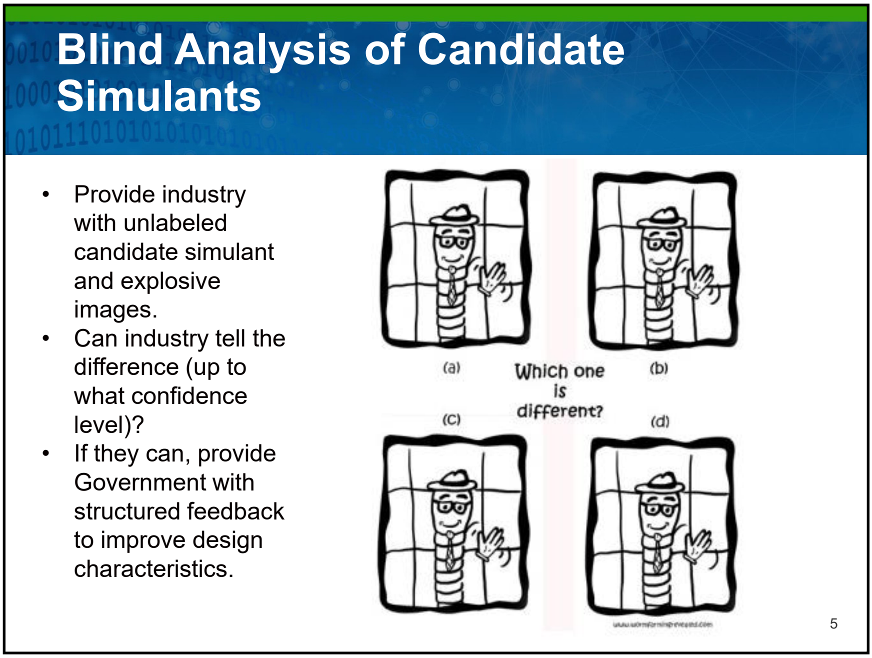
- The Mission Needs for the Simulant Accreditation Program was established by a multi-agency panel (Fall 2015) to serve the need for a unified approach to Simulant V&V.
- DHS/S&T/HSARPA/EXD is funding development of a simulant verification and validation accreditation process
- Verification – did we make it right?
  - What is the feature set needed?
  - What should the tolerances be on matching those features?
- Validation – did we make the right thing?
  - Is the simulant suitable for its intended use?
  - Answer depends on end user and application

- Defining texture is a significant issue to be addressed



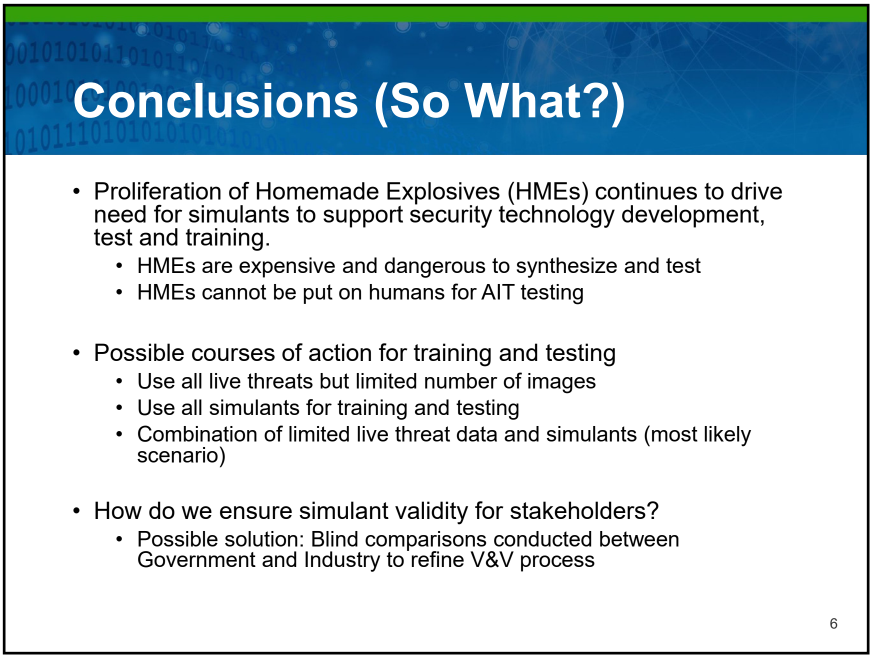
V&V Implementation Concerns

- Defining the feature space
  - Regions of responsibility define very limited feature space
  - Vendors use some common features for material discrimination
  - Unique (proprietary) features applied as well
- What is a meaningful difference?
  - How close do two measurements of a feature have to be to be considered equivalent
  - Does the closeness of two measurements of one feature affect how close a pair of measurements of another feature need to be?
- How can vendors share information without disclosing proprietary features and methods?



Blind Analysis of Candidate Simulants

- Provide industry with unlabeled candidate simulant and explosive images.
- Can industry tell the difference (up to what confidence level)?
- If they can, provide Government with structured feedback to improve design characteristics.



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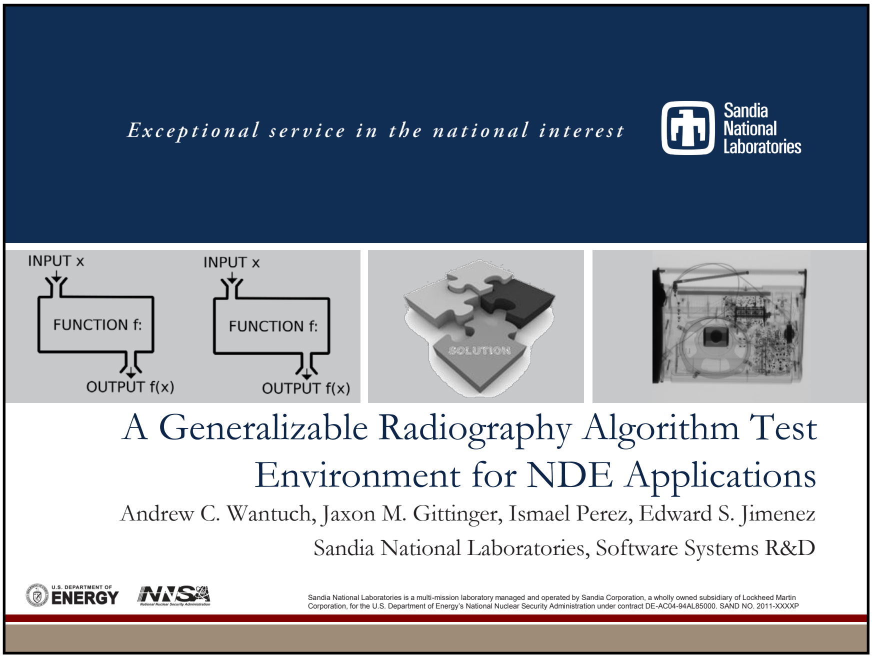
  - Combination of limited live threat data and simulants (most likely scenario)

- How do we ensure simulant validity for stakeholders?
  - Possible solution: Blind comparisons conducted between Government and Industry to refine V&V process

Homeland
Security

Science and Technology

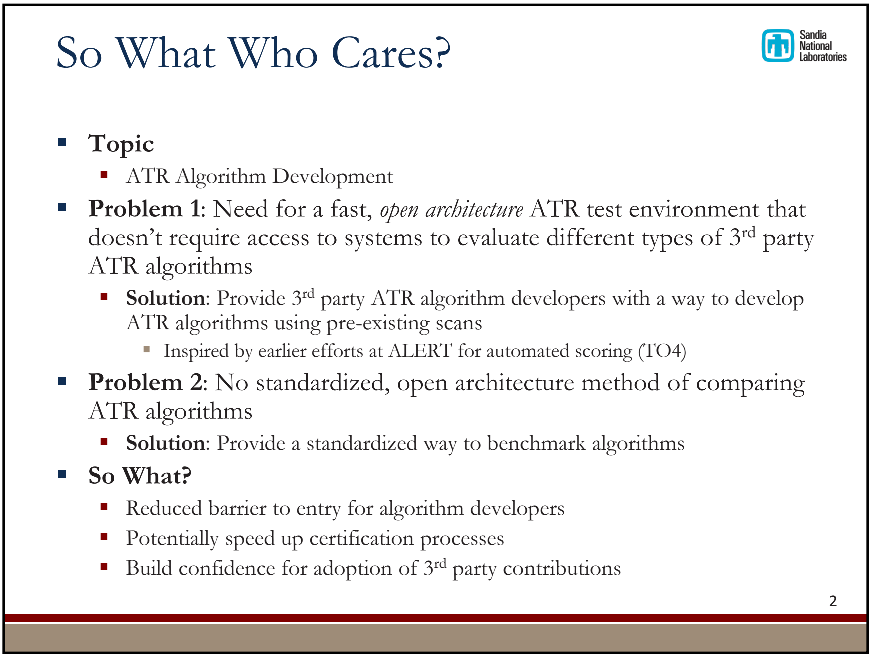
16.29 Andrew Wantuch: A Generalizable Radiography Algorithm Test Environment for NDE Applications



Exceptional service in the national interest

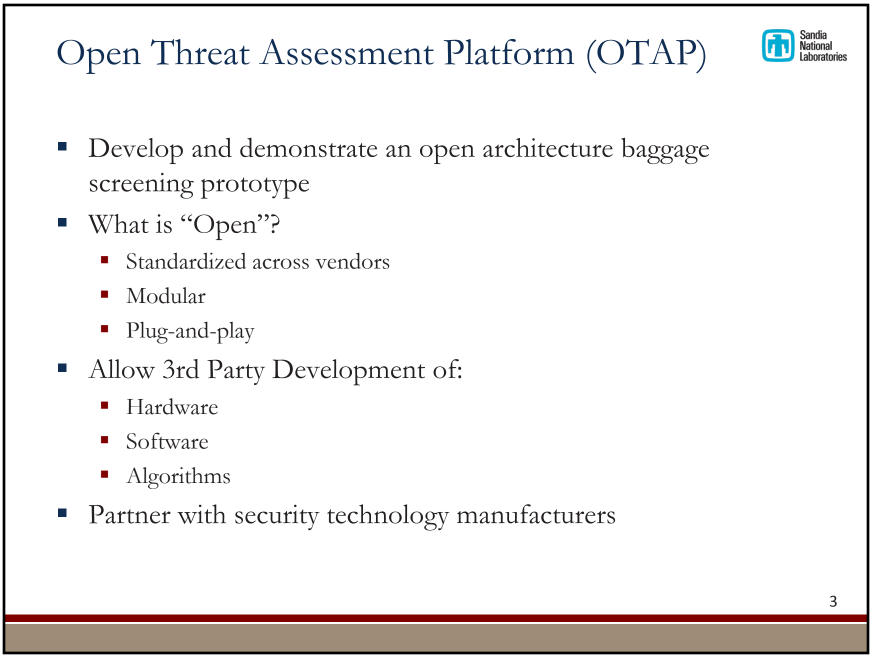
A Generalizable Radiography Algorithm Test Environment for NDE Applications

Andrew C. Wantuch, Jaxon M. Gittinger, Ismael Perez, Edward S. Jimenez
Sandia National Laboratories, Software Systems R&D



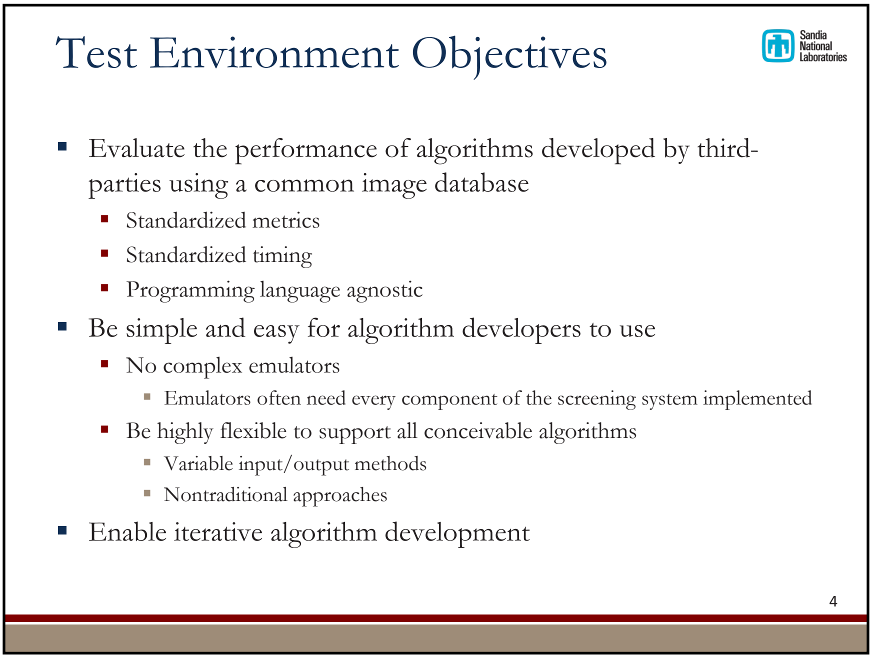
So What Who Cares?

- **Topic**
  - ATR Algorithm Development
- **Problem 1**: Need for a fast, *open architecture* ATR test environment that doesn't require access to systems to evaluate different types of 3rd party ATR algorithms
  - **Solution**: Provide 3rd party ATR algorithm developers with a way to develop ATR algorithms using pre-existing scans
    - Inspired by earlier efforts at ALERT for automated scoring (TO4)
- **Problem 2**: No standardized, open architecture method of comparing ATR algorithms
  - **Solution**: Provide a standardized way to benchmark algorithms
- **So What?**
  - Reduced barrier to entry for algorithm developers
  - Potentially speed up certification processes
  - Build confidence for adoption of 3rd party contributions



Open Threat Assessment Platform (OTAP)

- Develop and demonstrate an open architecture baggage screening prototype
- What is "Open"?
    - Standardized across vendors
    - Modular
    - Plug-and-play
- Allow 3rd Party Development of:
    - Hardware
    - Software
    - Algorithms
- Partner with security technology manufacturers



Test Environment Objectives

- Evaluate the performance of algorithms developed by third-parties using a common image database
    - Standardized metrics
    - Standardized timing
    - Programming language agnostic
- Be simple and easy for algorithm developers to use
    - No complex emulators
        - Emulators often need every component of the screening system implemented
    - Be highly flexible to support all conceivable algorithms
        - Variable input/output methods
        - Nontraditional approaches
- Enable iterative algorithm development

Design

Sandia National Laboratories

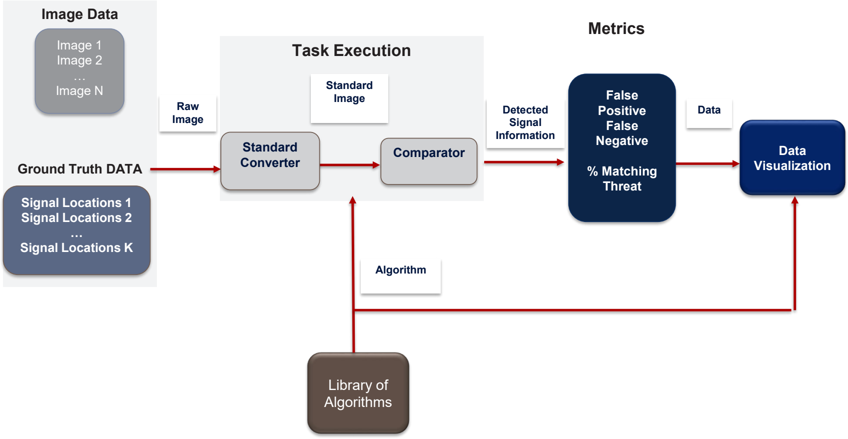


Image Data

Image 1
Image 2
…
Image N

Ground Truth DATA

Signal Locations 1
Signal Locations 2
…
Signal Locations K

Raw Image

Task Execution

Standard Image

Standard Converter

Comparator

Detected Signal Information

Metrics

False Positive
False Negative

% Matching Threat

Data

Data Visualization

Algorithm

Library of Algorithms

Example

Sandia National Laboratories

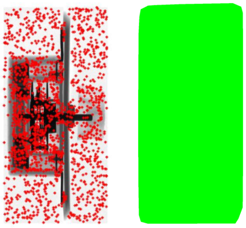
- Algorithms: SIFT and SURF
  - Popular computer vision algorithms
  - Identify features in images such as corners and changes in contrast
  - Only feature locations used for this example
- Database: Radiographs of various COTS components
- Ground Truth: Features extracted by Matlab SIFT

SIFT Features

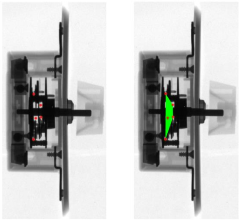
SURF Features

Example – Continued

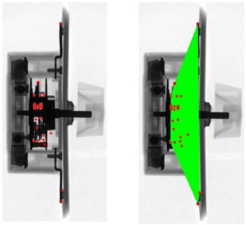
Ground Truth: 1948 points



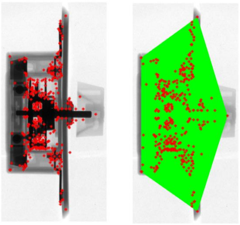
Algorithm 1: Use 5 Points



Algorithm 2: Use 25 Points



Algorithm 3: Use All Points (349)



Results

	Runtime	Average Recognition Metric
MatlabSURFAll.bat	00:18:44:12	0.6876
PythonSIFTAll.bat	01:11:46:01	0.8036

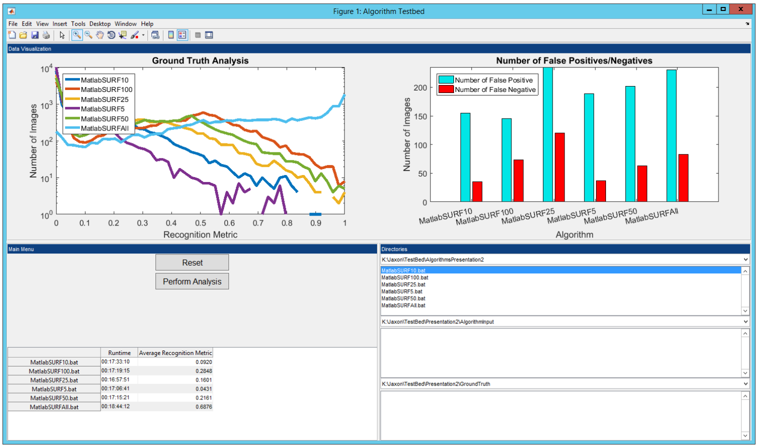
K:\Jaxon\TestBed\AlgorithmsPresentation1

MatlabSURFAll.bat
PythonSIFTAll.bat

K:\Jaxon\TestBed\Presentation1\AlgorithmInput

K:\Jaxon\TestBed\Presentation1\GroundTruth

Results



	Runtime	Average Recognition Metric
MatlabSURF10.bat	00:17:33:10	0.0920
MatlabSURF100.bat	00:17:19:15	0.2848
MatlabSURF25.bat	00:16:57:51	0.1601
MatlabSURF5.bat	00:17:06:41	0.0431
MatlabSURF50.bat	00:17:15:21	0.2161
MatlabSURFAll.bat	00:18:44:12	0.6876

K:\Jaxon\TestBed\AlgorithmsPresentation2

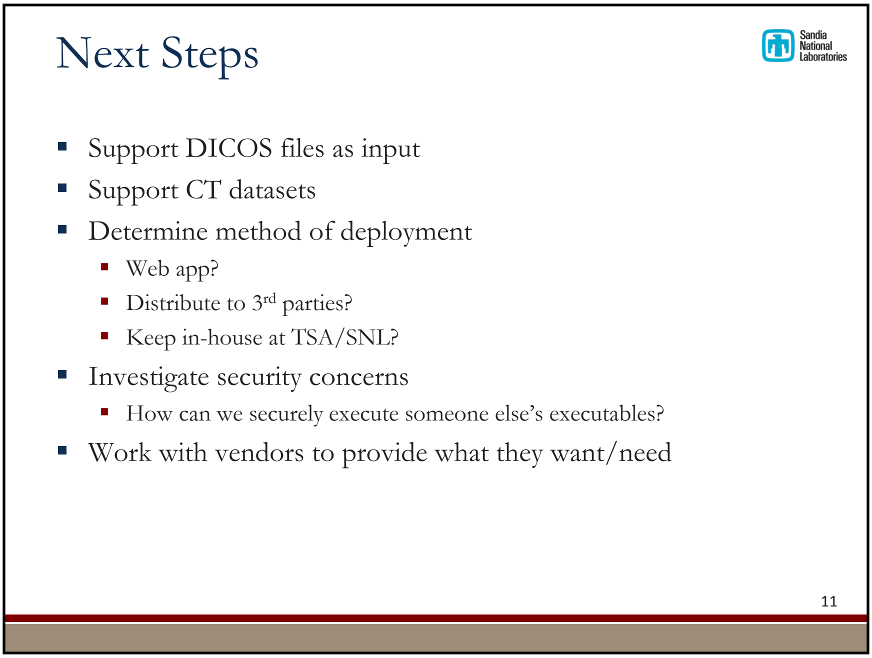
MatlabSURF10.bat
MatlabSURF100.bat
MatlabSURF25.bat
MatlabSURF5.bat
MatlabSURF50.bat
MatlabSURFAll.bat

K:\Jaxon\TestBed\Presentation2\AlgorithmInput

K:\Jaxon\TestBed\Presentation2\GroundTruth

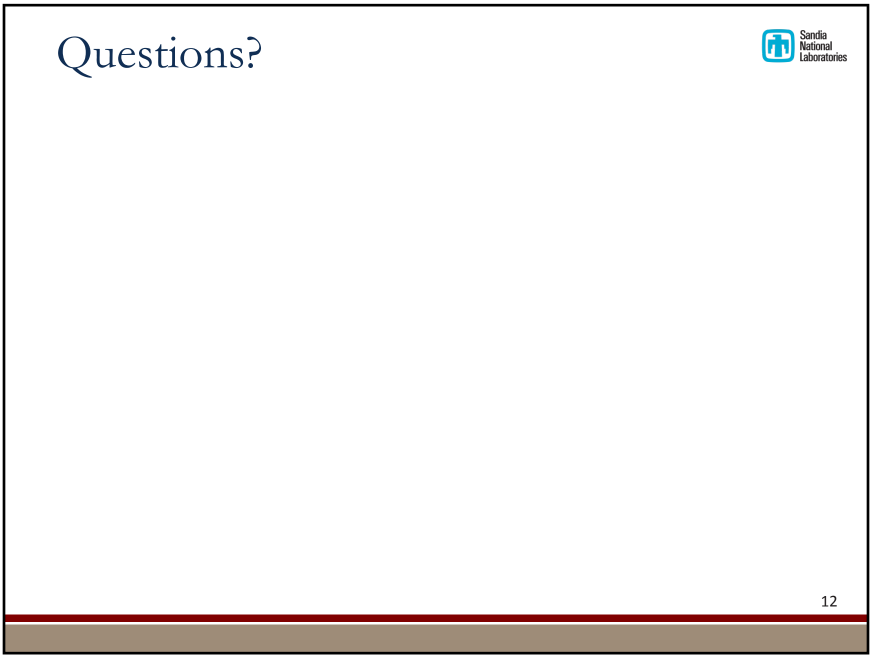
Conclusions

- Implemented a functional Prototype in Matlab
  - Likely supports algorithms written in any programming language
    - Tested with Python and Matlab
  - Generates standardized metrics for algorithms
  - Compares multiple algorithms or multiple versions of the same algorithm
  - Helps with rapid and iterative development of new algorithms with lower barrier to entry

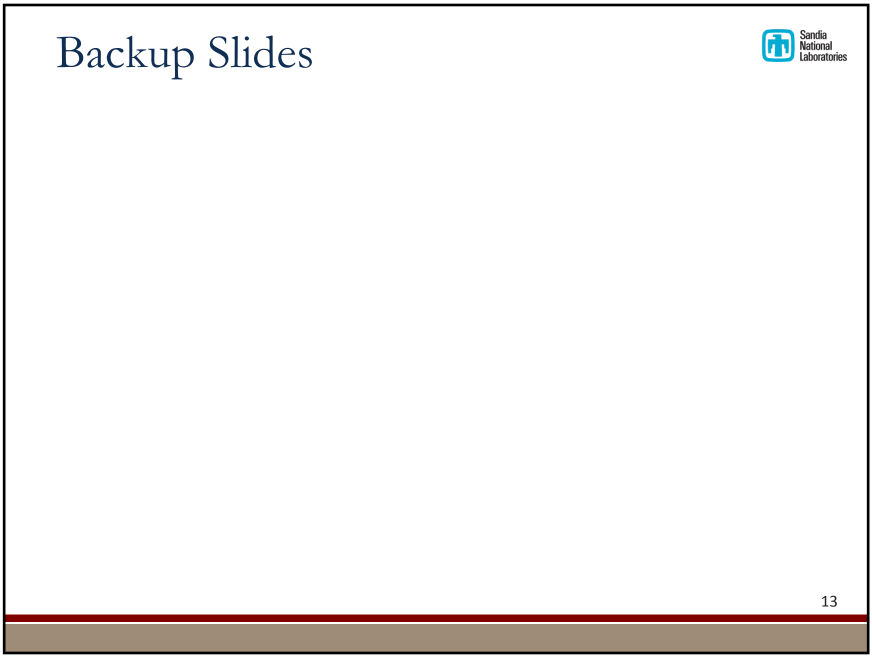


Next Steps

- Support DICOS files as input
- Support CT datasets
- Determine method of deployment
  - Web app?
  - Distribute to 3rd parties?
  - Keep in-house at TSA/SNL?
- Investigate security concerns
  - How can we securely execute someone else's executables?
- Work with vendors to provide what they want/need

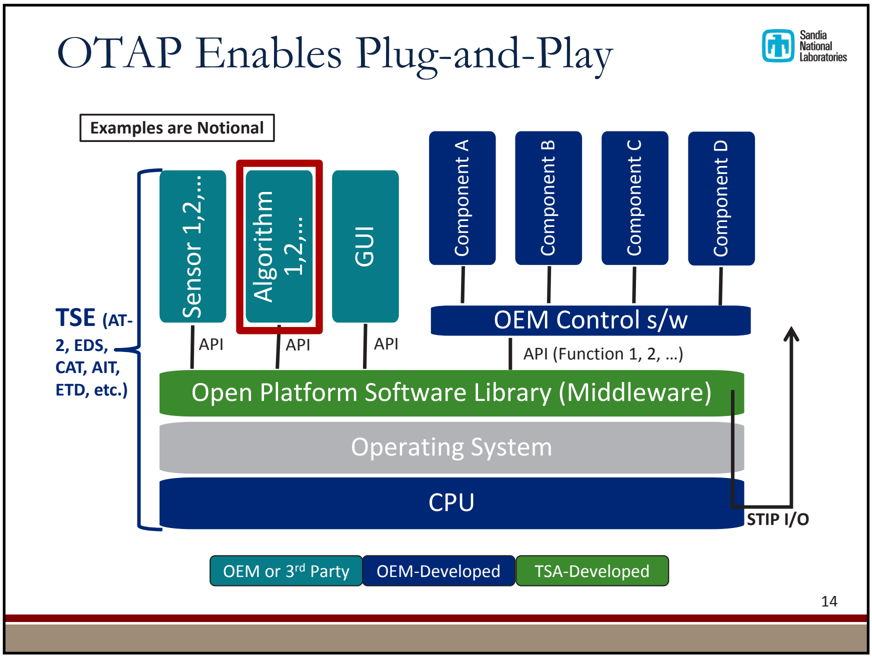


Questions?



Backup Slides

Sandia National Laboratories



OTAP Enables Plug-and-Play

Sandia National Laboratories

Examples are Notional

TSE (AT-2, EDS, CAT, AIT, ETD, etc.)

Sensor 1,2,…

Algorithm 1,2,…

GUI

API

API

API

Component A

Component B

Component C

Component D

OEM Control s/w

API (Function 1, 2, …)

Open Platform Software Library (Middleware)

Operating System

CPU

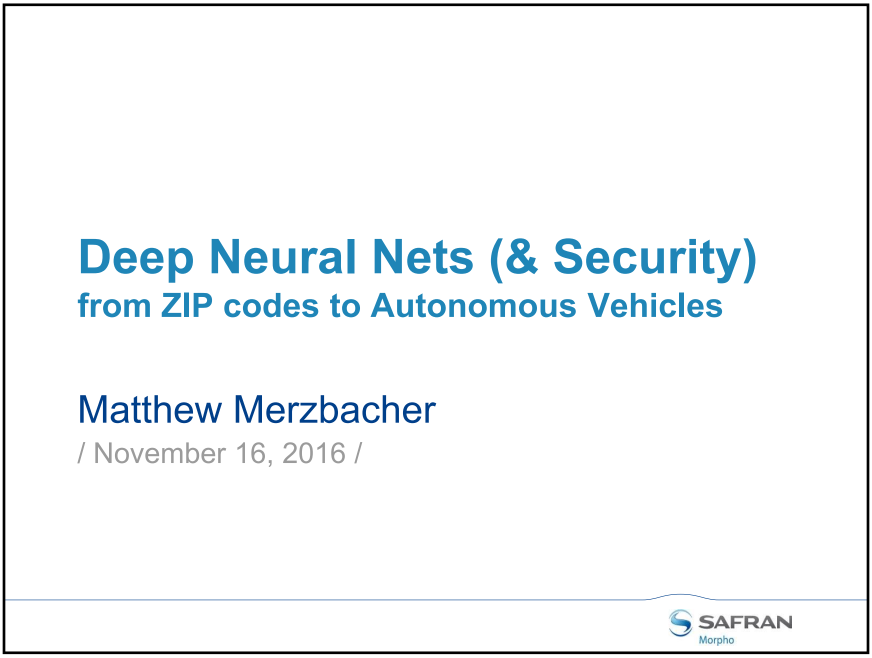
STIP I/O

OEM or 3rd Party

OEM-Developed

TSA-Developed

16.30 Matthew Merzbacher: Deep Learning Overview

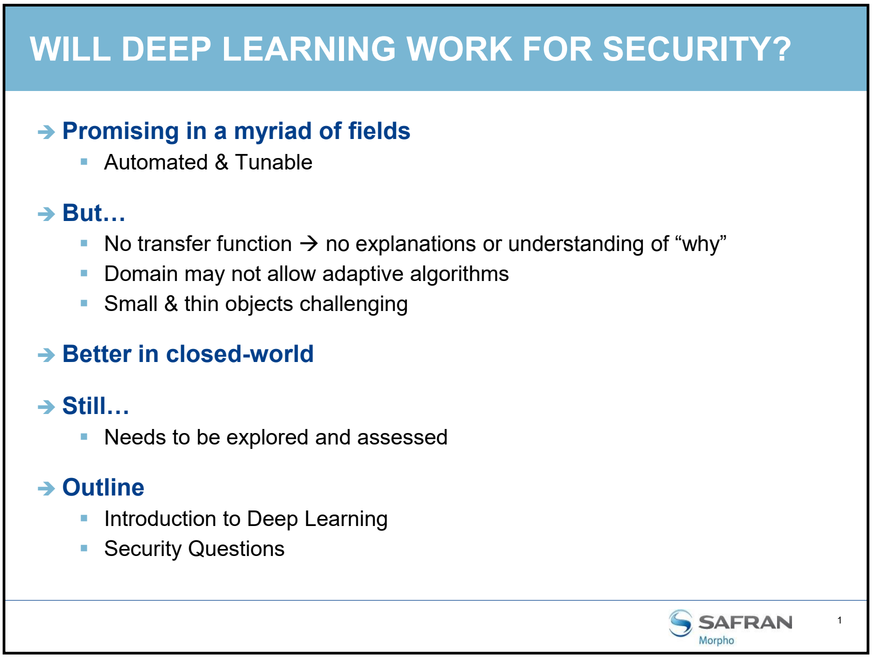


Deep Neural Nets (& Security)

from ZIP codes to Autonomous Vehicles

Matthew Merzbacher

/ November 16, 2016 /



WILL DEEP LEARNING WORK FOR SECURITY?

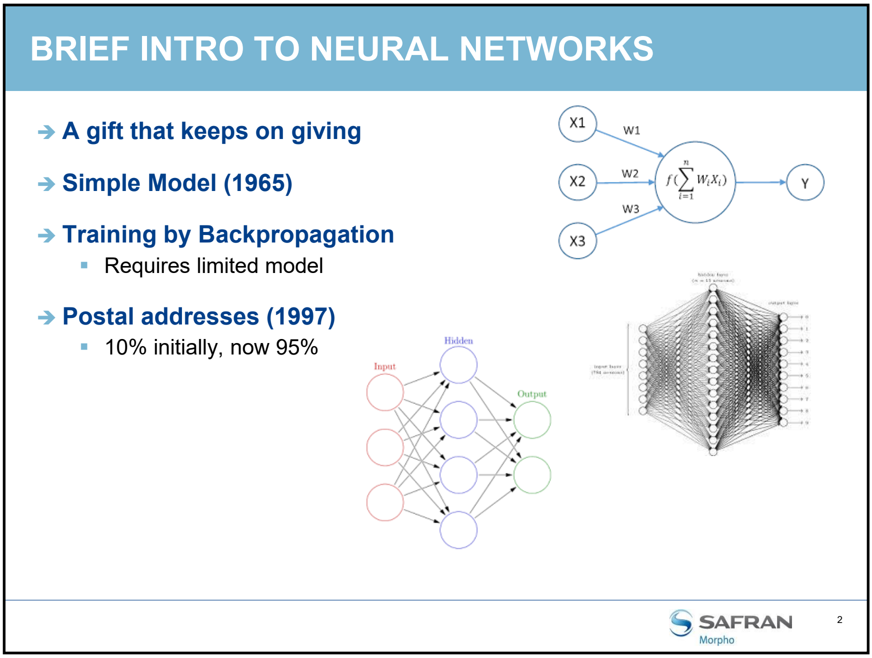
→ **Promising in a myriad of fields**
- Automated & Tunable

→ **But…**
- No transfer function → no explanations or understanding of “why”
- Domain may not allow adaptive algorithms
- Small & thin objects challenging

→ **Better in closed-world**

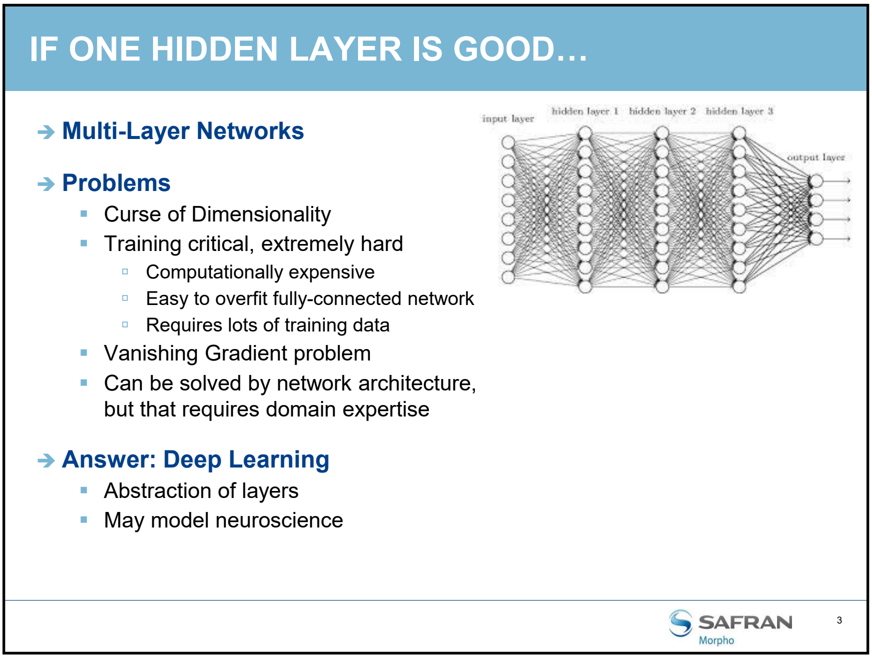
→ **Still…**
- Needs to be explored and assessed

→ **Outline**
- Introduction to Deep Learning
- Security Questions



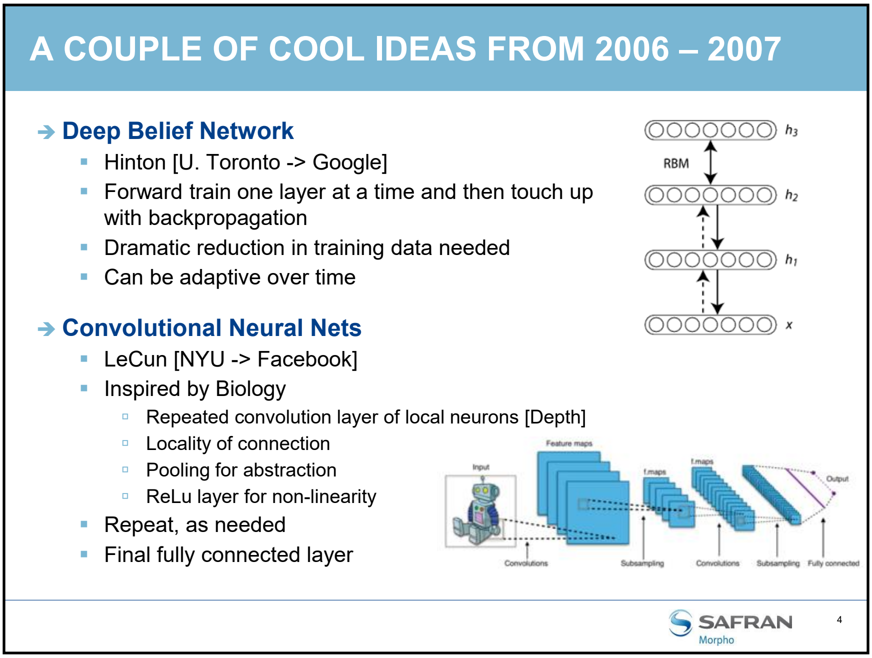
BRIEF INTRO TO NEURAL NETWORKS

- **A gift that keeps on giving**
- **Simple Model (1965)**
- **Training by Backpropagation**
  - Requires limited model
- **Postal addresses (1997)**
  - 10% initially, now 95%



IF ONE HIDDEN LAYER IS GOOD…

- **Multi-Layer Networks**
- **Problems**
  - Curse of Dimensionality
  - Training critical, extremely hard
    - Computationally expensive
    - Easy to overfit fully-connected network
    - Requires lots of training data
  - Vanishing Gradient problem
  - Can be solved by network architecture, but that requires domain expertise
- **Answer: Deep Learning**
  - Abstraction of layers
  - May model neuroscience



A COUPLE OF COOL IDEAS FROM 2006 – 2007

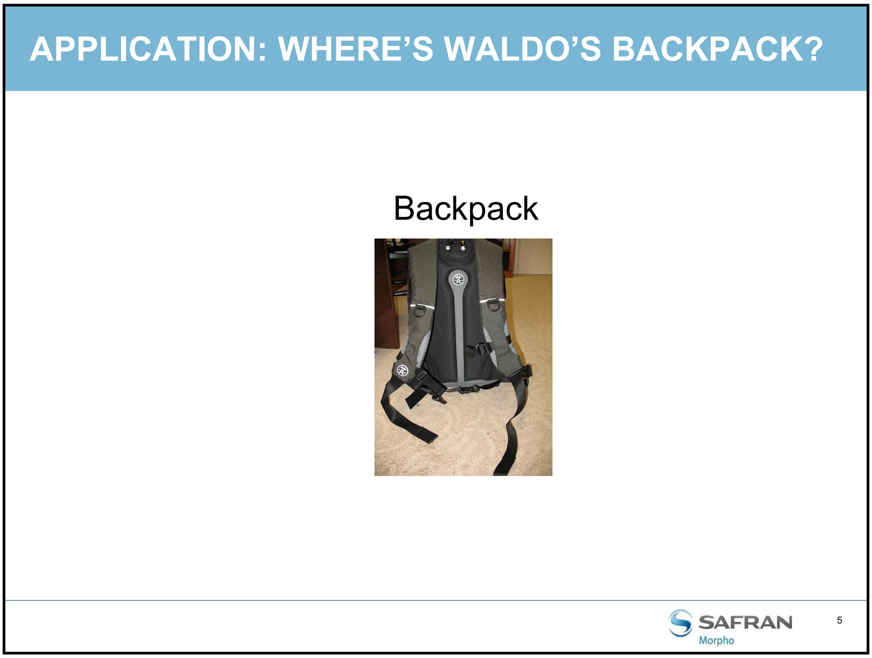
→ Deep Belief Network

- Hinton [U. Toronto -> Google]
- Forward train one layer at a time and then touch up with backpropagation
- Dramatic reduction in training data needed
- Can be adaptive over time

→ Convolutional Neural Nets

- LeCun [NYU -> Facebook]
- Inspired by Biology
  - Repeated convolution layer of local neurons [Depth]
  - Locality of connection
  - Pooling for abstraction
  - ReLu layer for non-linearity
- Repeat, as needed
- Final fully connected layer

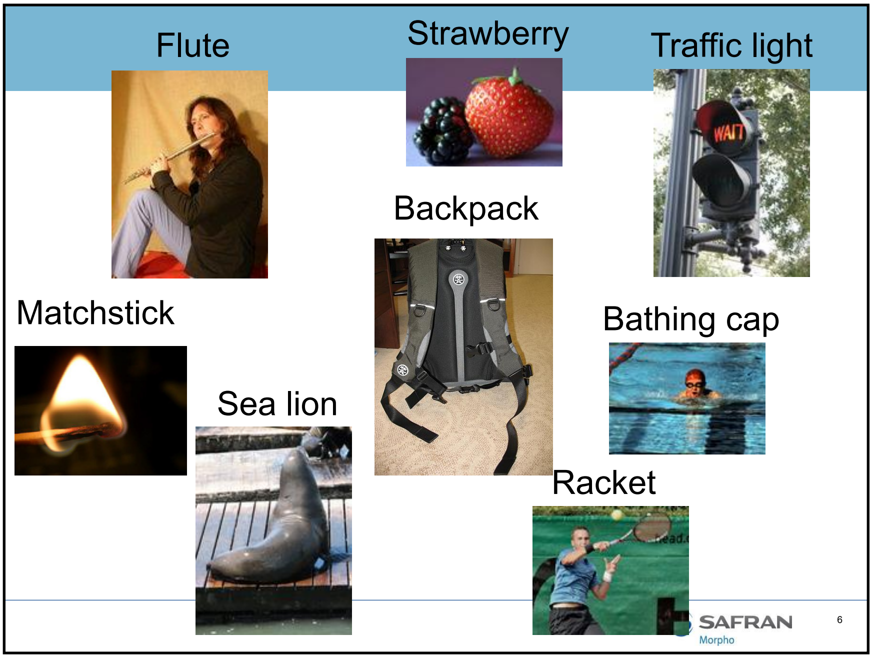
SAFRAN
Morpho



APPLICATION: WHERE'S WALDO'S BACKPACK?

Backpack

SAFRAN
Morpho



Flute

Strawberry

Traffic light

Backpack

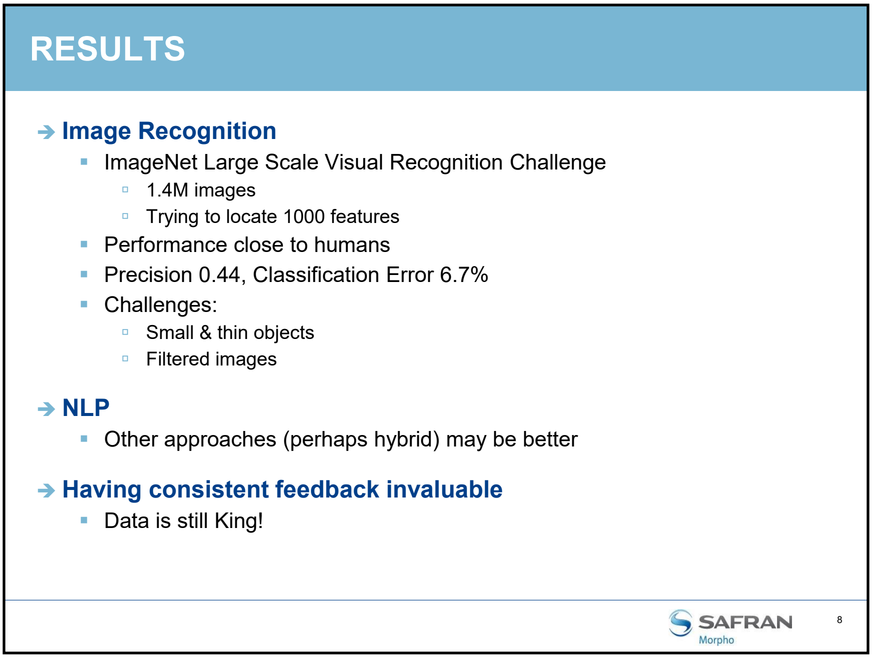
Matchstick

Bathing cap

Sea lion

Racket

SAFRAN
Morpho

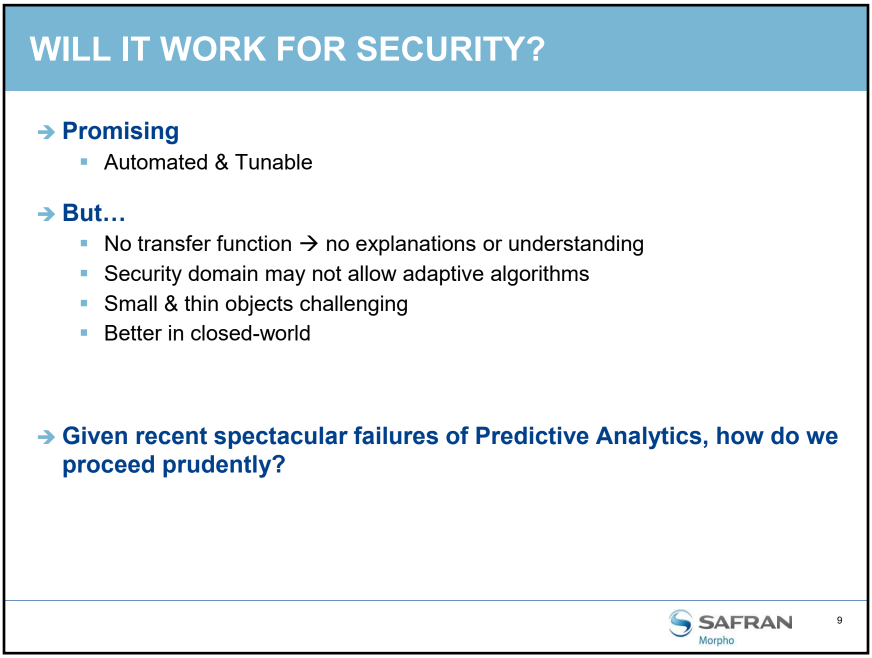


RESULTS

→ Image Recognition
- ImageNet Large Scale Visual Recognition Challenge
  - 1.4M images
  - Trying to locate 1000 features
- Performance close to humans
- Precision 0.44, Classification Error 6.7%
- Challenges:
  - Small & thin objects
  - Filtered images

→ NLP
- Other approaches (perhaps hybrid) may be better

→ Having consistent feedback invaluable
- Data is still King!

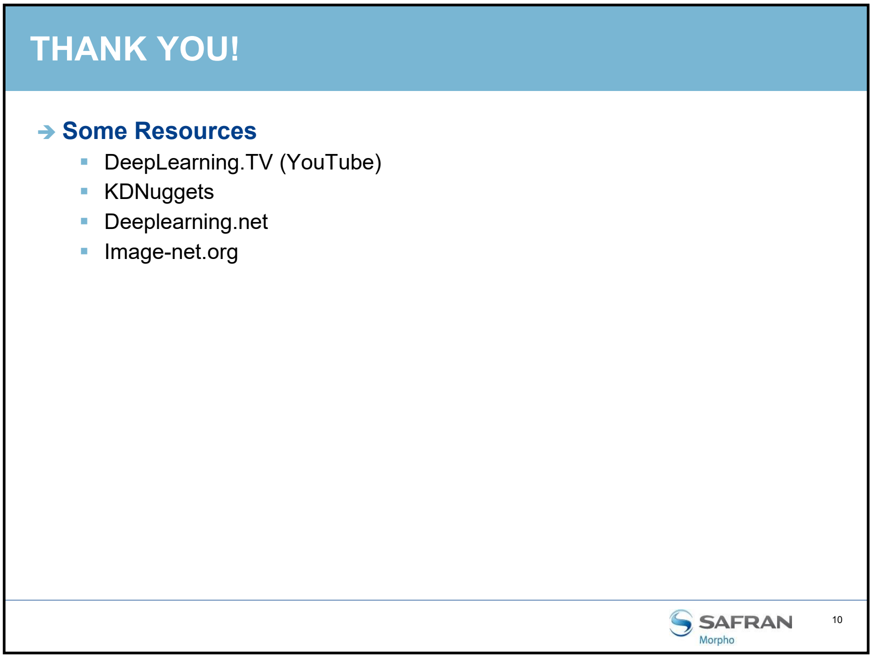


WILL IT WORK FOR SECURITY?

→ Promising
- Automated & Tunable

→ But…
- No transfer function → no explanations or understanding
- Security domain may not allow adaptive algorithms
- Small & thin objects challenging
- Better in closed-world

→ Given recent spectacular failures of Predictive Analytics, how do we proceed prudently?



THANK YOU!

→ **Some Resources**

- DeepLearning.TV (YouTube)
- KDNuggets
- Deeplearning.net
- Image-net.org

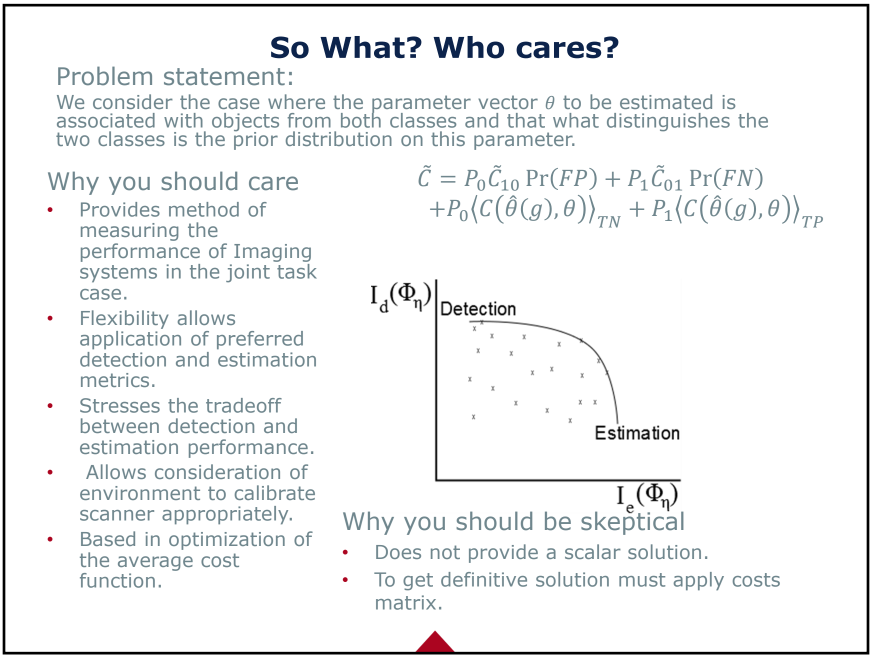
SAFRAN
Morpho

16.31 Johnathan Cushing: Estimation and Detection Information Tradoff for X-Ray System Optimization

Estimation and Detection Information Tradeoff for X-ray System Optimization

By: Johnathan B. Cushing, Dr. Eric W. Clarkson,
Sagar Mandava, and Dr. Ali Bilgin

THE UNIVERSITY
OF ARIZONA



So What? Who cares?

Problem statement:

We consider the case where the parameter vector θ to be estimated is associated with objects from both classes and that what distinguishes the two classes is the prior distribution on this parameter.

Why you should care

- Provides method of measuring the performance of Imaging systems in the joint task case.
- Flexibility allows application of preferred detection and estimation metrics.
- Stresses the tradeoff between detection and estimation performance.
- Allows consideration of environment to calibrate scanner appropriately.
- Based in optimization of the average cost function.

$$\tilde{C} = P_0\tilde{C}_{10}\Pr(FP) + P_1\tilde{C}_{01}\Pr(FN)$$
$$+P_0\langle C(\hat{\theta}(g),\theta)\rangle_{TN} + P_1\langle C(\hat{\theta}(g),\theta)\rangle_{TP}$$

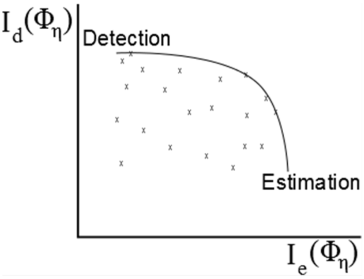
Why you should be skeptical

- Does not provide a scalar solution.
- To get definitive solution must apply costs matrix.

How does it work?

EDIT Curve[1]:

Average Cost: $C = P_0[C_{10}\,\mathrm{Pr}(FP) +$

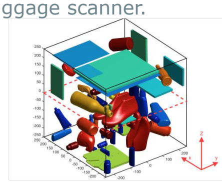


Two methods of calculation

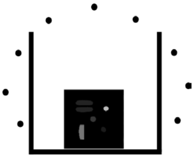
- Can calculate this directly by finding the maximizing parameter vector ϕ.
- Could create a number of systems and treat the convex hull of these point as an approximated EDIT.

So What? Have you done anything with EDIT?

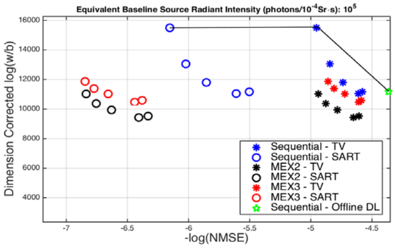
- Used a series of stochastically generated bags to test the performance of a fixed geometry baggage scanner.



Stochastic Bag



Fixed geometry slice scans

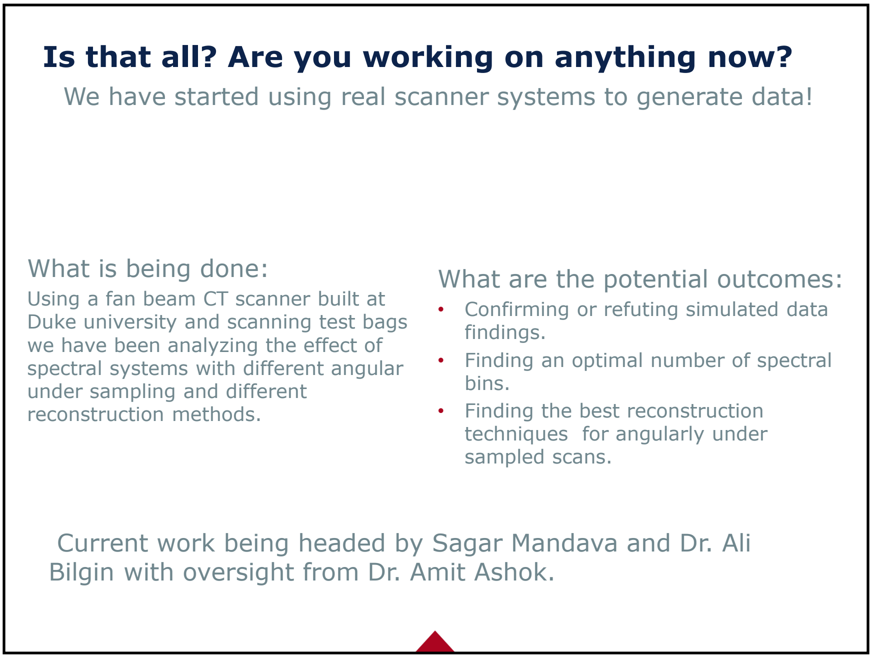


Example of curve generated.

- Method used whereby the convex hull of the data generated sets the EDIT curve

Unique Conclusions

- At low SNR Sequential scanning outperforms multiplexed scanning.
- Spectral binning reduces estimation performance but increases detection performance at these SNR levels.



Is that all? Are you working on anything now?

We have started using real scanner systems to generate data!

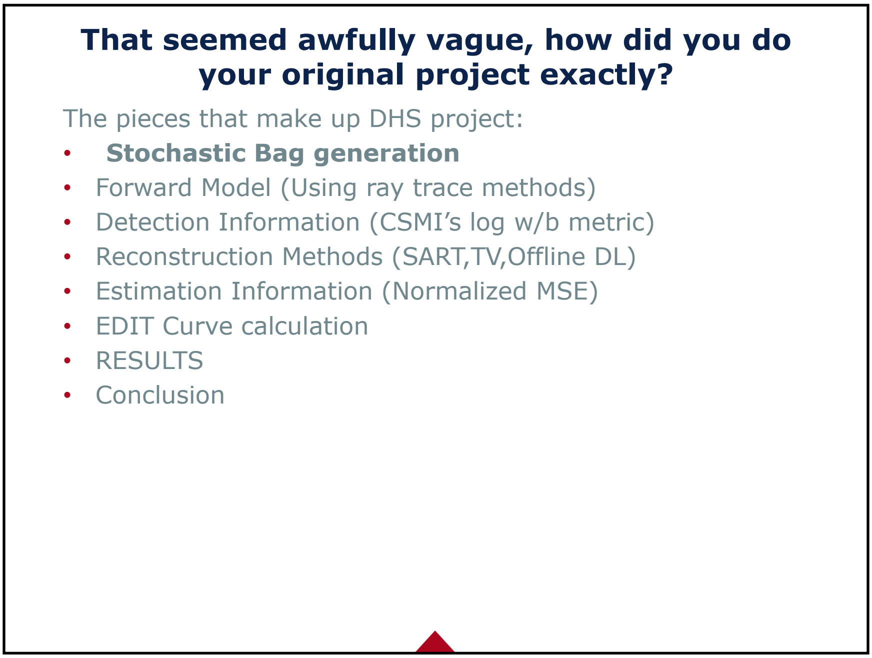
What is being done:

Using a fan beam CT scanner built at Duke university and scanning test bags we have been analyzing the effect of spectral systems with different angular under sampling and different reconstruction methods.

What are the potential outcomes:

- Confirming or refuting simulated data findings.
- Finding an optimal number of spectral bins.
- Finding the best reconstruction techniques for angularly under sampled scans.

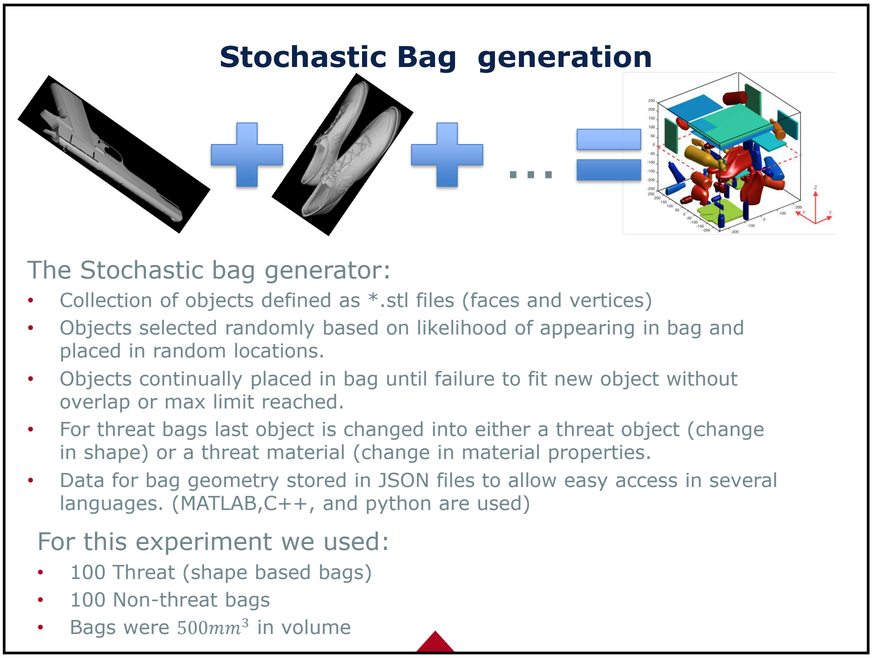
Current work being headed by Sagar Mandava and Dr. Ali Bilgin with oversight from Dr. Amit Ashok.



That seemed awfully vague, how did you do your original project exactly?

The pieces that make up DHS project:

- **Stochastic Bag generation**
- Forward Model (Using ray trace methods)
- Detection Information (CSMI's log w/b metric)
- Reconstruction Methods (SART,TV,Offline DL)
- Estimation Information (Normalized MSE)
- EDIT Curve calculation
- RESULTS
- Conclusion



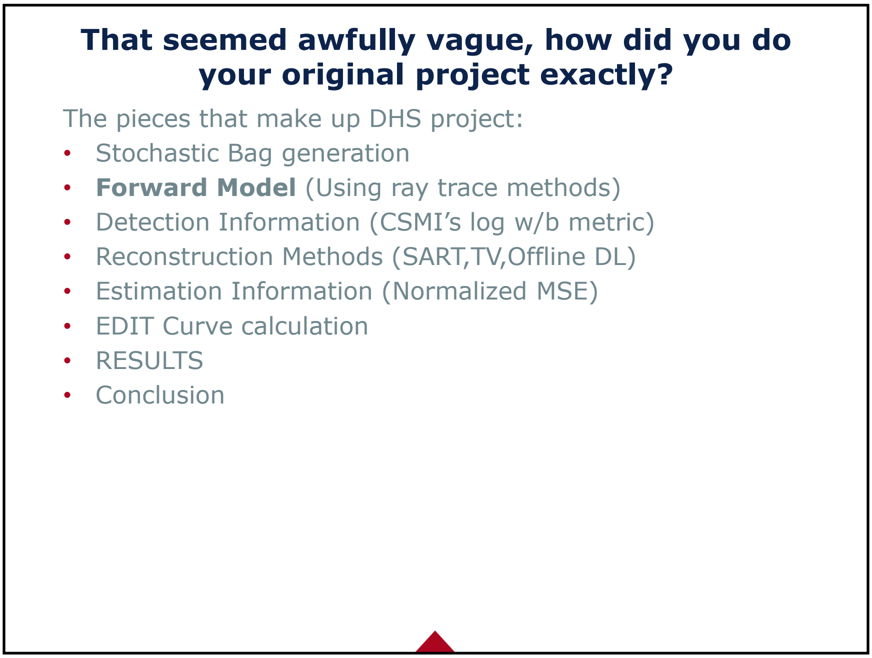
Stochastic Bag generation

The Stochastic bag generator:

- Collection of objects defined as *.stl files (faces and vertices)
- Objects selected randomly based on likelihood of appearing in bag and placed in random locations.
- Objects continually placed in bag until failure to fit new object without overlap or max limit reached.
- For threat bags last object is changed into either a threat object (change in shape) or a threat material (change in material properties.
- Data for bag geometry stored in JSON files to allow easy access in several languages. (MATLAB,C++, and python are used)

For this experiment we used:

- 100 Threat (shape based bags)
- 100 Non-threat bags
- Bags were $500mm^3$ in volume



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How do you run your virtual bags through your virtual machine?

- The ray trace based method defined source location and cavity geometry. The source strength and scan time was then used to generate a number of rays in random direction within the source emission output angle.
- A GPU based algorithm then propagated each ray from its source to the first object of contact. At this point scattering and absorption effects could be calculated
- Once a path from source to detector was traced the total absorption effects of materials along the path were then used to adjust source ray strength.

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What detection metric did you use for EDIT?

CS Mutual information used for detection information[4]:

CSMI measures the divergence between 2 pdfs. equivalent to $\log\left(\frac{w}{b}\right)$.

- $I_{CS}(\vec{g}, C) = -\frac{1}{2} log \frac{\left[\sum_C \int [p(g|C)p(C)][p(g)p(C)]dg\right]^2}{\sum_c \int p^2(g|C)p^2(C)dg \cdot \sum_C \int p^2(g)p^2(C)dg} = \frac{1}{2}\left(\log(2) + \log\left(\frac{w}{w+b}\right)\right)$

This expression can then be simplified further using a modified Bessel function. The end result is a quick to calculate metric that for our systems was shown to correlate with Pe (Probability of error). See reference 4 for more information.

Remember EDIT does not require the use of these metrics. It would be best to employ the same detection algorithm you plan to use in the field for analysis.

That seemed awfully vague, how did you do your original project exactly?

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- Conclusion

You had to of created images at some point.

Our detection method is accomplished entirely in the image space of the system. This means that we did not need to reconstruct in order to detect. For estimation though, not only must a gold standard be created but a reconstruction of data must also be performed.

Gold standard:

- To create a gold standard a voxelizer program was developed which took the parsed data of a json file and generated a 3D matrix containing the absorption values at each location.

Reconstruction methods:

We compared 3 different reconstruction techniques.

SART- Simultaneous Algebraic Reconstruction Technique

$$x^{k+1} = x^k + \lambda_k A^T (y - Ax)$$

Iterative based reconstruction technique.

TV- Total variation technique

$$\hat{x} = \underset{x}{\operatorname{argmin}} \|y - Ax\|_2 + \lambda TV(x)$$

Offline DL- Dictionary Learning

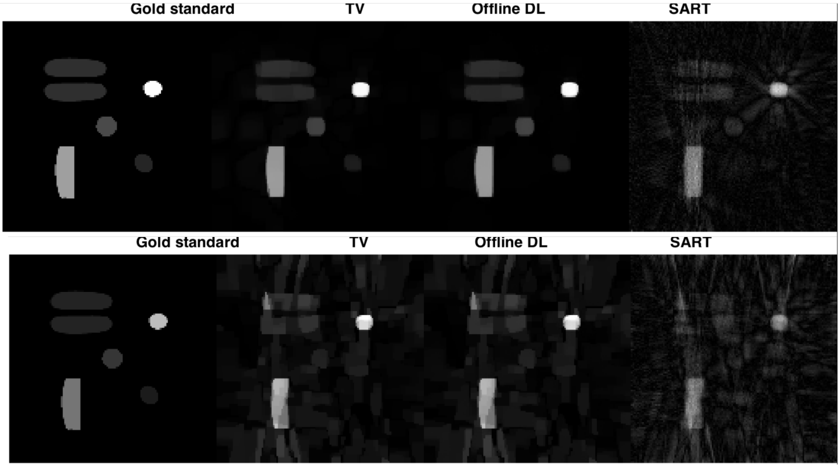
$$\hat{x} = \underset{x}{\operatorname{argmin}} \|y - Ax\|_2 + \lambda TV(x) \ s.t.$$
$$\|DA - Px\| < \sigma, \|\alpha_i\|_0 < \tau$$

Equivalently iterate between:

$$\hat{x} = \underset{x}{\operatorname{argmin}} \|y - Ax\|_2 + \lambda TV(x)$$
$$A_{n+1} = OMP(A_n, x_n, \tau), \qquad x_{n+1} = P^{-1}(D, A_{n+1})$$

What do these reconstructions look like.

Reconstructions are slice by slice.



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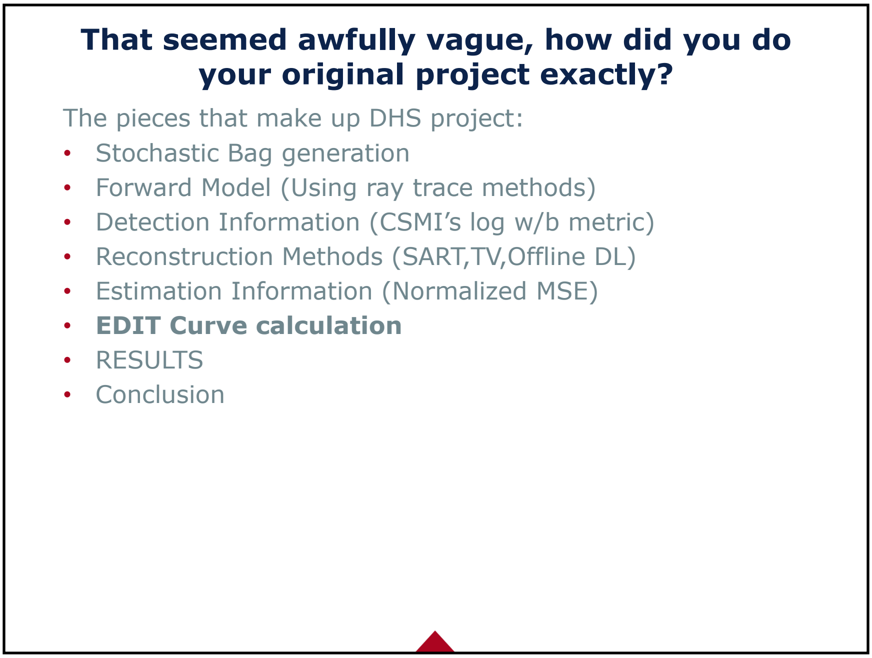
NMSE

- *Normalized mean square error. Allows for unitless MSE we can then take the log of to compare with our detection metric.*

$$NMSE = \frac{1}{N}\sum_i \frac{(P_i - M_i)^2}{\bar{P}\bar{M}}$$



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- **EDIT Curve calculation**
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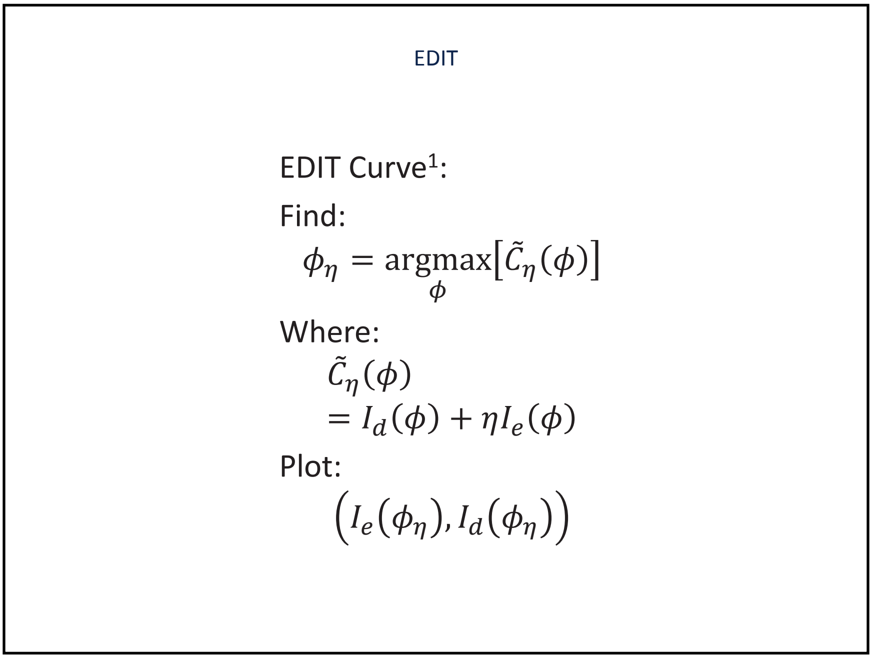
- Conclusion



EDIT

EDIT Curve[1]:

Find:

$$\phi_\eta = \underset{\phi}{\operatorname{argmax}}\left[\tilde{C}_\eta(\phi)\right]$$

Where:

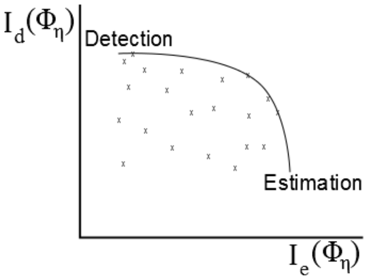
$$\tilde{C}_\eta(\phi) \\ = I_d(\phi) + \eta I_e(\phi)$$

Plot:

$$\left(I_e(\phi_\eta), I_d(\phi_\eta)\right)$$

EDIT

- Method 1:
- Can calculate this directly by finding the maximizing parameter vector ϕ.



- Method 2:
- Could create a number of systems and treat the convex hull of these point as an approximated EDIT.

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- Estimation Information (Normalized MSE)
- EDIT Curve calculation
- **RESULTS**
- Conclusion

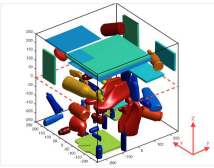
Stochastic Bag

Stochastic bag generator[1] used to create randomly filled 3D luggage objects[2].

100 threat bags

100 non-threat bags

$500mm^3$ bag volume



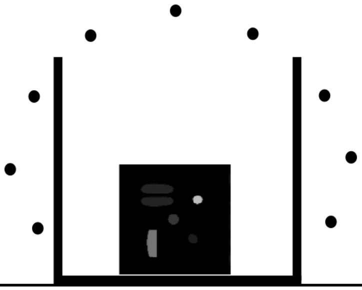
Forward Model

GPU-based ray-tracing method[3].

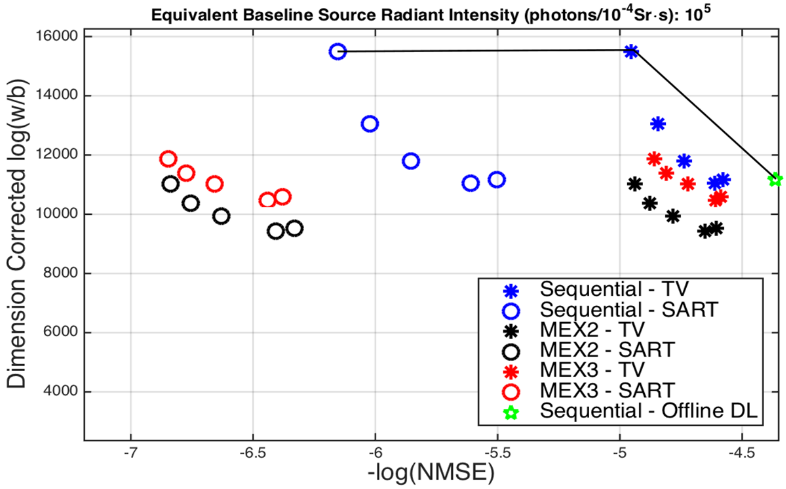
Multi-source, fixed gantry, rectangular CT system.

16,8,4,2,1 spectral bin scans used.

Sequential and Multiplexed Scanning

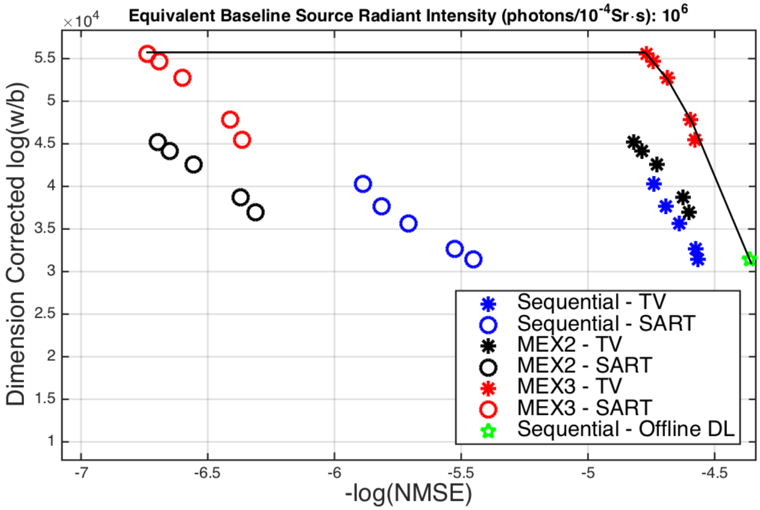


EDIT Curves



Low SNR Region

EDIT Curves



High SNR Region

Conclusion

- EDIT curves can be used to make design decisions.
- At low SNR Sequential scanning outperforms multiplexed scanning.
- Spectral binning reduces estimation performance but increases detection performance at these SNR levels.

Future Work

- Offline DL provides the best estimation but is computational intensive compared to simpler methods.
- Adjust EDIT curve to consider operator performance with estimation information.
- Use EDIT to determine the best tunable system parameters.
- Spectral binning reduces estimation performance but increases detection performance at these SNR levels.

Acknowledgments

National Institute of Health

Department of Homeland Security

University of Arizona TRIF scholarship

SMART Scholarship

SPAWAR SSC Pacific

References

[1] E. Clarkson, “*Figures of merit for optimizing imaging systems on joint estimation/detection tasks*,” in ADIX,9847-27 (2016).

[2] D. Coccarelli, e.a., “*Information-theoretic analysis of x-ray scatter and phase architectures for anomaly detection*,” in ADIX,9847-10 (2016).

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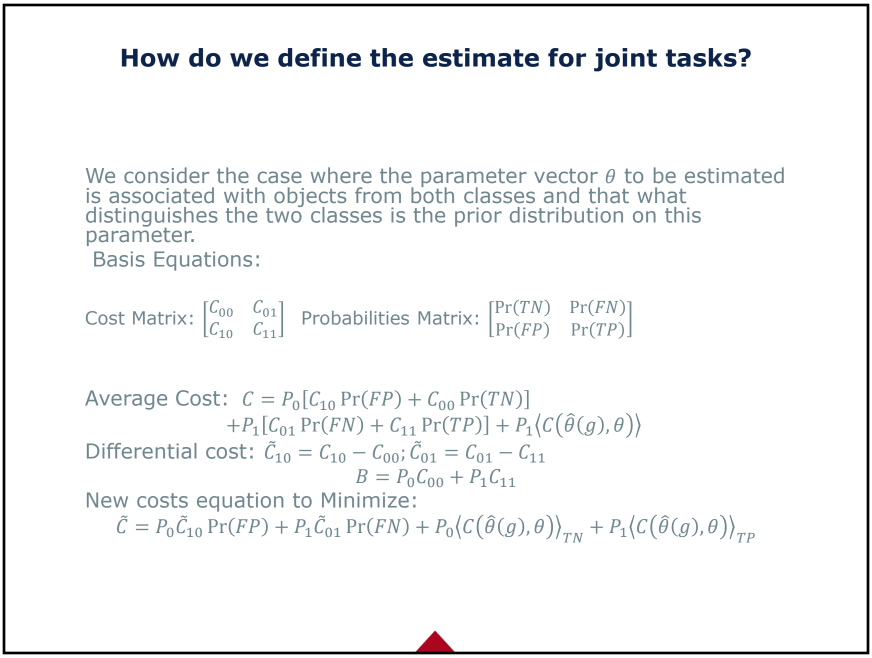


How do we define the estimate for joint tasks?

We consider the case where the parameter vector θ to be estimated is associated with objects from both classes and that what distinguishes the two classes is the prior distribution on this parameter.

Basis Equations:

Cost Matrix: $\begin{bmatrix} C_{00} & C_{01} \\ C_{10} & C_{11} \end{bmatrix}$ Probabilities Matrix: $\begin{bmatrix} \Pr(TN) & \Pr(FN) \\ \Pr(FP) & \Pr(TP) \end{bmatrix}$

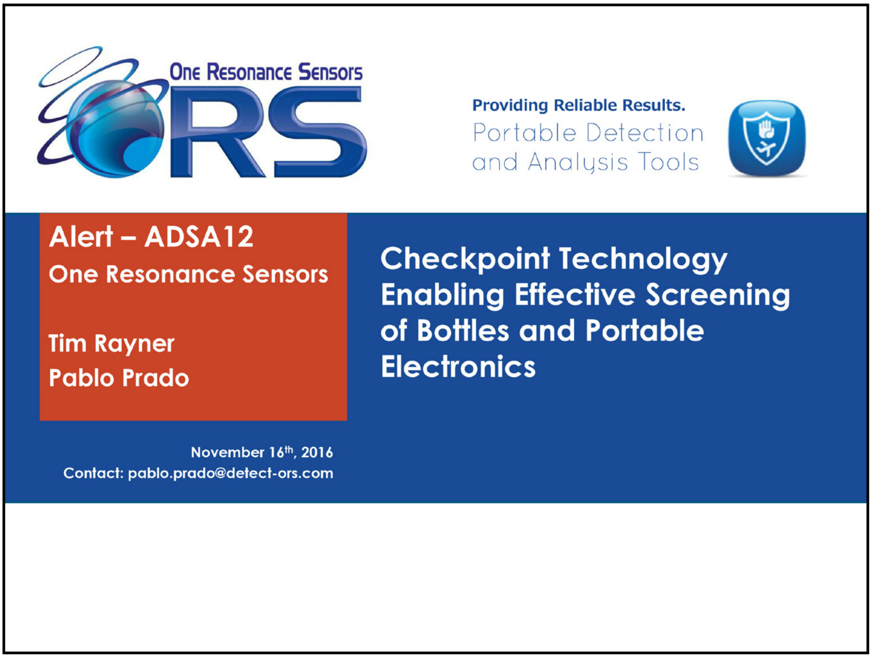
Average Cost: $C = P_0[C_{10}\Pr(FP) + C_{00}\Pr(TN)]$
$+P_1[C_{01}\Pr(FN) + C_{11}\Pr(TP)] + P_1\langle C(\hat{\theta}(g),\theta)\rangle$

Differential cost: $\tilde{C}_{10} = C_{10} - C_{00}; \tilde{C}_{01} = C_{01} - C_{11}$
$B = P_0C_{00} + P_1C_{11}$

New costs equation to Minimize:

$$\tilde{C} = P_0\tilde{C}_{10}\Pr(FP) + P_1\tilde{C}_{01}\Pr(FN) + P_0\langle C(\hat{\theta}(g),\theta)\rangle_{TN} + P_1\langle C(\hat{\theta}(g),\theta)\rangle_{TP}$$

16.32 Tim Rayner & Pablo Prado: Integration of Bottled Liquid Scanners and Electronic Scanners in the Innovation Lanes



One Resonance Sensors
ORS

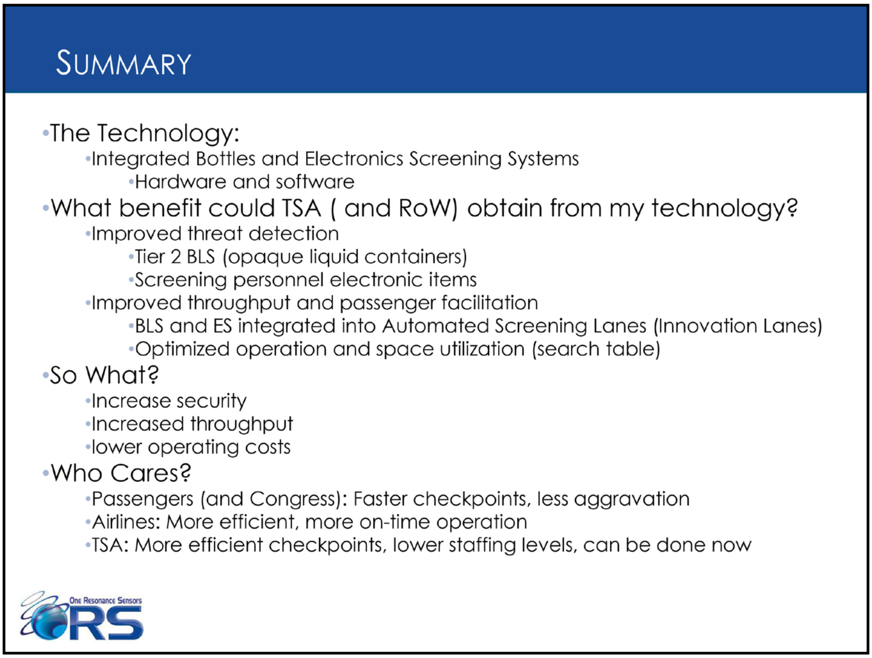
Providing Reliable Results.
Portable Detection
and Analysis Tools

Alert – ADSA12
One Resonance Sensors

Tim Rayner
Pablo Prado

Checkpoint Technology Enabling Effective Screening of Bottles and Portable Electronics

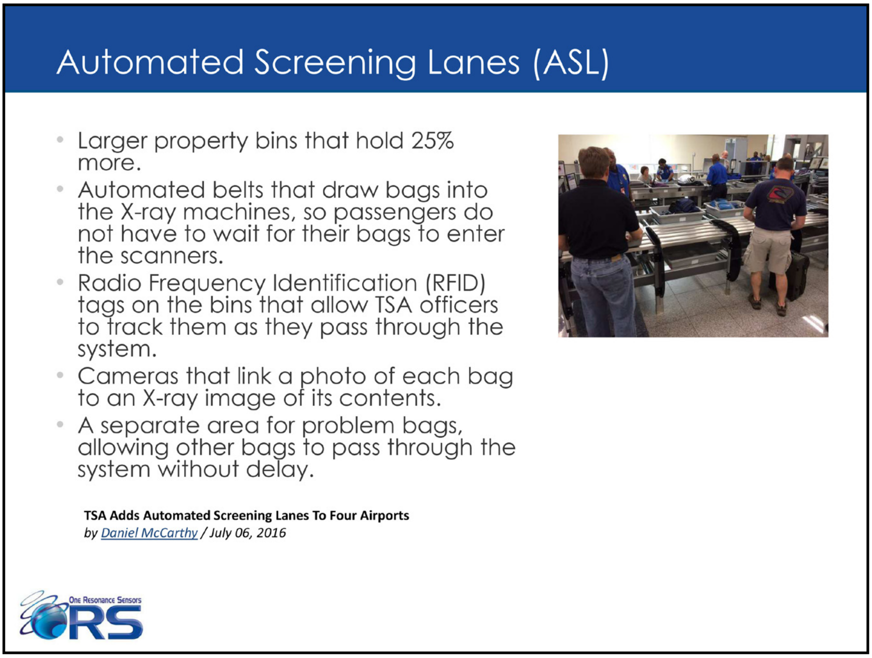
November 16th, 2016
Contact: pablo.prado@detect-ors.com



SUMMARY

- The Technology:
  - Integrated Bottles and Electronics Screening Systems
    - Hardware and software
- What benefit could TSA (and RoW) obtain from my technology?
  - Improved threat detection
    - Tier 2 BLS (opaque liquid containers)
    - Screening personnel electronic items
  - Improved throughput and passenger facilitation
    - BLS and ES integrated into Automated Screening Lanes (Innovation Lanes)
    - Optimized operation and space utilization (search table)
- So What?
  - Increase security
  - Increased throughput
  - lower operating costs
- Who Cares?
  - Passengers (and Congress): Faster checkpoints, less aggravation
  - Airlines: More efficient, more on-time operation
  - TSA: More efficient checkpoints, lower staffing levels, can be done now

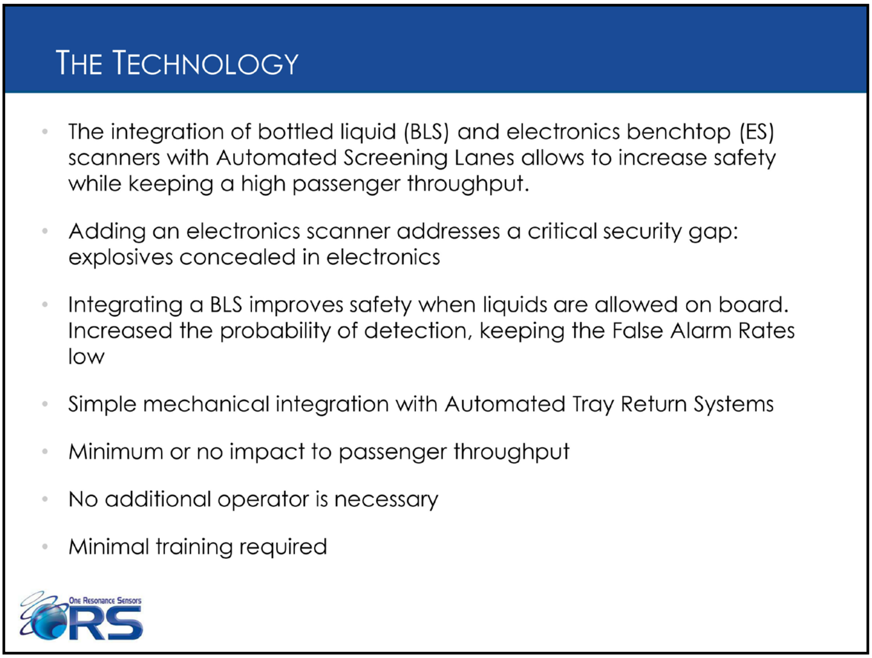
One Resonance Sensors
ORS



Automated Screening Lanes (ASL)

- Larger property bins that hold 25% more.
- Automated belts that draw bags into the X-ray machines, so passengers do not have to wait for their bags to enter the scanners.
- Radio Frequency Identification (RFID) tags on the bins that allow TSA officers to track them as they pass through the system.
- Cameras that link a photo of each bag to an X-ray image of its contents.
- A separate area for problem bags, allowing other bags to pass through the system without delay.

TSA Adds Automated Screening Lanes To Four Airports
by Daniel McCarthy / July 06, 2016



THE TECHNOLOGY

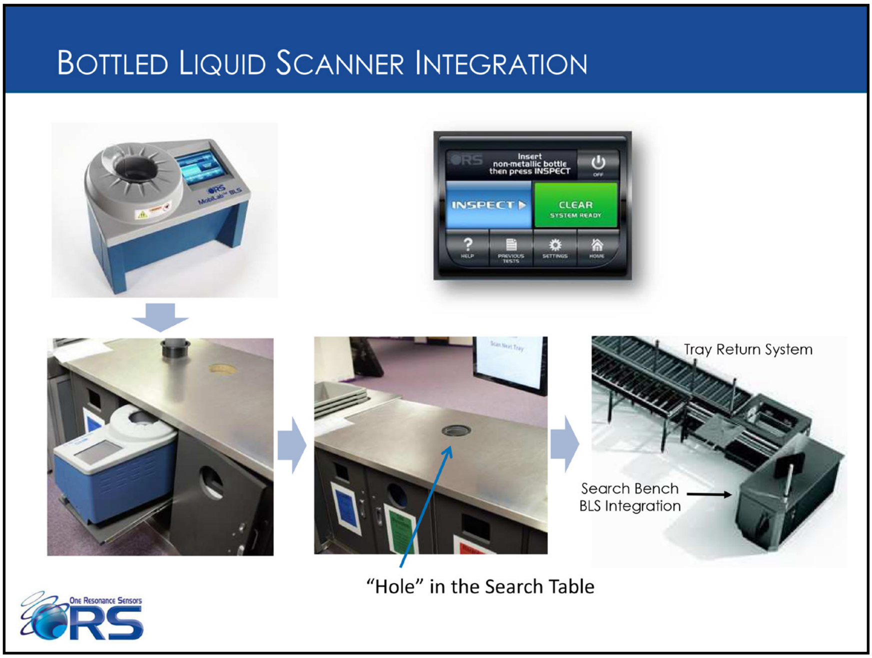
- The integration of bottled liquid (BLS) and electronics benchtop (ES) scanners with Automated Screening Lanes allows to increase safety while keeping a high passenger throughput.
- Adding an electronics scanner addresses a critical security gap: explosives concealed in electronics
- Integrating a BLS improves safety when liquids are allowed on board. Increased the probability of detection, keeping the False Alarm Rates low
- Simple mechanical integration with Automated Tray Return Systems
- Minimum or no impact to passenger throughput
- No additional operator is necessary
- Minimal training required

TECHNOLOGY SUMMARY

Integration of benchtop scanners with
Automated Tray Return Systems

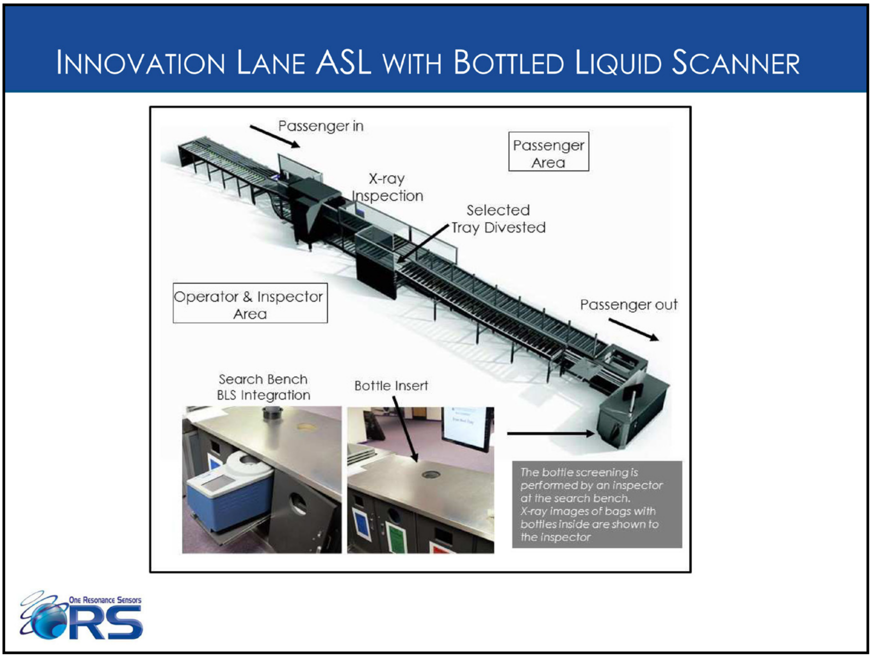
Benchtop Scanners

- Quadrupole Resonance-based portable electronics screening: detects explosives concealed in phones, tablets and other electronics. Recently evaluated by DHS and UK DSTL. Trials in Doha and TelAviv
- NMR-based screening of bottled liquids: improves efficiencies to ban to travel with liquids. ECAC endorsed. Installation in Spain. Trials in Doha, Luton, Narita. Proposal for live trials in the US, Innovation Lanes integrated into a ASL



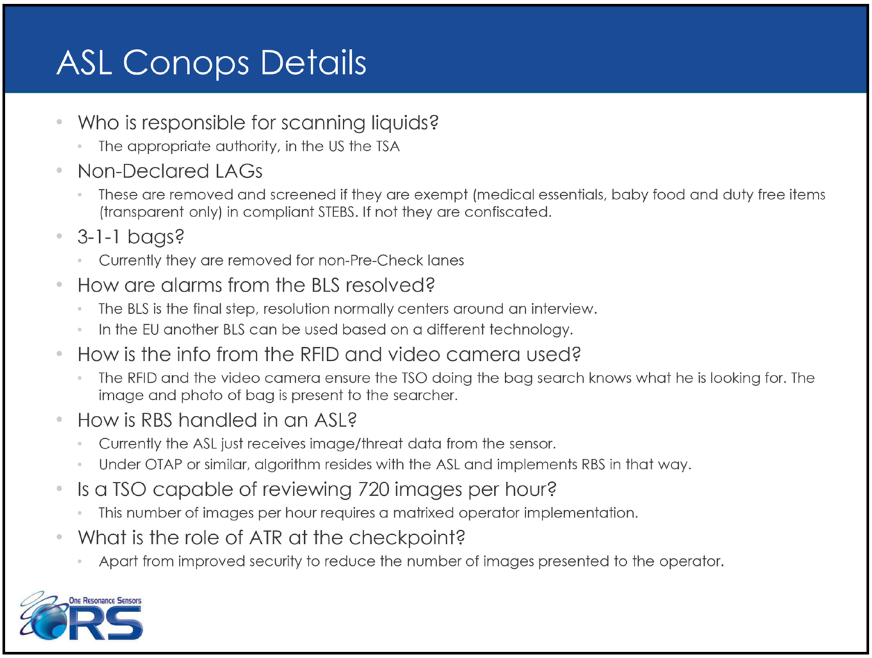
BOTTLED LIQUID SCANNER INTEGRATION

“Hole” in the Search Table



INNOVATION LANE ASL WITH BOTTLED LIQUID SCANNER

The bottle screening is performed by an inspector at the search bench. X-ray images of bags with bottles inside are shown to the inspector

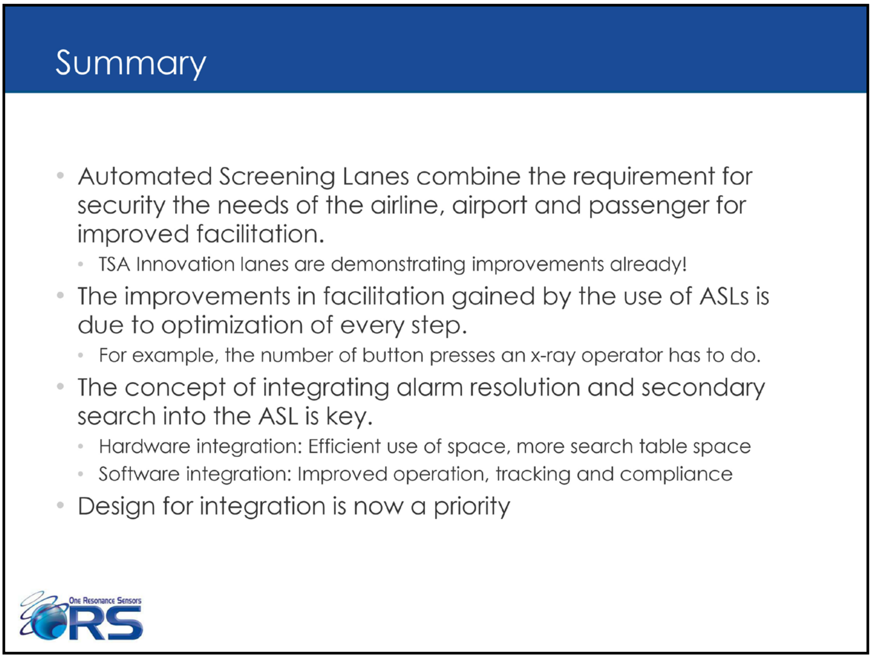


ASL Conops Details

- Who is responsible for scanning liquids?
  - The appropriate authority, in the US the TSA
- Non-Declared LAGs
  - These are removed and screened if they are exempt (medical essentials, baby food and duty free items (transparent only) in compliant STEBS. If not they are confiscated.
- 3-1-1 bags?
  - Currently they are removed for non-Pre-Check lanes
- How are alarms from the BLS resolved?
  - The BLS is the final step, resolution normally centers around an interview.
  - In the EU another BLS can be used based on a different technology.
- How is the info from the RFID and video camera used?
  - The RFID and the video camera ensure the TSO doing the bag search knows what he is looking for. The image and photo of bag is present to the searcher.
- How is RBS handled in an ASL?
  - Currently the ASL just receives image/threat data from the sensor.
  - Under OTAP or similar, algorithm resides with the ASL and implements RBS in that way.
- Is a TSO capable of reviewing 720 images per hour?
  - This number of images per hour requires a matrixed operator implementation.
- What is the role of ATR at the checkpoint?
  - Apart from improved security to reduce the number of images presented to the operator.

ELECTRONICS SCANNER INTEGRATION: CONCEPT

Integrated with Checkpoint Search Bench



Summary

- Automated Screening Lanes combine the requirement for security the needs of the airline, airport and passenger for improved facilitation.
  - TSA Innovation lanes are demonstrating improvements already!
- The improvements in facilitation gained by the use of ASLs is due to optimization of every step.
  - For example, the number of button presses an x-ray operator has to do.
- The concept of integrating alarm resolution and secondary search into the ASL is key.
  - Hardware integration: Efficient use of space, more search table space
  - Software integration: Improved operation, tracking and compliance
- Design for integration is now a priority

16.33 Carey Rappaport: AIT Opportunities and Challenges

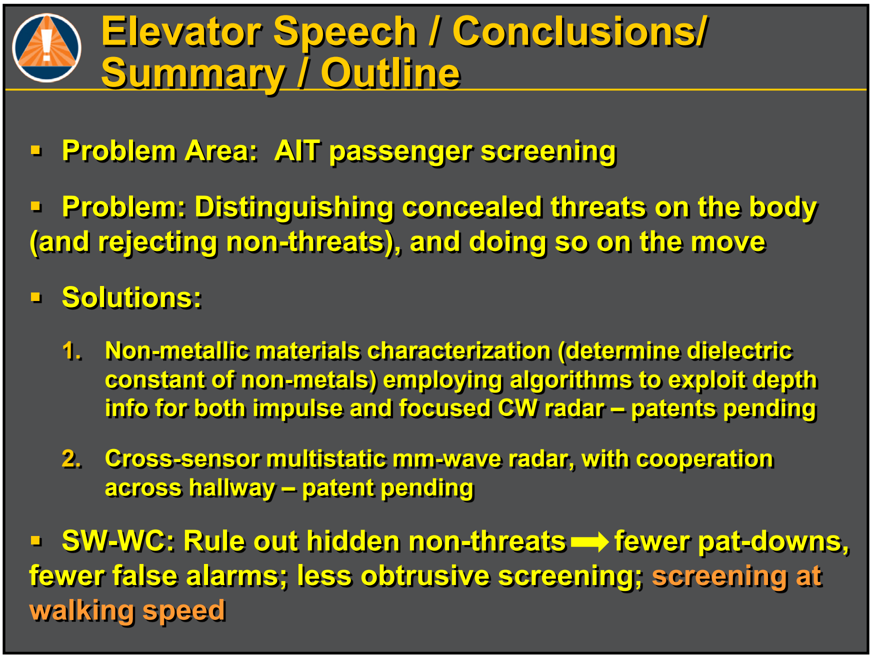
Improved Millimeter-Wave Radar Concealed-Threat Person Scanning

Northeastern University

ALERT
AWARENESS AND LOCALIZATION
OF EXPLOSIVES-RELATED THREATS

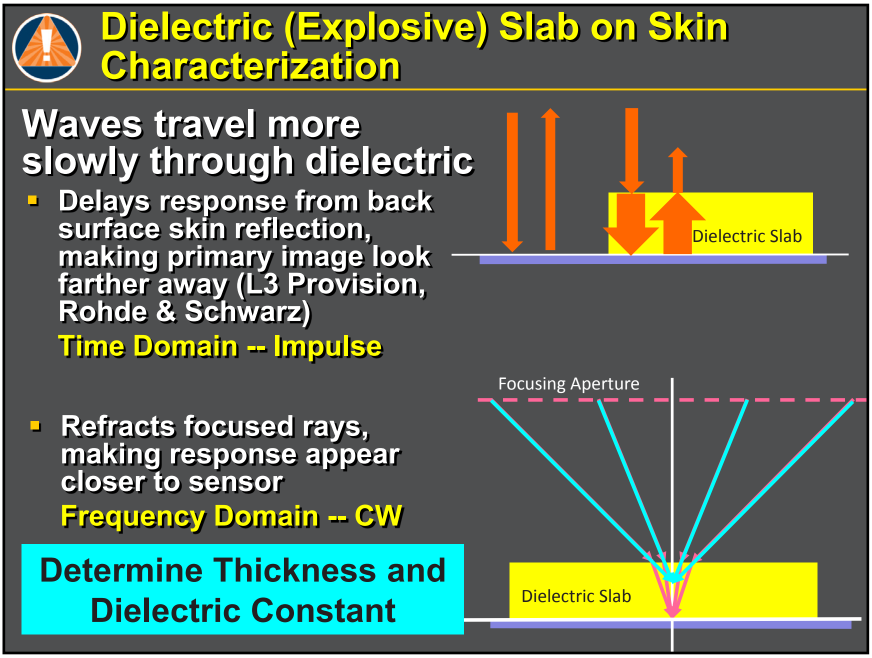
Carey Rappaport
ALERT Center of Excellence
Northeastern University, Boston, MA

ADSA15 –November, 2016



Elevator Speech / Conclusions/ Summary / Outline

- Problem Area: AIT passenger screening
- Problem: Distinguishing concealed threats on the body (and rejecting non-threats), and doing so on the move
- Solutions:
    1. Non-metallic materials characterization (determine dielectric constant of non-metals) employing algorithms to exploit depth info for both impulse and focused CW radar – patents pending
    2. Cross-sensor multistatic mm-wave radar, with cooperation across hallway – patent pending
- SW-WC: Rule out hidden non-threats ➡ fewer pat-downs, fewer false alarms; less obtrusive screening; screening at walking speed



Dielectric (Explosive) Slab on Skin Characterization

Waves travel more slowly through dielectric

- Delays response from back surface skin reflection, making primary image look farther away (L3 Provision, Rohde & Schwarz)

  Time Domain -- Impulse

- Refracts focused rays, making response appear closer to sensor

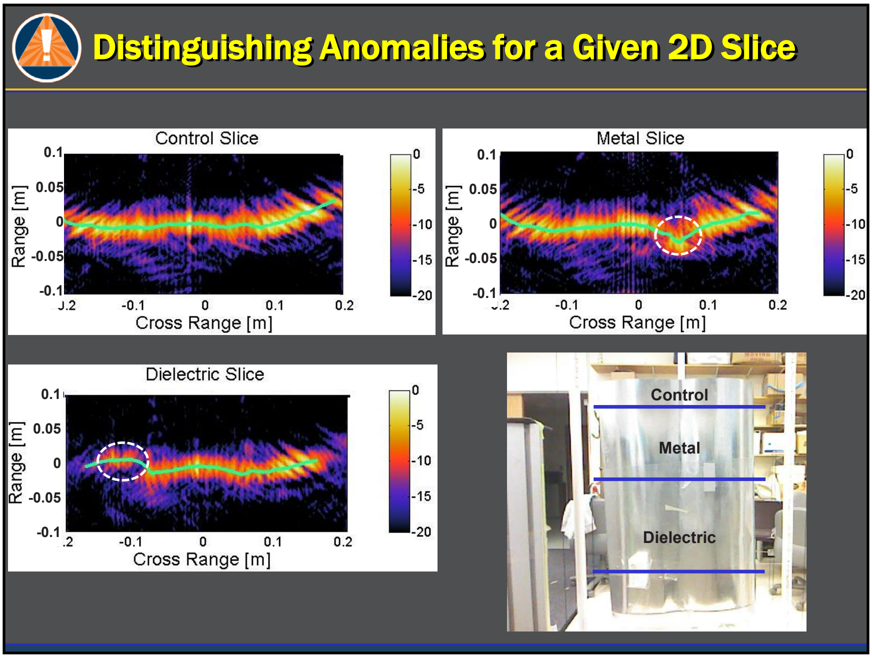
  Frequency Domain -- CW

Determine Thickness and Dielectric Constant

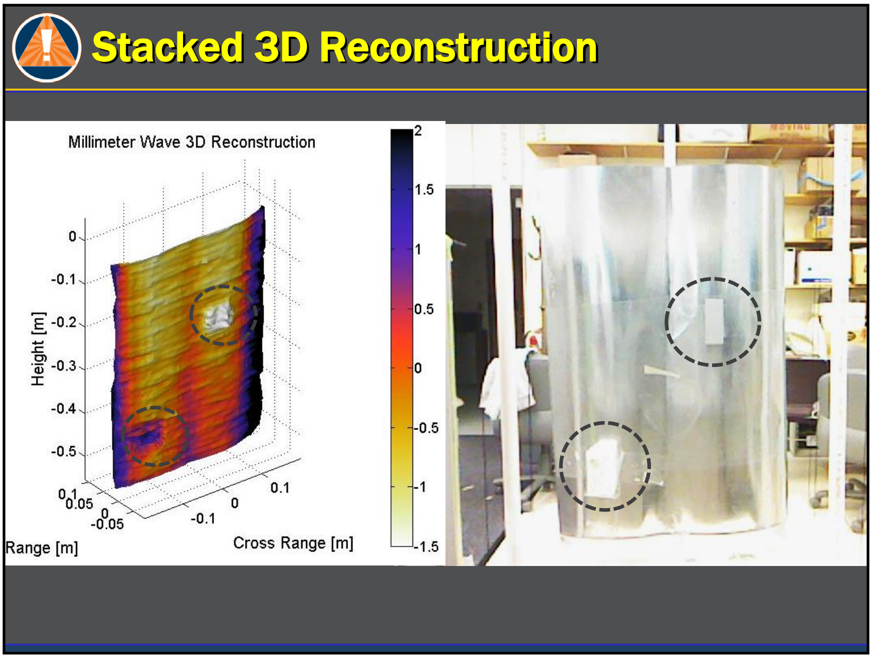
Body Surrogate Scan

Clothed Torso Surrogate

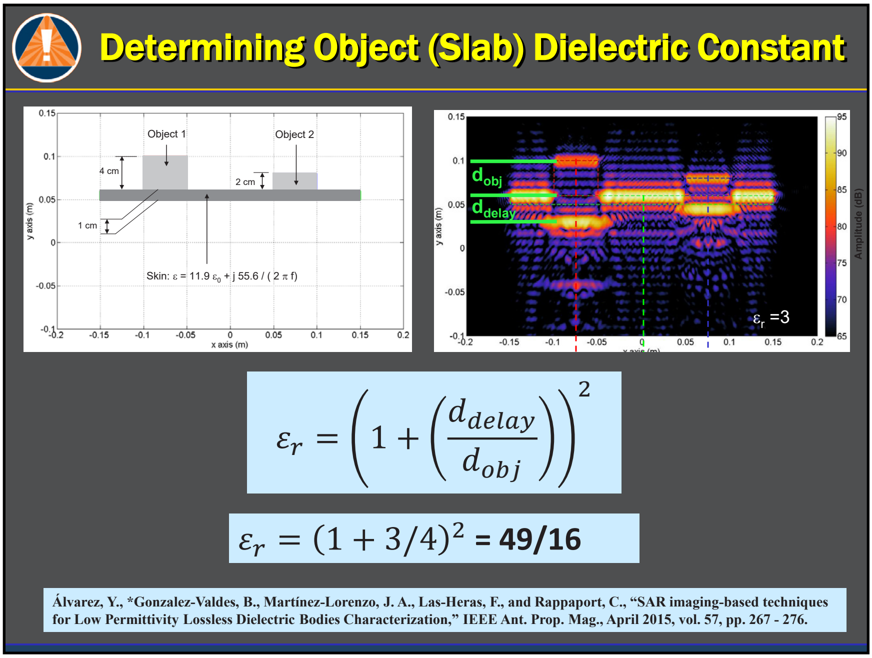
Concealed Objects



Distinguishing Anomalies for a Given 2D Slice



Stacked 3D Reconstruction

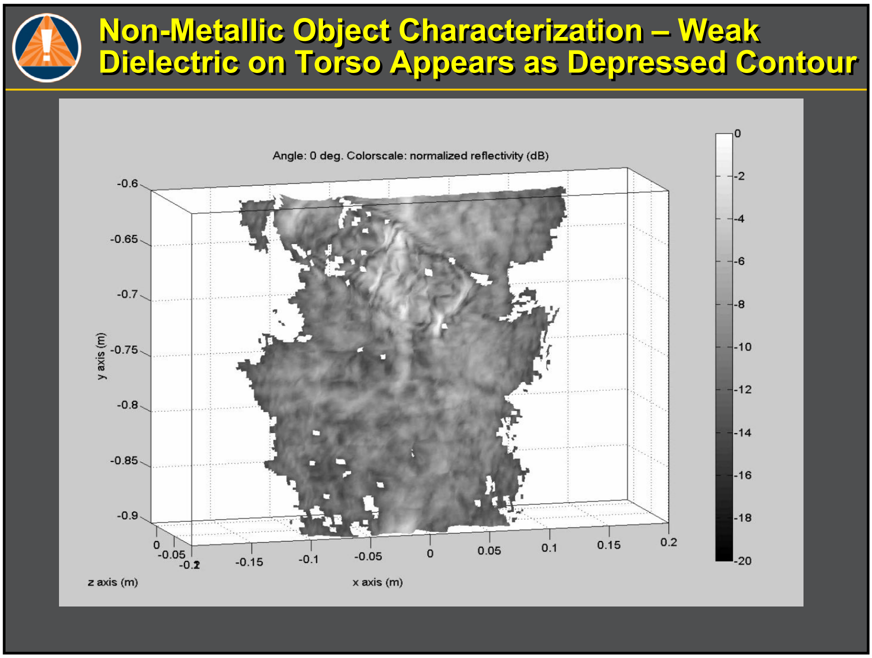


Determining Object (Slab) Dielectric Constant

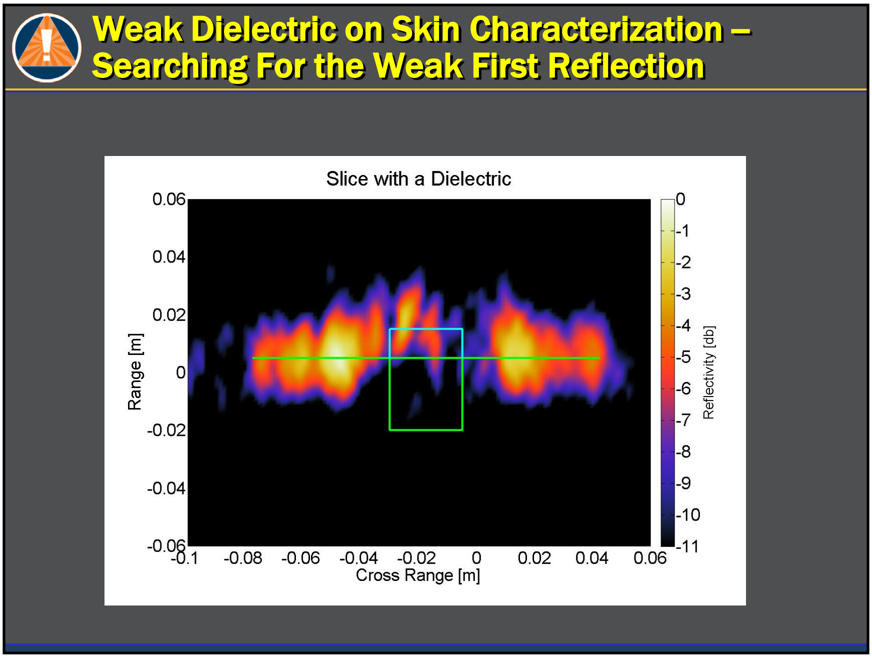
$$\varepsilon_r = \left(1 + \left(\frac{d_{delay}}{d_{obj}}\right)\right)^2$$

$$\varepsilon_r = (1 + 3/4)^2 = \mathbf{49/16}$$

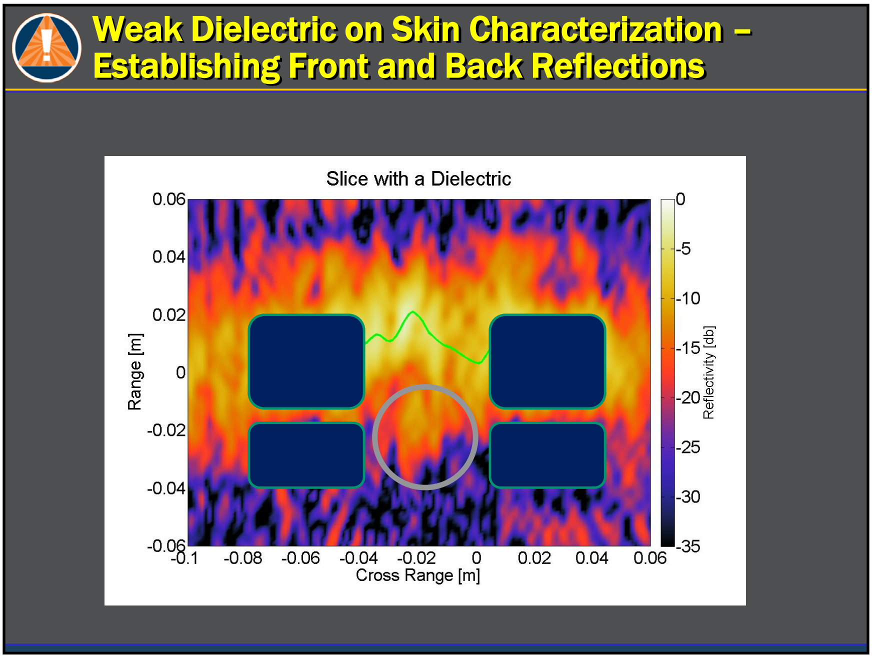
Álvarez, Y., *Gonzalez-Valdes, B., Martínez-Lorenzo, J. A., Las-Heras, F., and Rappaport, C., "SAR imaging-based techniques for Low Permittivity Lossless Dielectric Bodies Characterization," IEEE Ant. Prop. Mag., April 2015, vol. 57, pp. 267 - 276.



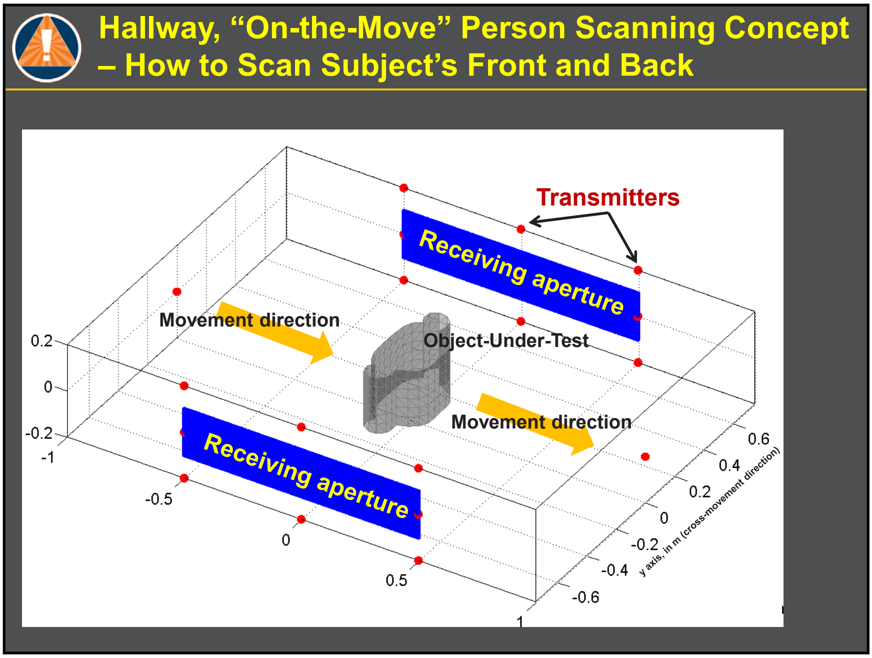
Non-Metallic Object Characterization – Weak Dielectric on Torso Appears as Depressed Contour



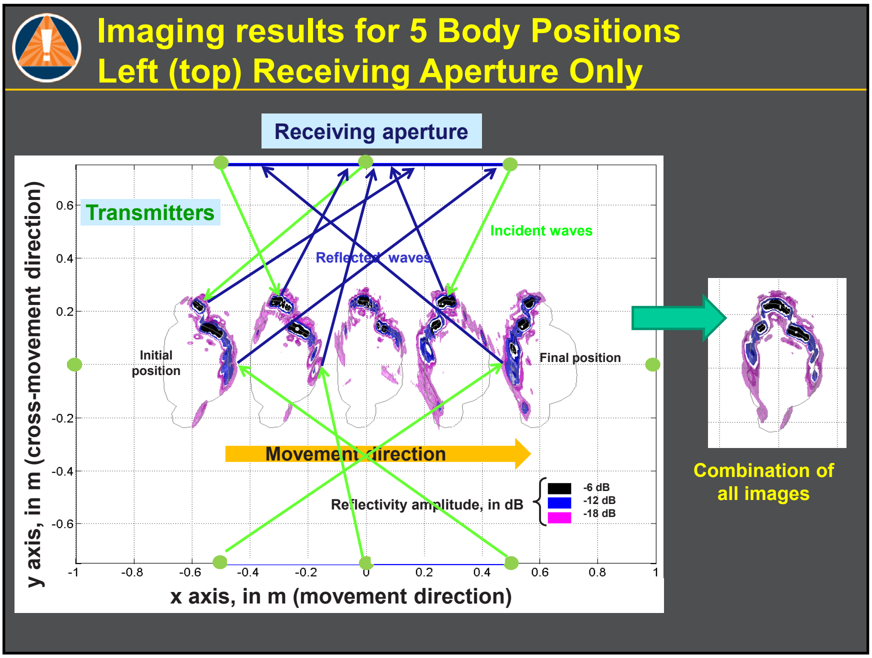
Weak Dielectric on Skin Characterization – Searching For the Weak First Reflection



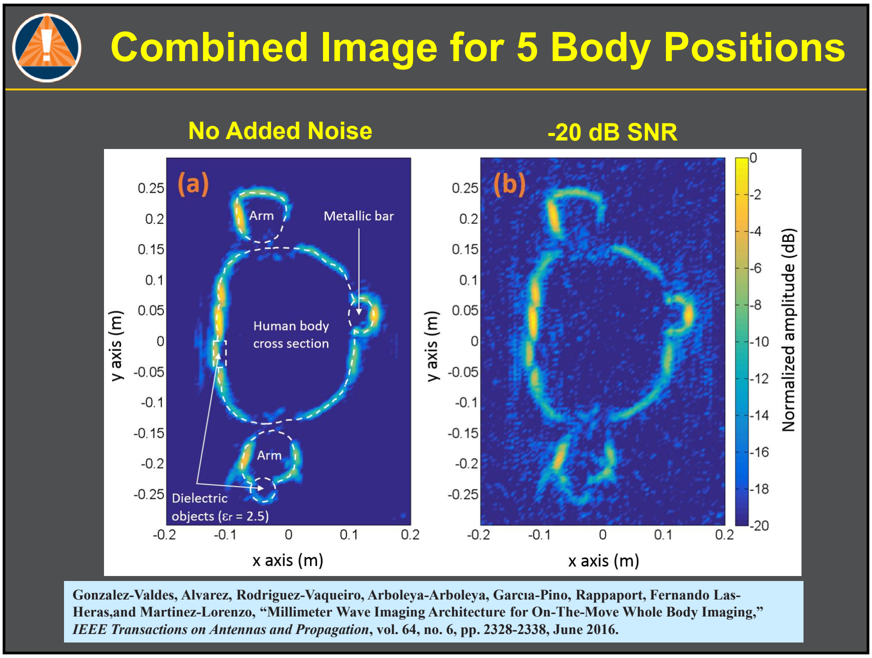
Weak Dielectric on Skin Characterization – Establishing Front and Back Reflections



Hallway, “On-the-Move” Person Scanning Concept – How to Scan Subject’s Front and Back

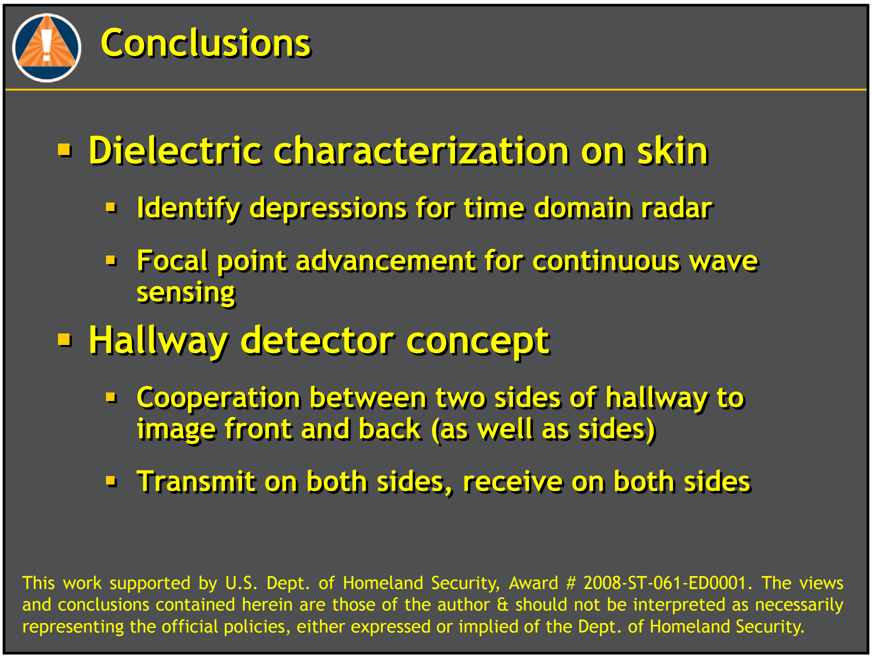


Imaging results for 5 Body Positions Left (top) Receiving Aperture Only



Combined Image for 5 Body Positions

Gonzalez-Valdes, Alvarez, Rodriguez-Vaqueiro, Arboleya-Arboleya, Garcıa-Pino, Rappaport, Fernando Las-Heras,and Martinez-Lorenzo, "Millimeter Wave Imaging Architecture for On-The-Move Whole Body Imaging," *IEEE Transactions on Antennas and Propagation*, vol. 64, no. 6, pp. 2328-2338, June 2016.

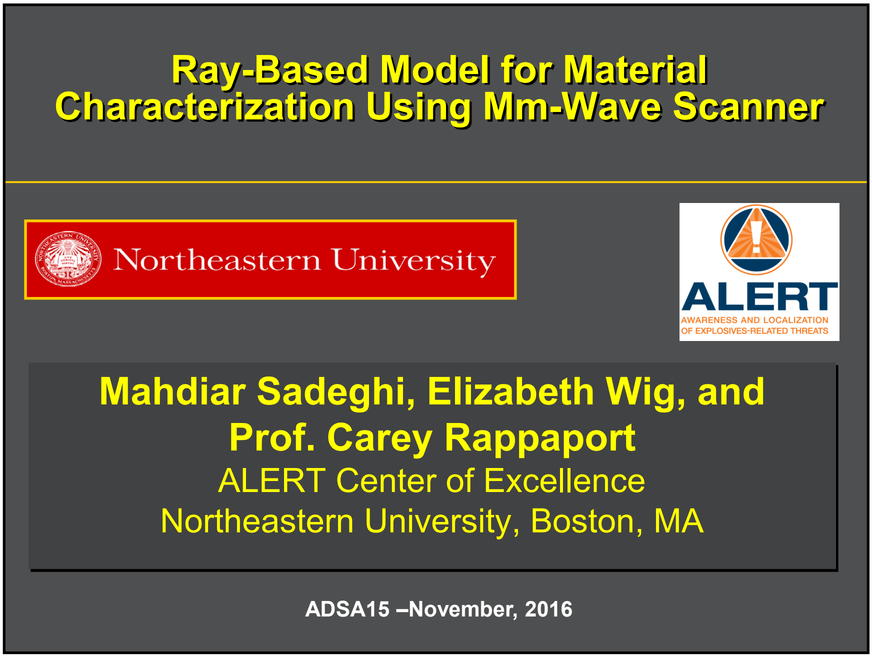


Conclusions

- Dielectric characterization on skin
  - Identify depressions for time domain radar
  - Focal point advancement for continuous wave sensing
- Hallway detector concept
  - Cooperation between two sides of hallway to image front and back (as well as sides)
  - Transmit on both sides, receive on both sides

This work supported by U.S. Dept. of Homeland Security, Award # 2008-ST-061-ED0001. The views and conclusions contained herein are those of the author & should not be interpreted as necessarily representing the official policies, either expressed or implied of the Dept. of Homeland Security.

16.34 Elizabeth Wig & Mahdiar Sadeghi: Ray-Based Model for Material Characterization Using Mm-Wave Scanner



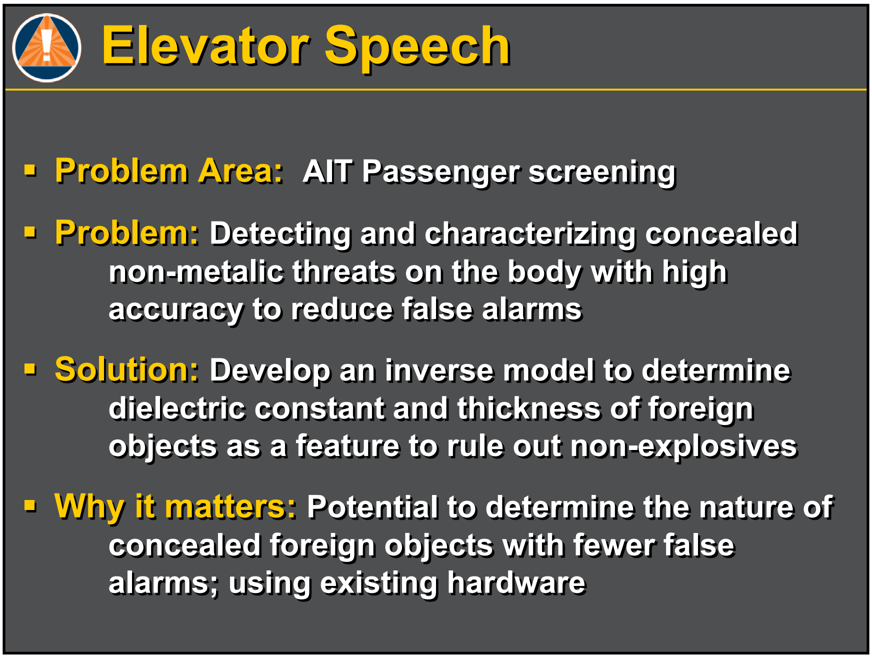
Ray-Based Model for Material Characterization Using Mm-Wave Scanner

Northeastern University

ALERT
AWARENESS AND LOCALIZATION OF EXPLOSIVES-RELATED THREATS

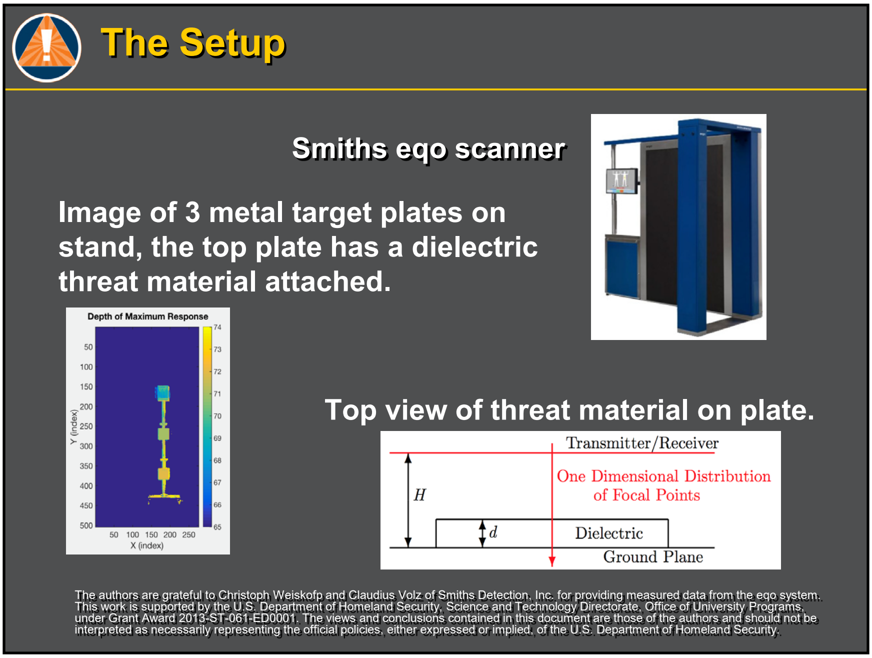
Mahdiar Sadeghi, Elizabeth Wig, and Prof. Carey Rappaport
ALERT Center of Excellence
Northeastern University, Boston, MA

ADSA15 –November, 2016



Elevator Speech

- **Problem Area:** AIT Passenger screening
- **Problem:** Detecting and characterizing concealed non-metalic threats on the body with high accuracy to reduce false alarms
- **Solution:** Develop an inverse model to determine dielectric constant and thickness of foreign objects as a feature to rule out non-explosives
- **Why it matters:** Potential to determine the nature of concealed foreign objects with fewer false alarms; using existing hardware



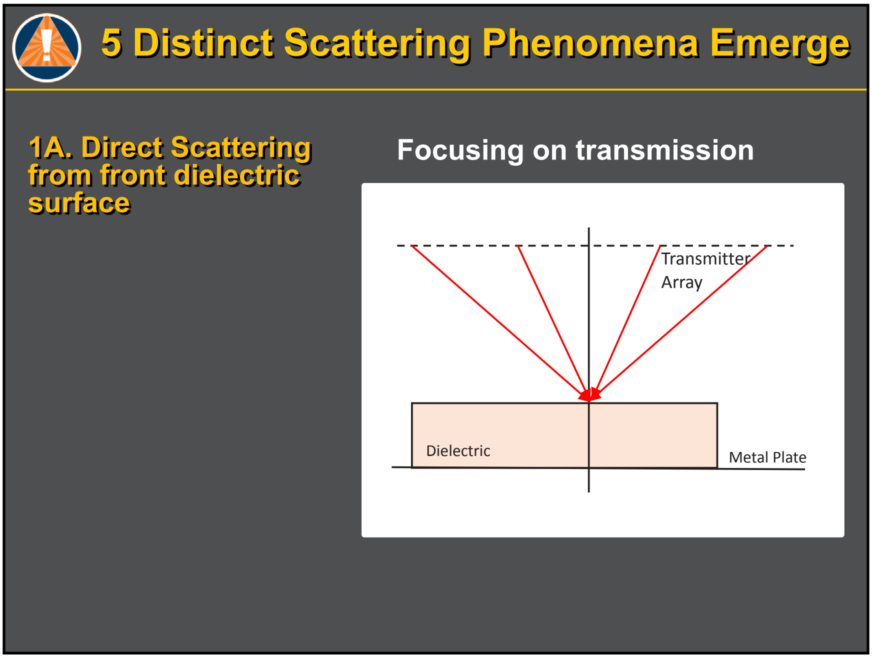
The Setup

Smiths eqo scanner

Image of 3 metal target plates on stand, the top plate has a dielectric threat material attached.

Top view of threat material on plate.

The authors are grateful to Christoph Weiskofp and Claudius Volz of Smiths Detection, Inc. for providing measured data from the eqo system. This work is supported by the U.S. Department of Homeland Security, Science and Technology Directorate, Office of University Programs, under Grant Award 2013-ST-061-ED0001. The views and conclusions contained in this document are those of the authors and should not be interpreted as necessarily representing the official policies, either expressed or implied, of the U.S. Department of Homeland Security.



5 Distinct Scattering Phenomena Emerge

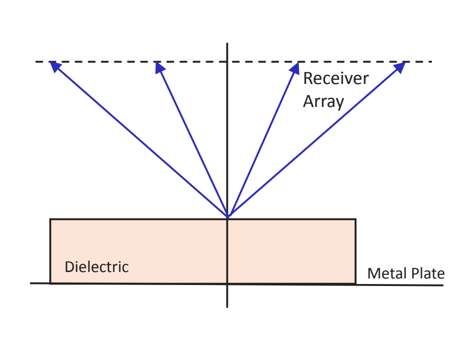
1A. Direct Scattering from front dielectric surface

Focusing on transmission

5 Distinct Scattering Phenomena Emerge

1A. Direct Scattering from front dielectric surface

Focusing on reception

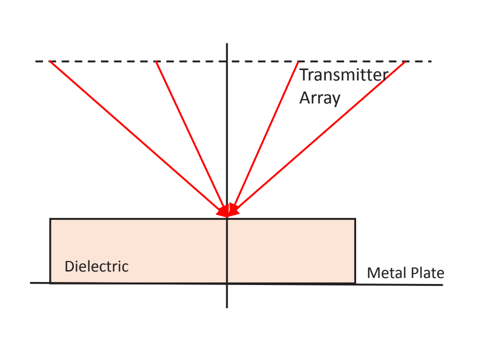


5 Distinct Scattering Phenomena Emerge

1A. Direct Scattering from front dielectric surface

1B. Focus at front surface, consider scattering through dielectric from front surface image

Focusing on transmission

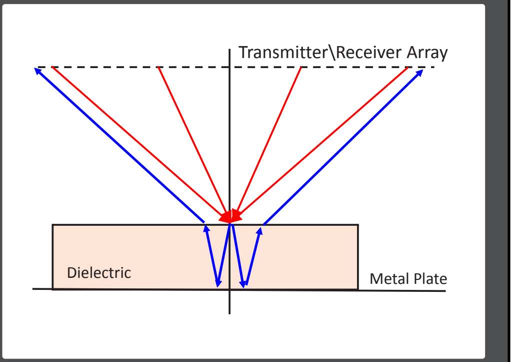


5 Distinct Scattering Phenomena Emerge

1A. Direct Scattering from front dielectric surface

1B. Focus at front surface, consider scattering through dielectric from front surface image

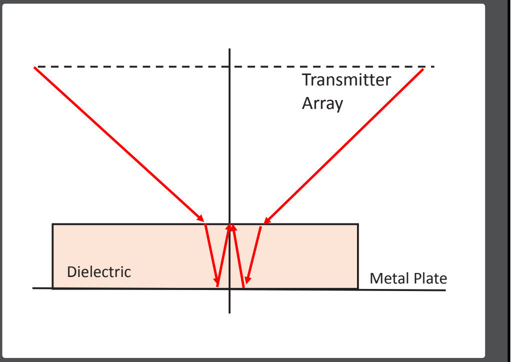
Receiving scattered rays

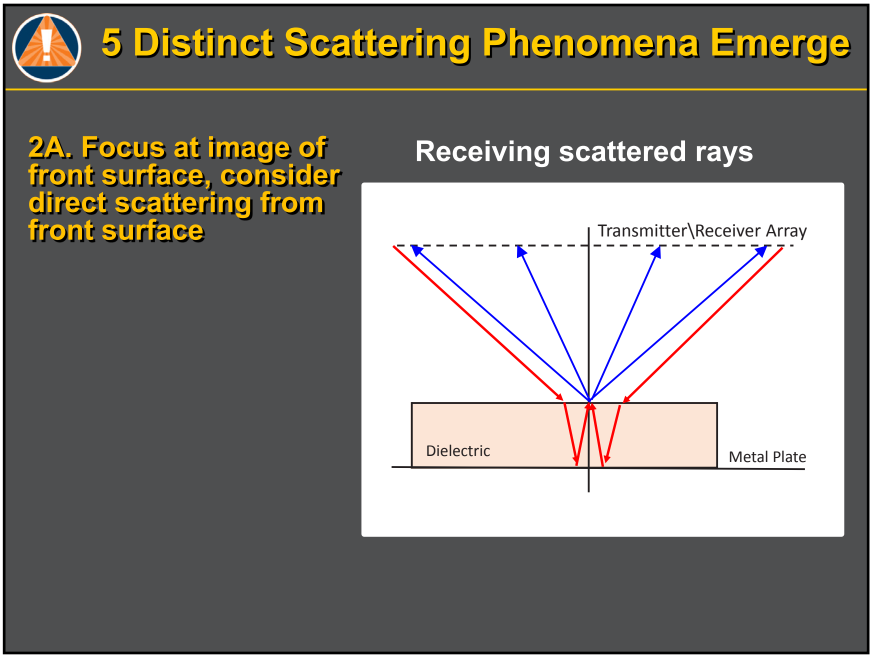


5 Distinct Scattering Phenomena Emerge

2A. Focus at image of front surface, consider direct scattering from front surface

Focusing on transmission

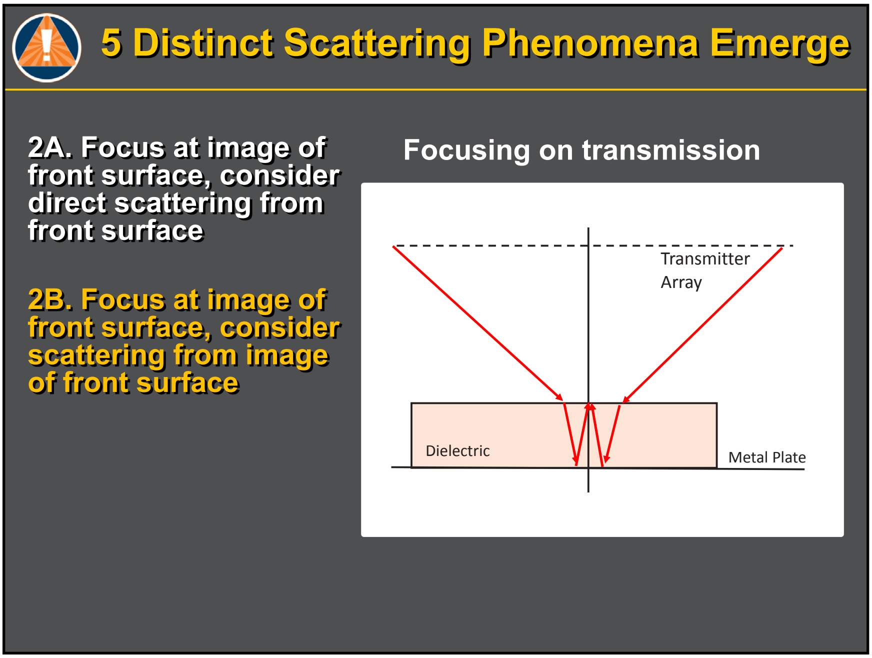




5 Distinct Scattering Phenomena Emerge

2A. Focus at image of front surface, consider direct scattering from front surface

Receiving scattered rays

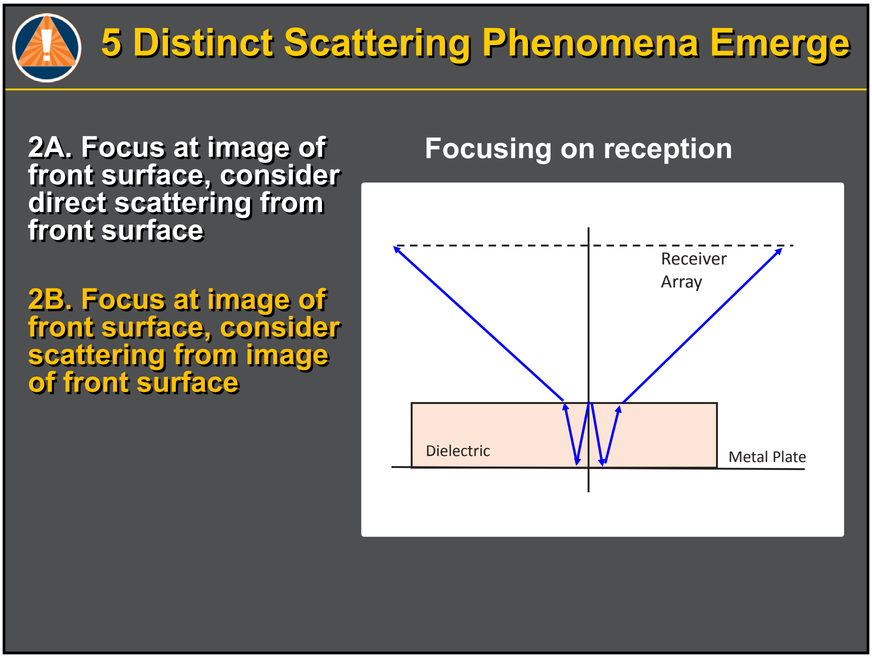


5 Distinct Scattering Phenomena Emerge

2A. Focus at image of front surface, consider direct scattering from front surface

2B. Focus at image of front surface, consider scattering from image of front surface

Focusing on transmission

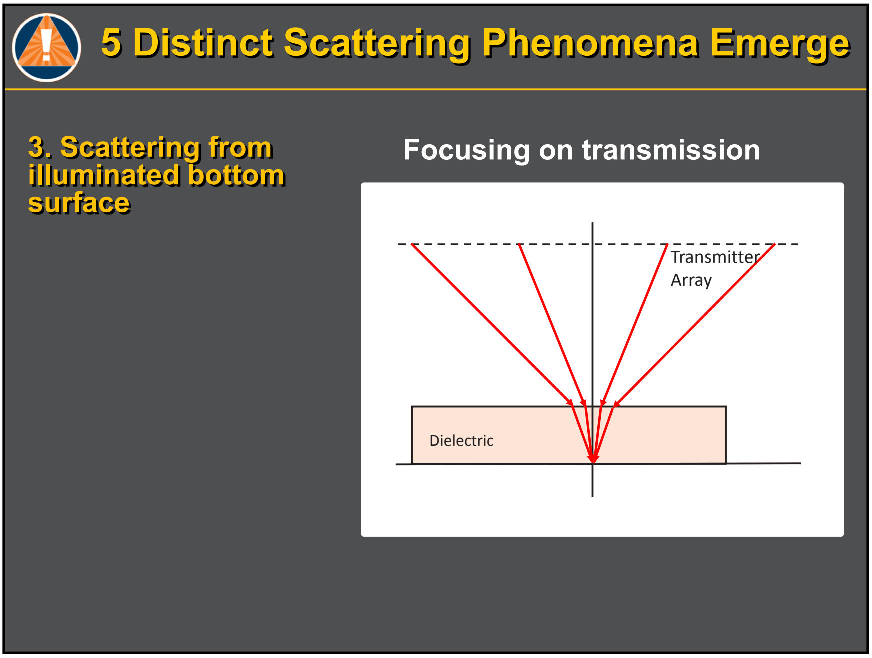


5 Distinct Scattering Phenomena Emerge

2A. Focus at image of front surface, consider direct scattering from front surface

2B. Focus at image of front surface, consider scattering from image of front surface

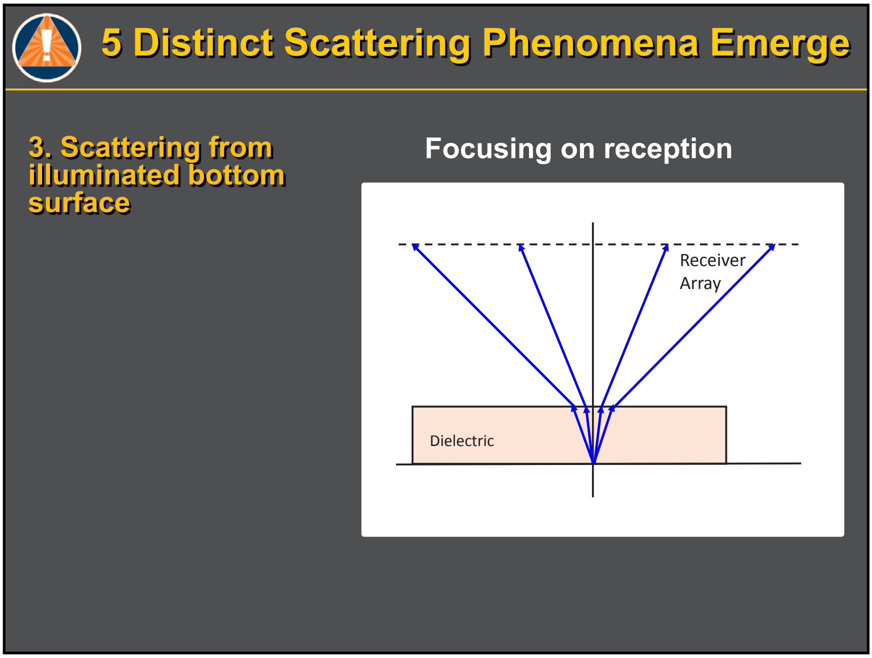
Focusing on reception



5 Distinct Scattering Phenomena Emerge

3. Scattering from illuminated bottom surface

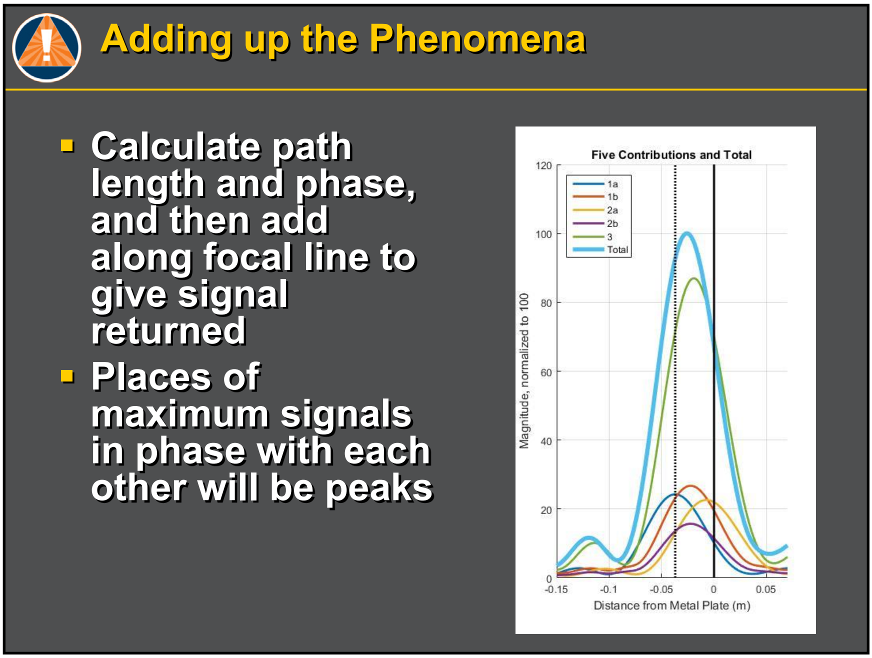
Focusing on transmission



5 Distinct Scattering Phenomena Emerge

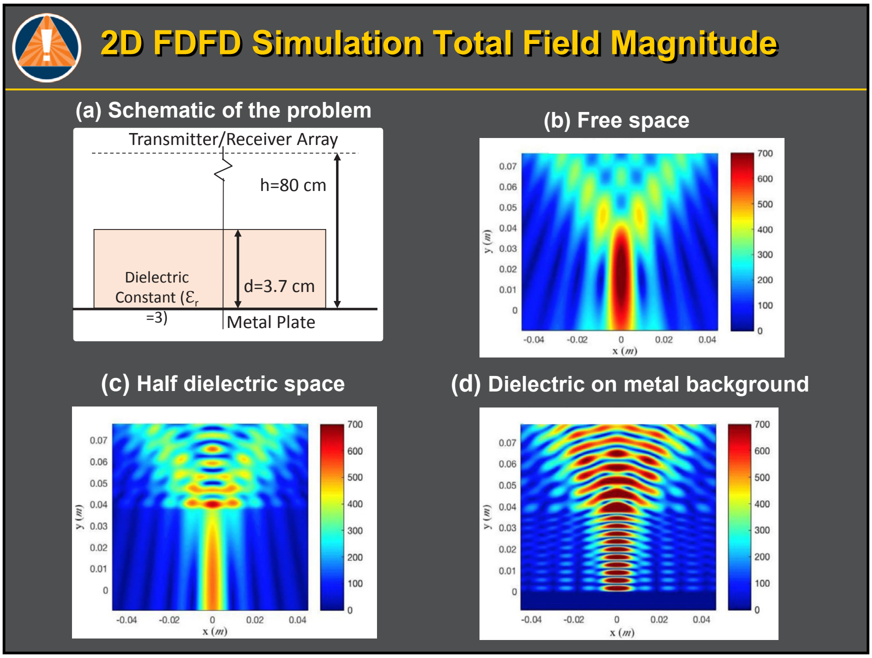
3. Scattering from illuminated bottom surface

Focusing on reception



Adding up the Phenomena

- Calculate path length and phase, and then add along focal line to give signal returned
- Places of maximum signals in phase with each other will be peaks



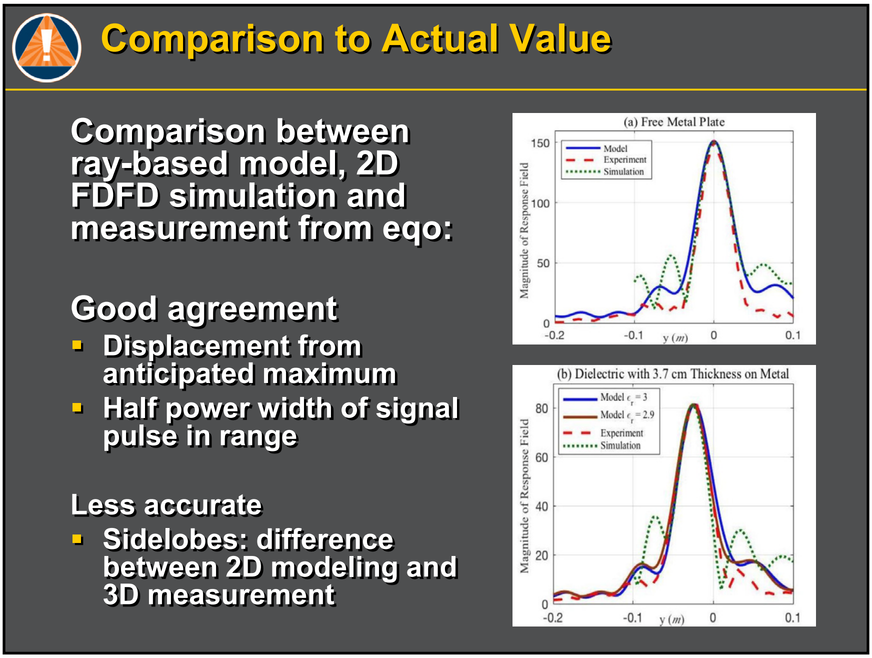
2D FDFD Simulation Total Field Magnitude

(a) Schematic of the problem

(b) Free space

(c) Half dielectric space

(d) Dielectric on metal background



Comparison to Actual Value

Comparison between ray-based model, 2D FDFD simulation and measurement from eqo:

Good agreement

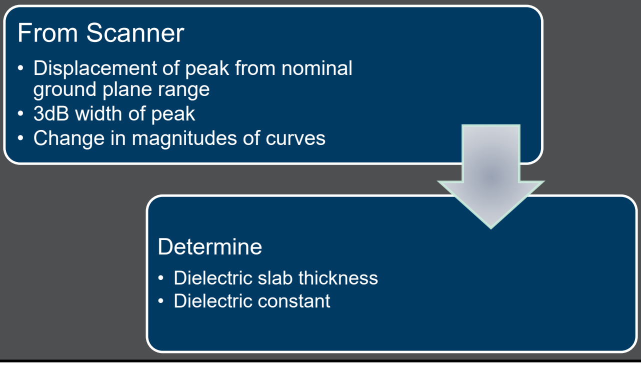
- Displacement from anticipated maximum
- Half power width of signal pulse in range

Less accurate

- Sidelobes: difference between 2D modeling and 3D measurement

Next Steps

- Use the developed forward model for simple inverse model to determine slab dielectric constant and thickness
- Inversion Problem



From Scanner

- Displacement of peak from nominal ground plane range
- 3dB width of peak
- Change in magnitudes of curves

Determine

- Dielectric slab thickness
- Dielectric constant

Conclusions

- Ray-based model of five scattering phenomena simplifies analysis
- Able to characterize material properties (thickness, dielectric constant) of potential threat material
- Thickness, extent, and dielectric constant (from 2D scans) can rule out non-threats
- Potential for faster, safer checkpoints

16.35 David Paquette: Safety Act - Specifics for Small Businesses and Academics

The SAFETY Act and Business

Protecting You and Informing Your Customers

Homeland Security
Science and Technology

November 16, 2016

David Paquette
OSAI@hq.dhs.gov
202-254-8637
Office of SAFETY Act Implementation
Science and Technology Directorate

Review: What is the SAFETY Act?

- Support Anti-terrorism by Fostering Effective Technologies (SAFETY) Act is part of the Homeland Security Act of 2002 and provides legal liability cap for manufacturers and sellers of qualified anti-terrorism technologies (QATTs).
- SAFETY Act serves to distinguish companies from others in the marketplace.
- Government agencies have partnered with the SAFETY Act Office for streamlined approval processes for certain technologies.
- Applications to the Office of SAFETY Act Implementation can be submitted at www.SAFETYAct.gov.

Homeland Security
Science and Technology

What is the
SAFETY Act?

The SAFETY Act provides important legal liability protections for providers of Qualified Anti-Terrorism Technologies - whether they are products or services. The goal of the SAFETY Act is to encourage the development and deployment of new and innovative anti-terrorism products and services by providing liability protections.

For more details, see the SAFETY Act Final Rule.

The SAFETY Act Benefits to Your Company

Encouraging the DEVELOPMENT *and* DEPLOYMENT *of* ANTI-TERRORISM TECHNOLOGIES

Benefits of SAFETY Act Coverage

Who is the "Seller"? That's you!

What do SAFETY Act liability protections mean:

- To You?
- To Your Customers?
- To Your Suppliers or Subcontractors?

How can you explain the approval to your customers and suppliers?

Trumpet your success with the SAFETY Act Mark.

Homeland Security
Science and Technology

SAFETY Act Protections for QATT

- Designation provides:
  - Exclusive action in Federal court,
  - No joint and several liability for non-economic damages,
  - No punitive damages or prejudgment interest, and
  - Limited liability for third-party claims with respect to an "Act of Terrorism".
- Seller is the **sole entity** that can be sued for third-party injuries due to the alleged failure of the QATT:
  - Protects all other companies and persons in developing or manufacturing ("upstream") and distribution ("downstream") chains.
- Certified Technologies can claim the "Government Contractor Defense" and can be protected from any liability.

Designated and Certified Technologies can be placed on SAFETY Act list of approved technologies available on our website www.safetyact.gov

Homeland Security
Science and Technology

How the SAFETY Act Benefits Your Business

What We Mean By…

Exclusive Action: ONLY you, as the Seller, can only be sued in Federal Civil Court (Federal jurisdiction)

Joint and Several Liability: You are only liable for the portion of noneconomic damages that is proportionate to your responsibility.

Punitive Damages: You can only be liable for actual losses experienced by the Plaintiff.

Prejudgment Interest: Plaintiffs are not entitled to collect interest on any judgment from before the time of the settlement.

Homeland Security
Science and Technology

Keep in Touch and Get Help

- **Online:** www.safetyact.gov
  - FAQs
  - Help Topics
  - SAFETY Act 101 for Small Businesses
  - SAFETY Act and Business
  - SAFETY Act 101 Briefing
  - Step-by-Step User Guide
  - Help Desk: Online form is available for questions requiring an individual response under Contact Us > Help Ticket links
- **Email:** SAFETYActHelpDesk@dhs.gov or OSAI@hq.dhs.gov
- **Phone:** 1-866-788-9318 or 202-254-8637

Homeland Security
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Homeland
Security

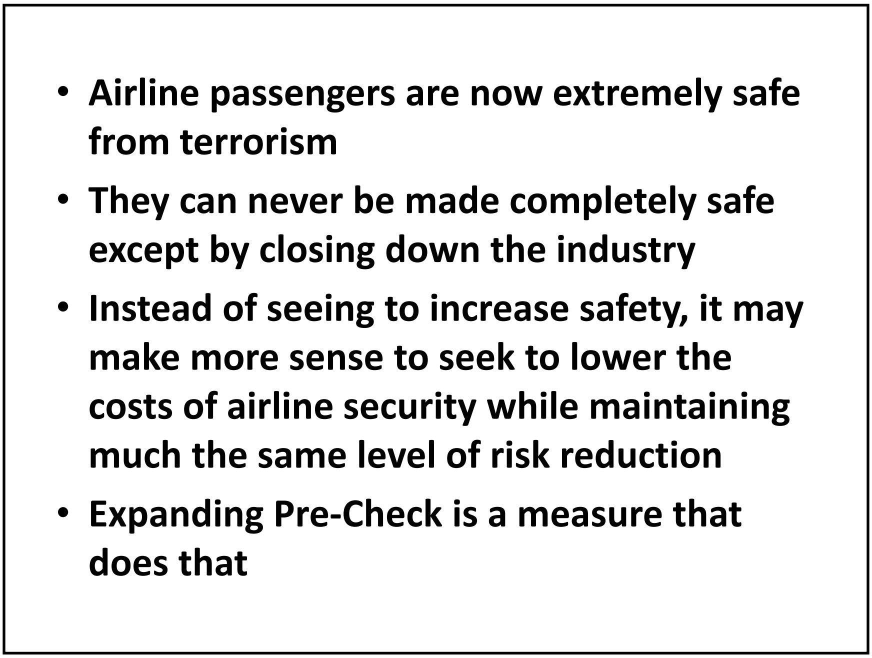
Science and Technology

16.36 John Mueller: Trade-Offs to Increasing Security and Adding Checkpoints

Next Generation Screening Technologies and Processes for the Checkpoint

Trade-offs to increasing security and adding checkpoints

John Mueller
Ohio State University/Cato Institute



- **Airline passengers are now extremely safe from terrorism**
- **They can never be made completely safe except by closing down the industry**
- **Instead of seeing to increase safety, it may make more sense to seek to lower the costs of airline security while maintaining much the same level of risk reduction**
- **Expanding Pre-Check is a measure that does that**

Are We Safe Enough? Measuring and Assessing Aviation Security

Mark G. Stewart
University of Newcastle, Australia
John Mueller
Ohio State University/Cato Institute

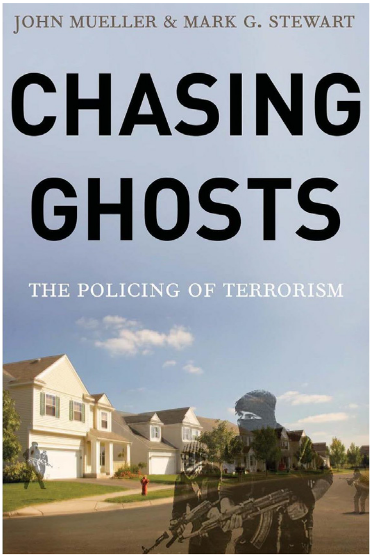
Elsevier, forthcoming, 2017

John Mueller and Mark G. Stewart

TERROR, SECURITY, AND MONEY

Balancing the Risks, Benefits, and Costs of Homeland Security

2011



JOHN MUELLER & MARK G. STEWART

CHASING GHOSTS

THE POLICING OF TERRORISM

2016

ARE WE SAFER?

HOW SAFE ARE WE?

> How much should we be willing to pay for a small reduction in probabilities that are already extremely low?
>
> —Howard Kunreuther, 2002

ACCEPTABLE RISK

Chance worldwide that an individual airline passenger will be killed by terrorists on an individual flight:

1973-2015: 1 in 25 million
2002-2015: 1 in 105 million

2002-2015:

- 22 times more likely to die on an airliner from an accident than from terrorism
- Need to fly once per day for 30,000 years before being involved in a terrorist attack

---

Given existing security layers

success in hijacking attempt: one in 200
success in downing with passenger-borne bomb: one in 50

Reducing the costs of aviation security

- Reduce FAMS, increase FFDO, add secondary barriers:
  - No change in risk reduction
  - Hundreds of millions of savings per year

Improving efficiency

- 50% PreCheck:
  - Probably slight improvement in risk reduction
  - Benefit of billions in screening costs, passenger experience

Does terrorism constitute a “threat”?

Six killed per year in US by Islamist terrorists since 9/11

Are security measures responsible for this?

Disclosed terrorists within the US

Undisclosed terrorists

- ☞ **The unreported**
- ☞ **The Al Capone approach**
- ☞ **The deterred**
- ☞ **The smart ones**

- ☝ **Incompetent**
- ☝ **Ineffective**
- ☝ **Unintelligent**
- ☝ **Idiotic**
- ☝ **Ignorant**
- ☝ **Inadequate**
- ☝ **Unorganized**
- ☝ **Misguided**
- ☝ **Muddled**
- ☝ **Amateurish**
- ☝ **Dopey**
- ☝ **Unrealistic**
- ☝ **Moronic**
- ☝ **Irrational**
- ☝ **Foolish**
- ☝ **Gullible**

Brian Jenkins: Their numbers remain small, their determination limp, and their competence poor.

16.37 Graeme Goldsworthy & Diederik Stolk: Solving TSA's Problems Using an Exercise in War Gaming

Improving Aviation Security through scenario-based gaming

ADSA 2016
Graeme Goldsworthy (GBR)
Diederik Stolk (NLD)

NATO Wargame during
Exercise. Noble Ledger 2014

SAMPLE GAME:
BLACK BOX.

Our Clients include:

Goldsworthy, Stolk & Associates (GS&A): world leading experts in scenario-based gaming, exercise design and decision-making simulations in the security sector.

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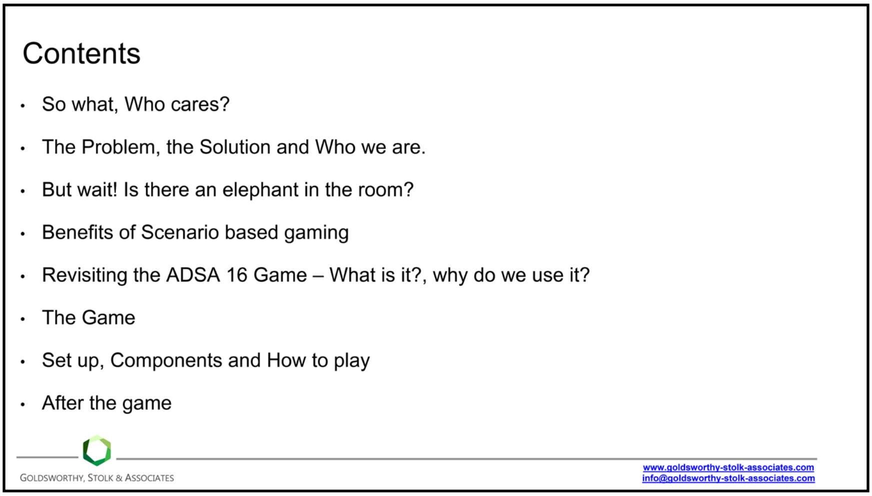

Contents

- So what, Who cares?
- The Problem, the Solution and Who we are.
- But wait! Is there an elephant in the room?
- Benefits of Scenario based gaming
- Revisiting the ADSA 16 Game – What is it?, why do we use it?
- The Game
- Set up, Components and How to play
- After the game

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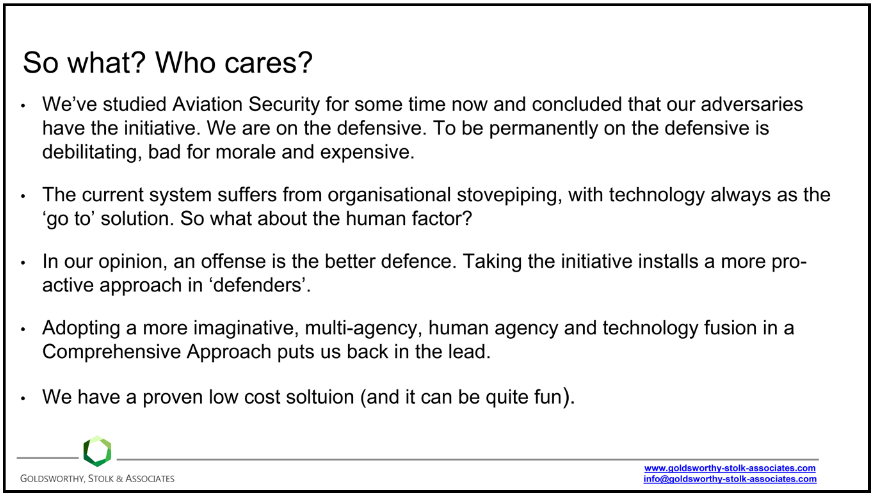

So what? Who cares?

- We've studied Aviation Security for some time now and concluded that our adversaries have the initiative. We are on the defensive. To be permanently on the defensive is debilitating, bad for morale and expensive.
- The current system suffers from organisational stovepiping, with technology always as the 'go to' solution. So what about the human factor?
- In our opinion, an offense is the better defence. Taking the initiative installs a more pro-active approach in 'defenders'.
- Adopting a more imaginative, multi-agency, human agency and technology fusion in a Comprehensive Approach puts us back in the lead.
- We have a proven low cost soltuion (and it can be quite fun).

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The Problem, the Solution and Who we are

Problem: The field of Aviation Security is a Complex Adaptive System defined by competing goals, technologies, stakeholders and adversaries.

Solution: to use scenario-based serious gaming to solve problems

About us: We solve complex inter-agency problems for serious people using serious games

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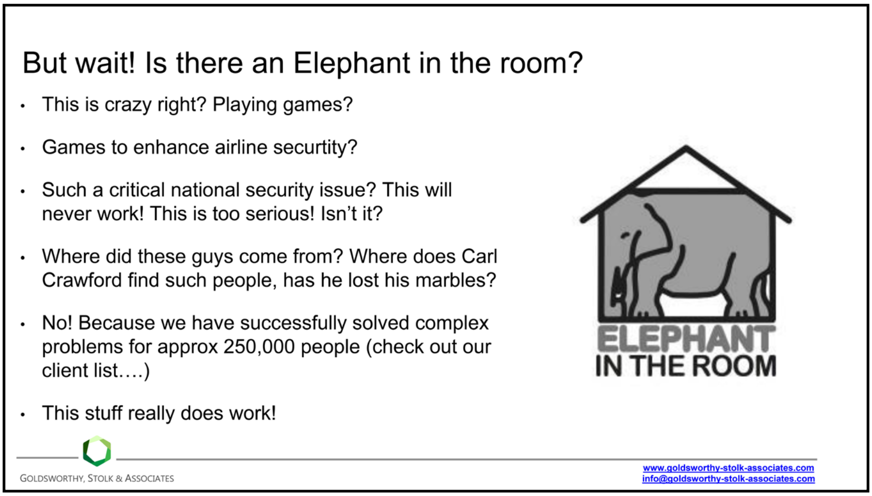

But wait! Is there an Elephant in the room?

- This is crazy right? Playing games?
- Games to enhance airline securtity?
- Such a critical national security issue? This will never work! This is too serious! Isn't it?
- Where did these guys come from? Where does Carl Crawford find such people, has he lost his marbles?
- No! Because we have successfully solved complex problems for approx 250,000 people (check out our client list….)
- This stuff really does work!

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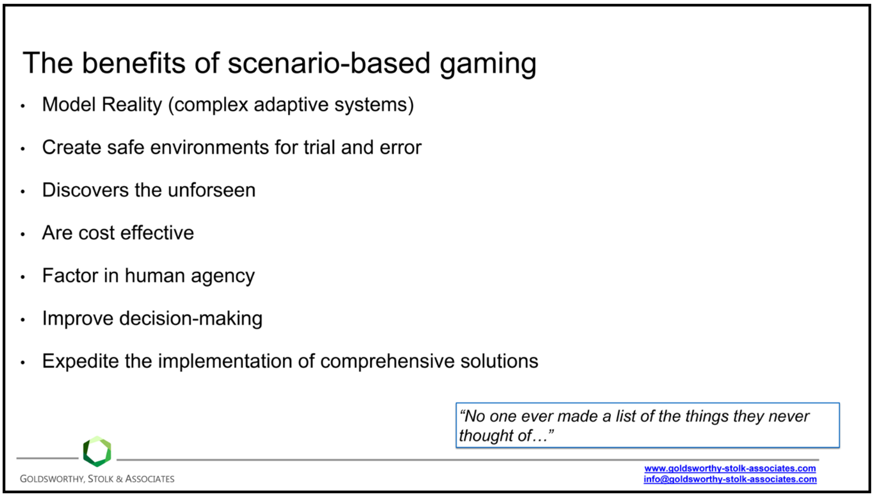

The benefits of scenario-based gaming

- Model Reality (complex adaptive systems)
- Create safe environments for trial and error
- Discovers the unforseen
- Are cost effective
- Factor in human agency
- Improve decision-making
- Expedite the implementation of comprehensive solutions

"No one ever made a list of the things they never thought of…"

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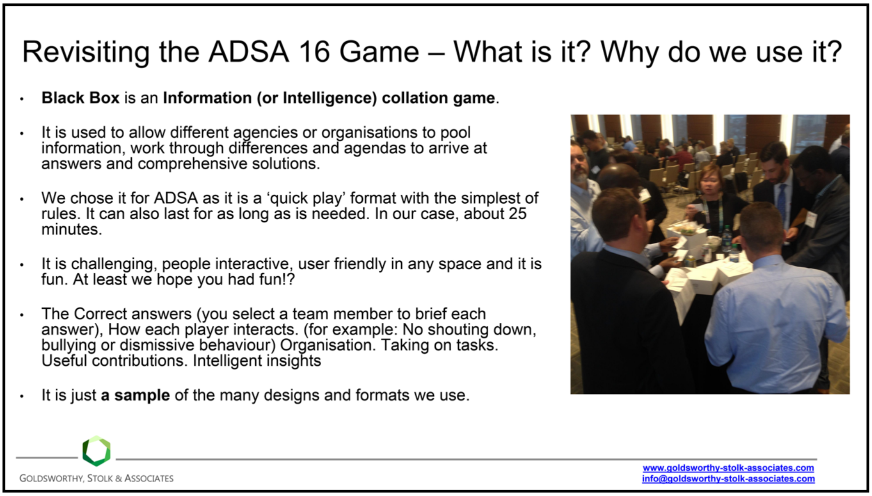

Revisiting the ADSA 16 Game – What is it? Why do we use it?

- **Black Box** is an **Information (or Intelligence) collation game**.
- It is used to allow different agencies or organisations to pool information, work through differences and agendas to arrive at answers and comprehensive solutions.
- We chose it for ADSA as it is a 'quick play' format with the simplest of rules. It can also last for as long as is needed. In our case, about 25 minutes.
- It is challenging, people interactive, user friendly in any space and it is fun. At least we hope you had fun!?
- The Correct answers (you select a team member to brief each answer), How each player interacts. (for example: No shouting down, bullying or dismissive behaviour) Organisation. Taking on tasks. Useful contributions. Intelligent insights
- It is just **a sample** of the many designs and formats we use.

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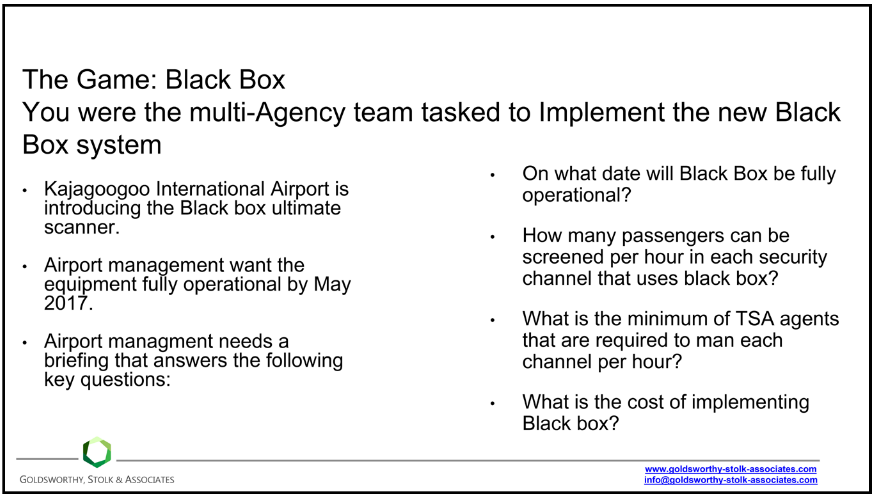

The Game: Black Box
You were the multi-Agency team tasked to Implement the new Black Box system

- Kajagoogoo International Airport is introducing the Black box ultimate scanner.
- Airport management want the equipment fully operational by May 2017.
- Airport managment needs a briefing that answers the following key questions:
- On what date will Black Box be fully operational?
- How many passengers can be screened per hour in each security channel that uses black box?
- What is the minimum of TSA agents that are required to man each channel per hour?
- What is the cost of implementing Black box?

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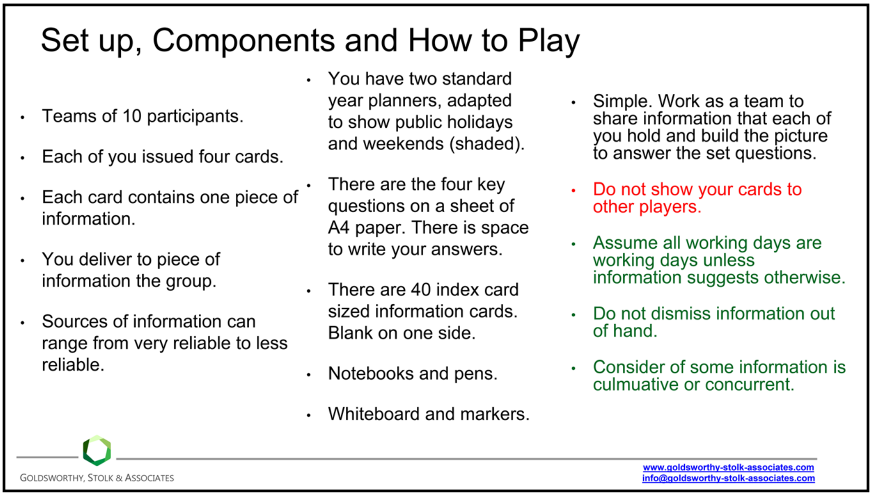

Set up, Components and How to Play

- Teams of 10 participants.
- Each of you issued four cards.
- Each card contains one piece of information.
- You deliver to piece of information the group.
- Sources of information can range from very reliable to less reliable.

- You have two standard year planners, adapted to show public holidays and weekends (shaded).
- There are the four key questions on a sheet of A4 paper. There is space to write your answers.
- There are 40 index card sized information cards. Blank on one side.
- Notebooks and pens.
- Whiteboard and markers.

- Simple. Work as a team to share information that each of you hold and build the picture to answer the set questions.
- Do not show your cards to other players.
- Assume all working days are working days unless information suggests otherwise.
- Do not dismiss information out of hand.
- Consider of some information is culmuative or concurrent.

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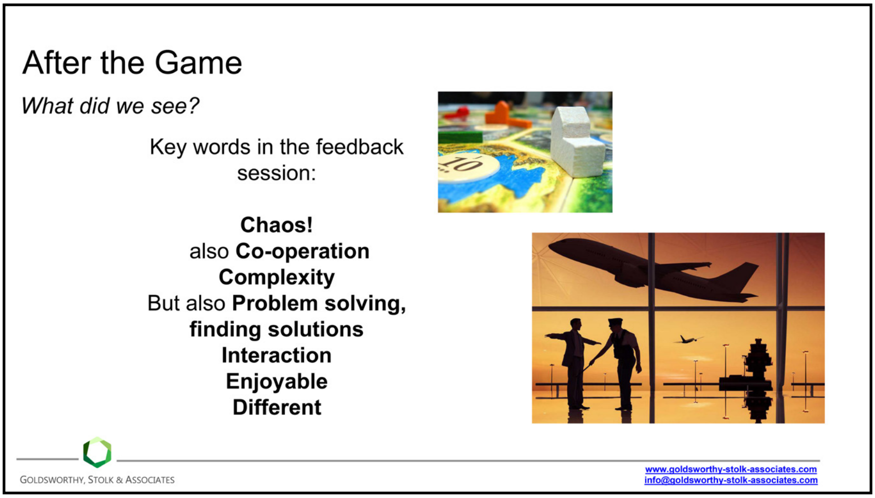

After the Game

What did we see?

Key words in the feedback session:

Chaos!
also **Co-operation**
Complexity
But also **Problem solving, finding solutions**
Interaction
Enjoyable
Different

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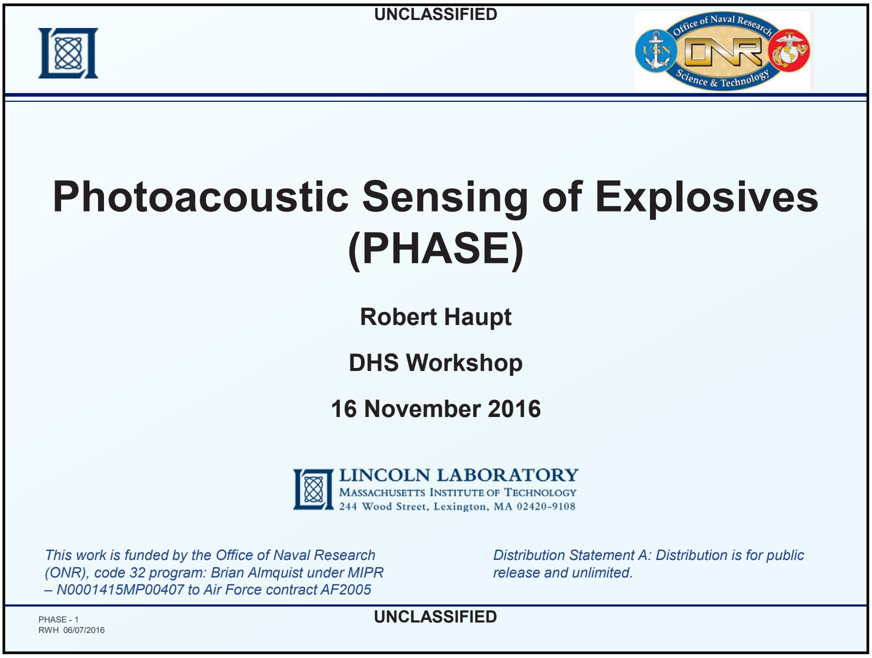
16.38 Robert Haupt: Photoacoustic Sensing of Explosives



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Photoacoustic Sensing of Explosives (PHASE)

Robert Haupt

DHS Workshop

16 November 2016

LINCOLN LABORATORY
Massachusetts Institute of Technology
244 Wood Street, Lexington, MA 02420-9108

This work is funded by the Office of Naval Research (ONR), code 32 program: Brian Almquist under MIPR – N0001415MP00407 to Air Force contract AF2005

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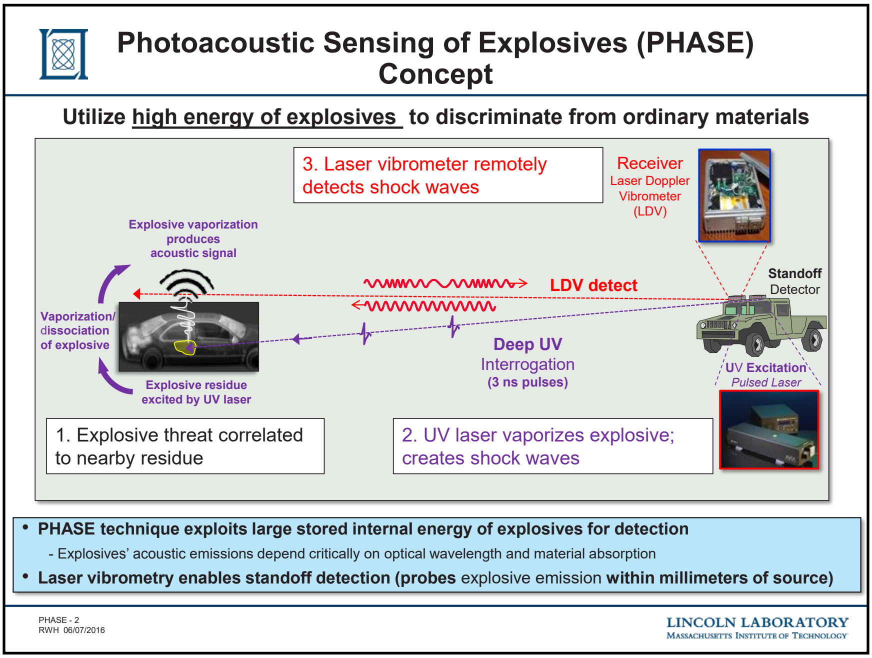

Photoacoustic Sensing of Explosives (PHASE) Concept

Utilize high energy of explosives to discriminate from ordinary materials

3. Laser vibrometer remotely detects shock waves

1. Explosive threat correlated to nearby residue

2. UV laser vaporizes explosive; creates shock waves

- **PHASE technique exploits large stored internal energy of explosives for detection**
  - Explosives' acoustic emissions depend critically on optical wavelength and material absorption
- **Laser vibrometry enables standoff detection (probes** explosive emission **within millimeters of source)**

PHASE - 2
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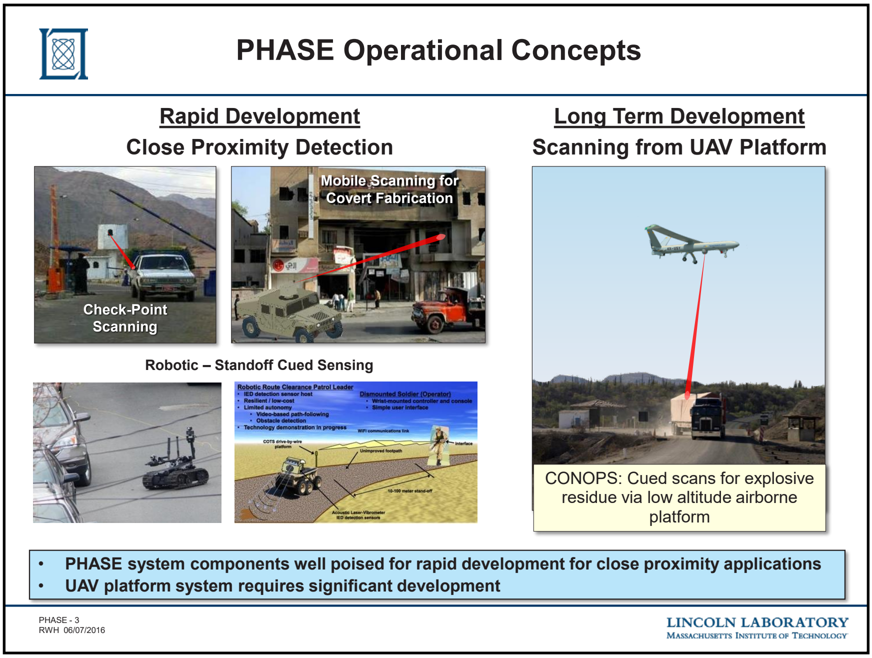

PHASE Operational Concepts

Rapid Development

Close Proximity Detection

Long Term Development

Scanning from UAV Platform

Robotic – Standoff Cued Sensing

Robotic Route Clearance Patrol Leader
- IED detection sensor host
- Resilient / low-cost
- Limited autonomy
  - Video-based path-following
  - Obstacle detection
- Technology demonstration in progress

Dismounted Soldier (Operator)
- Wrist-mounted controller and console
- Simple user interface

CONOPS: Cued scans for explosive residue via low altitude airborne platform

- **PHASE system components well poised for rapid development for close proximity applications**
- **UAV platform system requires significant development**

PHASE - 3
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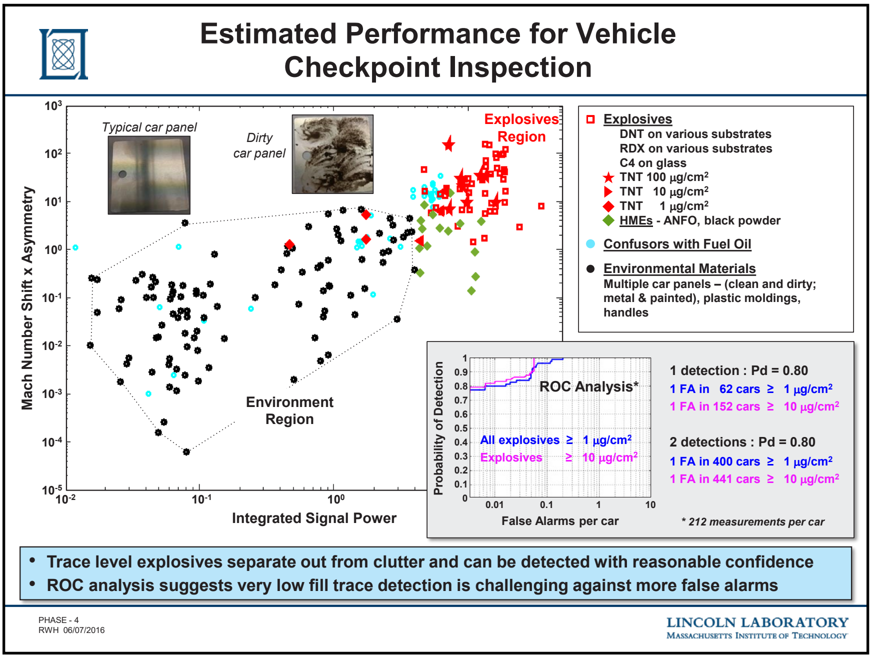

Estimated Performance for Vehicle Checkpoint Inspection

☐ **Explosives**
- DNT on various substrates
- RDX on various substrates
- C4 on glass
- ★ TNT 100 $\mu g/cm^2$
- ▶ TNT 10 $\mu g/cm^2$
- ◆ TNT 1 $\mu g/cm^2$
- ◆ **HMEs** - ANFO, black powder

● **Confusors with Fuel Oil**

● **Environmental Materials**
Multiple car panels – (clean and dirty; metal & painted), plastic moldings, handles

1 detection : Pd = 0.80
1 FA in 62 cars ≥ 1 $\mu g/cm^2$
1 FA in 152 cars ≥ 10 $\mu g/cm^2$

2 detections : Pd = 0.80
1 FA in 400 cars ≥ 1 $\mu g/cm^2$
1 FA in 441 cars ≥ 10 $\mu g/cm^2$

** 212 measurements per car*

- **Trace level explosives separate out from clutter and can be detected with reasonable confidence**
- **ROC analysis suggests very low fill trace detection is challenging against more false alarms**

PHASE - 4
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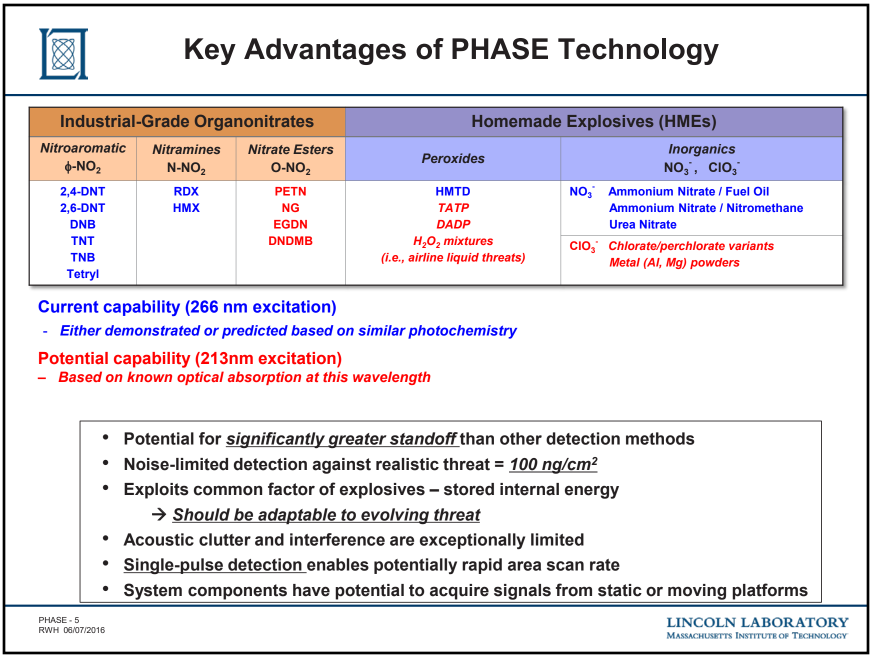

Key Advantages of PHASE Technology

Industrial-Grade Organonitrates			**Homemade Explosives (HMEs)**	
Nitroaromatic ϕ-NO_2	*Nitramines* N-NO_2	*Nitrate Esters* O-NO_2	*Peroxides*	*Inorganics* NO_3^-, ClO_3^-
2,4-DNT 2,6-DNT DNB TNT TNB Tetryl	RDX HMX	PETN NG EGDN DNDMB	HMTD *TATP* *DADP* *H_2O_2 mixtures* *(i.e., airline liquid threats)*	NO_3^- Ammonium Nitrate / Fuel Oil Ammonium Nitrate / Nitromethane Urea Nitrate ClO_3^- *Chlorate/perchlorate variants* *Metal (Al, Mg) powders*

Current capability (266 nm excitation)

- *Either demonstrated or predicted based on similar photochemistry*

Potential capability (213nm excitation)

– *Based on known optical absorption at this wavelength*

- Potential for ***significantly greater standoff*** than other detection methods
- Noise-limited detection against realistic threat = ***100 ng/cm²***
- Exploits common factor of explosives – stored internal energy
  - → ***Should be adaptable to evolving threat***
- Acoustic clutter and interference are exceptionally limited
- Single-pulse detection enables potentially rapid area scan rate
- System components have potential to acquire signals from static or moving platforms

PHASE - 5
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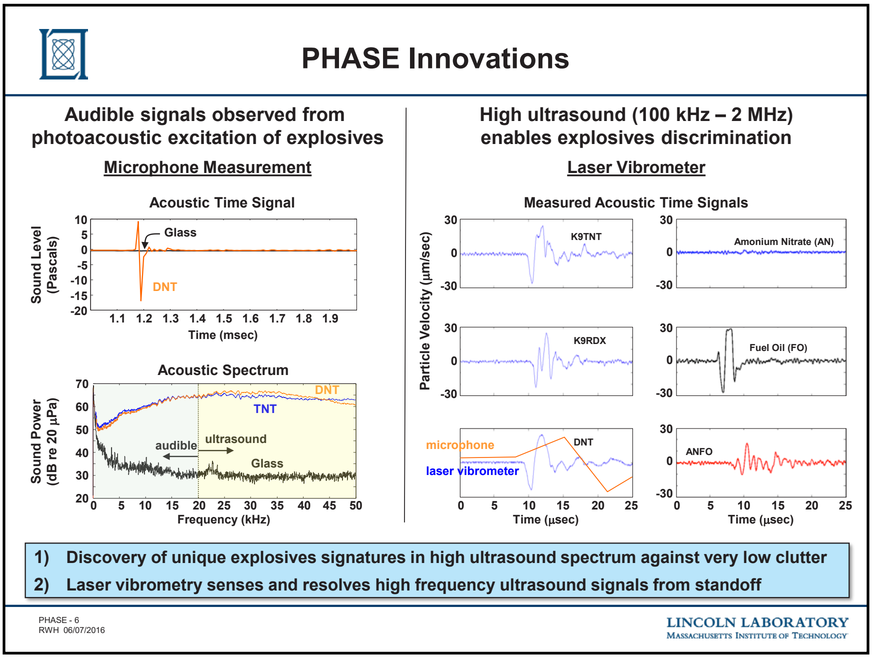

PHASE Innovations

Audible signals observed from photoacoustic excitation of explosives

Microphone Measurement

High ultrasound (100 kHz – 2 MHz) enables explosives discrimination

Laser Vibrometer

1) Discovery of unique explosives signatures in high ultrasound spectrum against very low clutter
2) Laser vibrometry senses and resolves high frequency ultrasound signals from standoff

PHASE - 6
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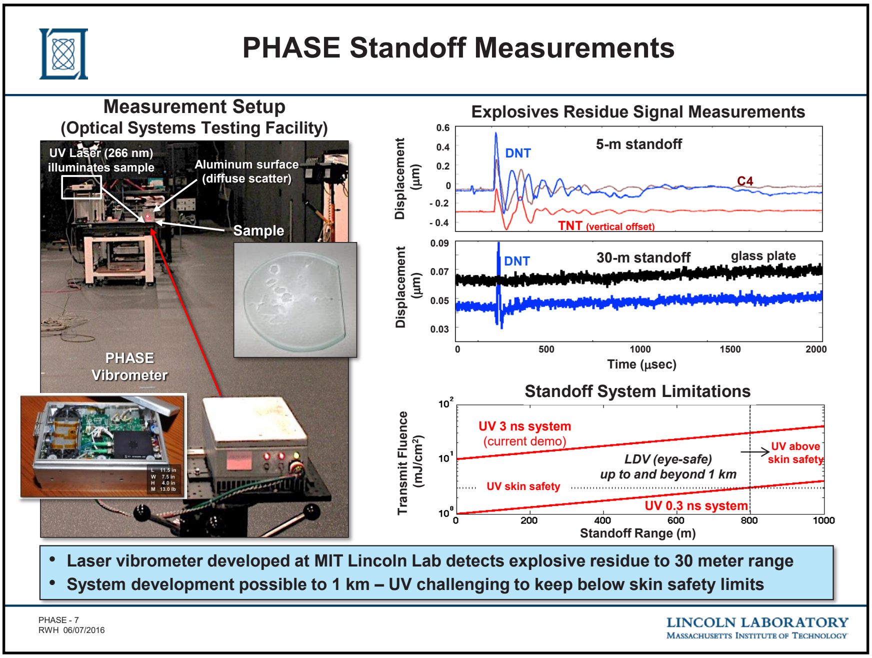


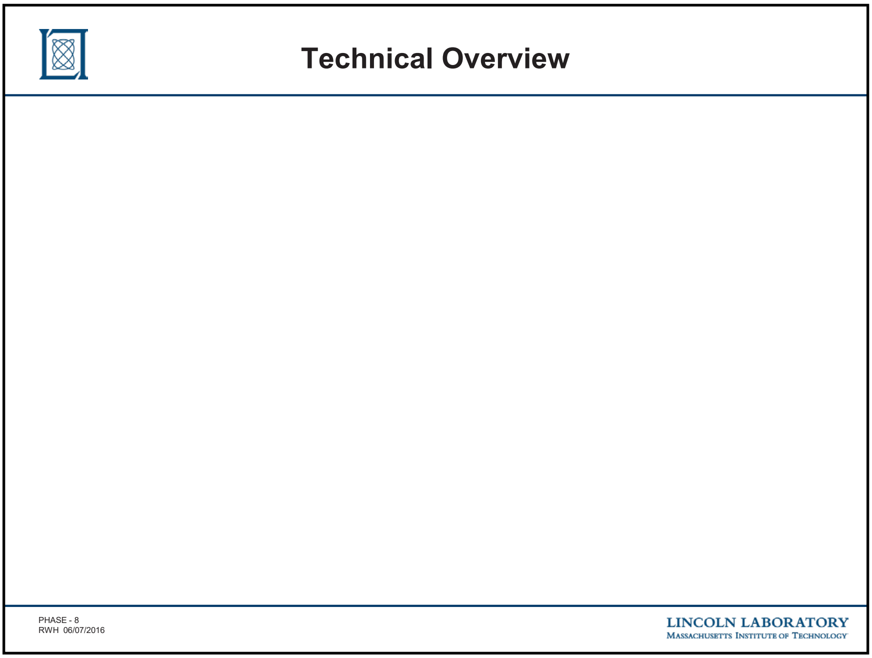
PHASE Standoff Measurements

Measurement Setup
(Optical Systems Testing Facility)

Explosives Residue Signal Measurements

Standoff System Limitations

- Laser vibrometer developed at MIT Lincoln Lab detects explosive residue to 30 meter range
- System development possible to 1 km – UV challenging to keep below skin safety limits



Technical Overview

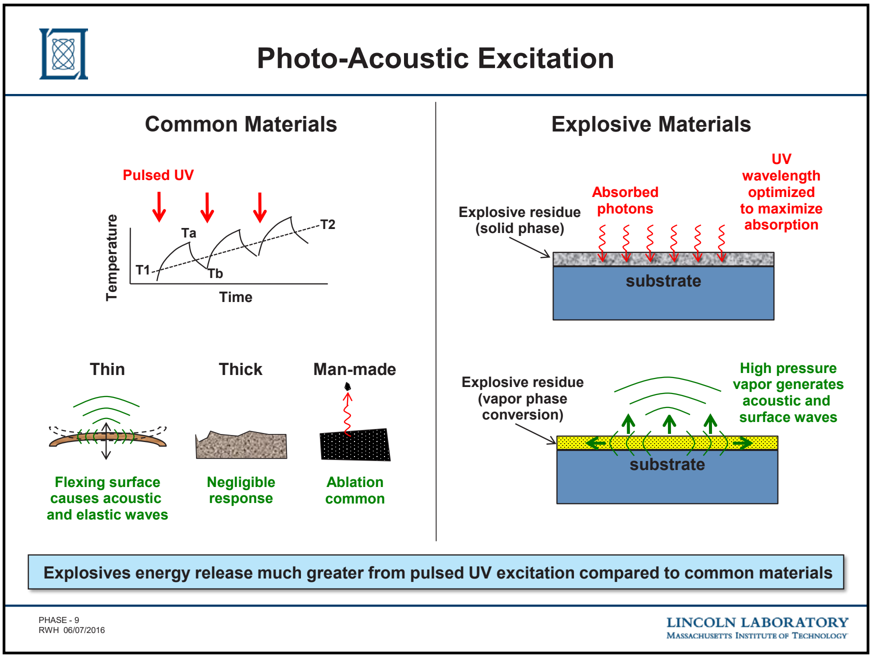


Photo-Acoustic Excitation

Common Materials

Pulsed UV

Thin

Flexing surface causes acoustic and elastic waves

Thick

Negligible response

Man-made

Ablation common

Explosive Materials

Explosive residue (solid phase)

Absorbed photons

UV wavelength optimized to maximize absorption

Explosive residue (vapor phase conversion)

High pressure vapor generates acoustic and surface waves

Explosives energy release much greater from pulsed UV excitation compared to common materials

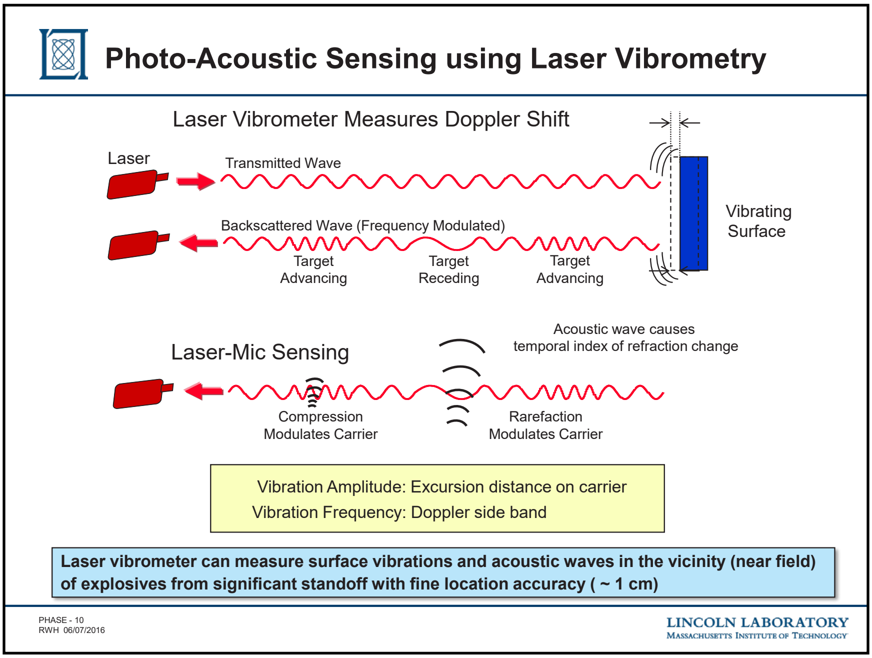


Photo-Acoustic Sensing using Laser Vibrometry

Laser Vibrometer Measures Doppler Shift

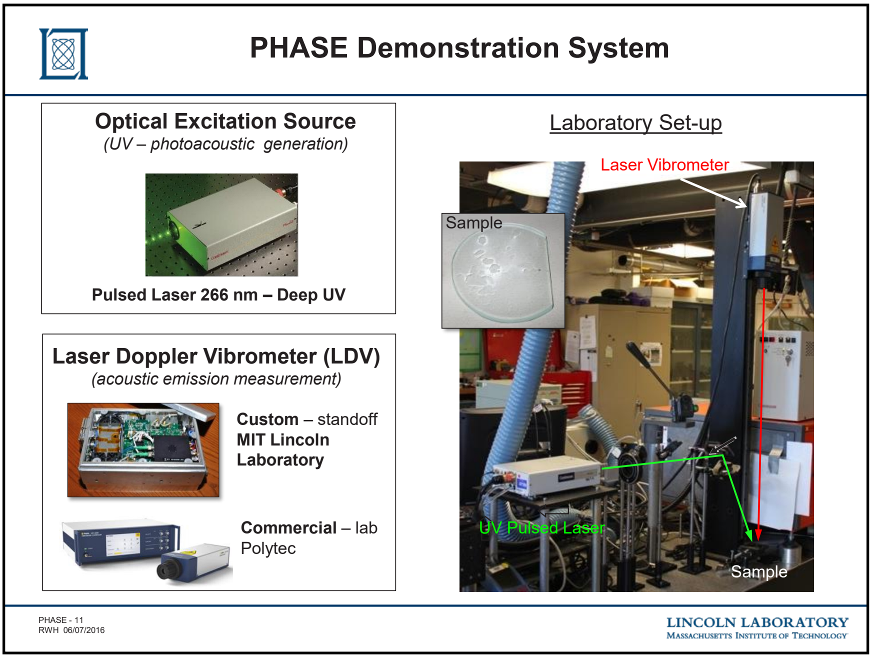
Laser-Mic Sensing

Acoustic wave causes temporal index of refraction change

Vibration Amplitude: Excursion distance on carrier

Vibration Frequency: Doppler side band

Laser vibrometer can measure surface vibrations and acoustic waves in the vicinity (near field) of explosives from significant standoff with fine location accuracy (~ 1 cm)



PHASE Demonstration System

Optical Excitation Source
(UV – photoacoustic generation)

Pulsed Laser 266 nm – Deep UV

Laser Doppler Vibrometer (LDV)
(acoustic emission measurement)

Custom – standoff
MIT Lincoln Laboratory

Commercial – lab
Polytec

Laboratory Set-up

PHASE - 11
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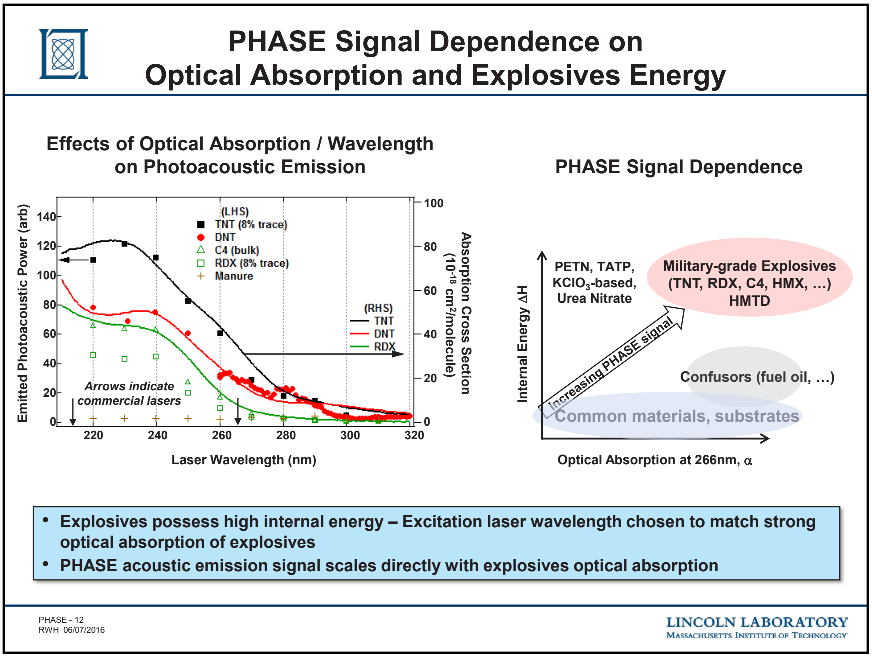

PHASE Signal Dependence on Optical Absorption and Explosives Energy

Effects of Optical Absorption / Wavelength on Photoacoustic Emission

PHASE Signal Dependence

- **Explosives possess high internal energy – Excitation laser wavelength chosen to match strong optical absorption of explosives**
- **PHASE acoustic emission signal scales directly with explosives optical absorption**

PHASE - 12
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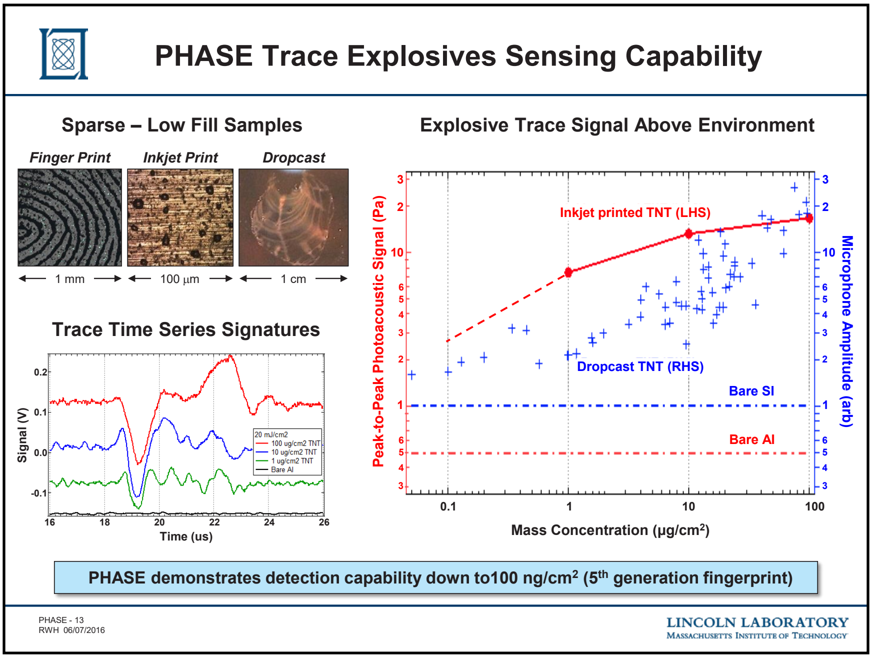

PHASE Trace Explosives Sensing Capability

Sparse – Low Fill Samples

Finger Print *Inkjet Print* *Dropcast*

Trace Time Series Signatures

Explosive Trace Signal Above Environment

PHASE demonstrates detection capability down to100 ng/cm² (5th generation fingerprint)

PHASE - 13
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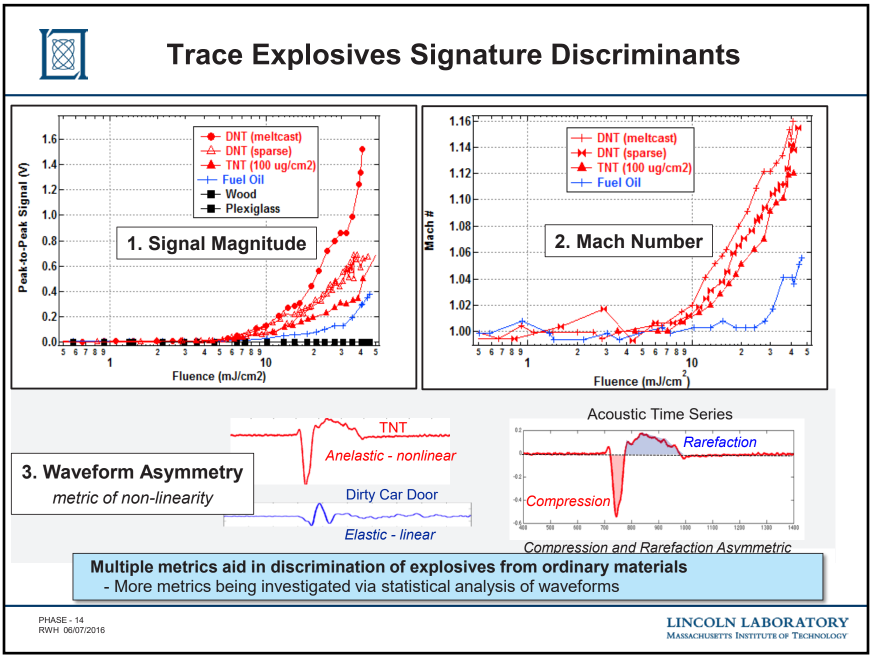

Trace Explosives Signature Discriminants

1. Signal Magnitude

2. Mach Number

3. Waveform Asymmetry
metric of non-linearity

Acoustic Time Series

Compression and Rarefaction Asymmetric

Multiple metrics aid in discrimination of explosives from ordinary materials
- More metrics being investigated via statistical analysis of waveforms

PHASE - 14
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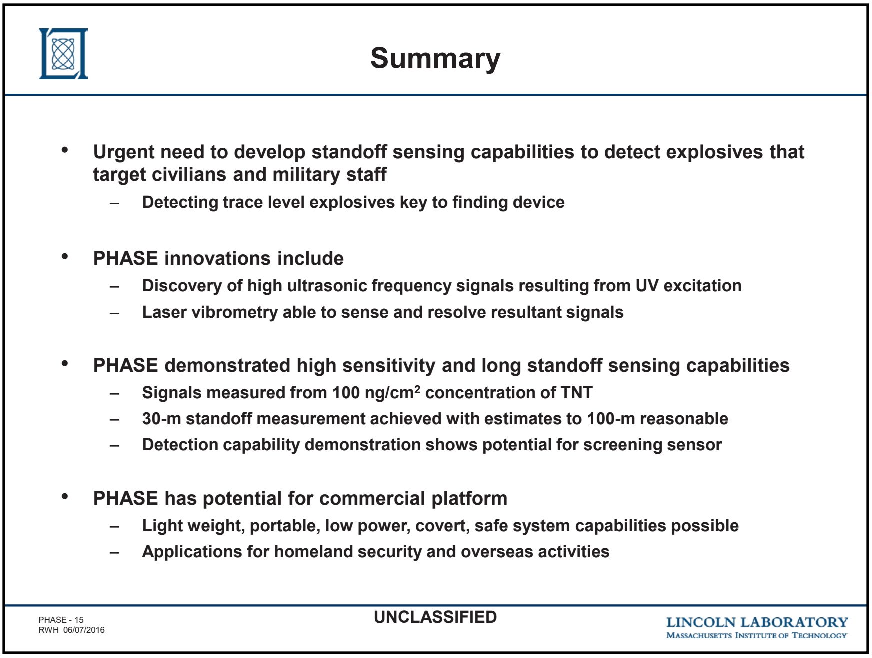

Summary

- **Urgent need to develop standoff sensing capabilities to detect explosives that target civilians and military staff**
  - **Detecting trace level explosives key to finding device**
- **PHASE innovations include**
  - **Discovery of high ultrasonic frequency signals resulting from UV excitation**
  - **Laser vibrometry able to sense and resolve resultant signals**
- **PHASE demonstrated high sensitivity and long standoff sensing capabilities**
  - **Signals measured from 100 ng/cm^2 concentration of TNT**
  - **30-m standoff measurement achieved with estimates to 100-m reasonable**
  - **Detection capability demonstration shows potential for screening sensor**
- **PHASE has potential for commercial platform**
  - **Light weight, portable, low power, covert, safe system capabilities possible**
  - **Applications for homeland security and overseas activities**

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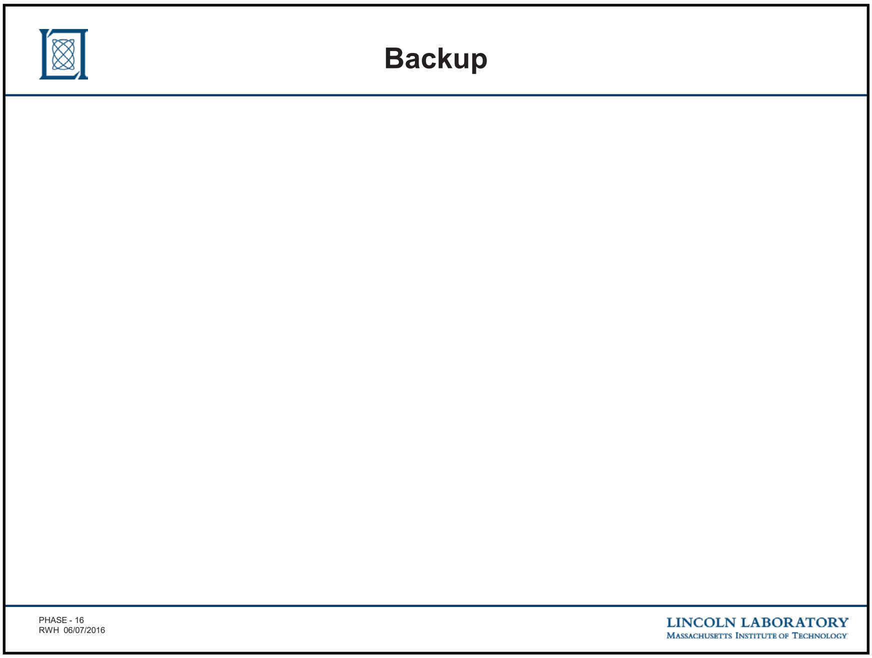

Backup

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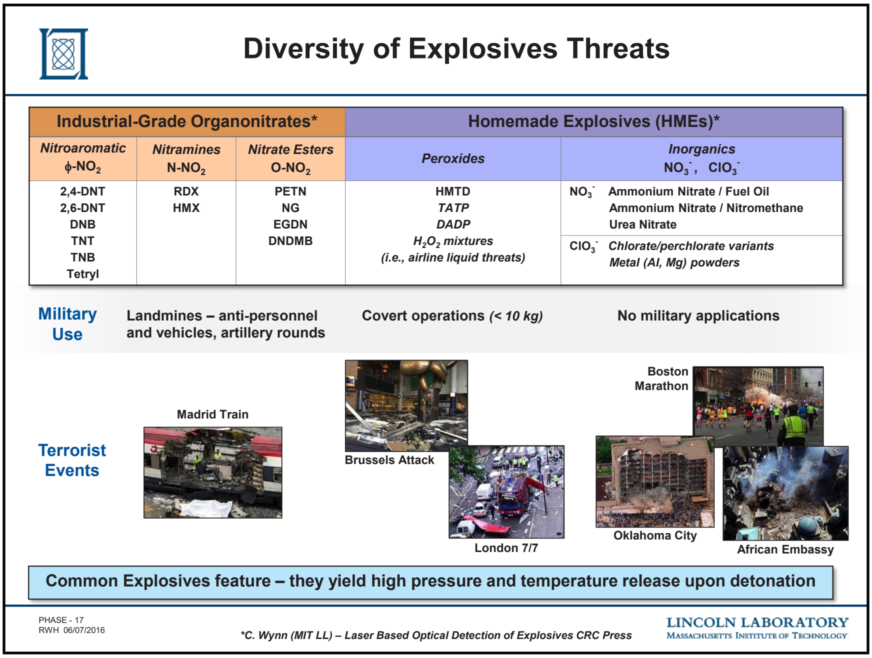

Diversity of Explosives Threats

Industrial-Grade Organonitrates*			Homemade Explosives (HMEs)*	
Nitroaromatic ϕ-NO$_2$	*Nitramines* N-NO$_2$	*Nitrate Esters* O-NO$_2$	*Peroxides*	*Inorganics* NO$_3^-$, ClO$_3^-$
2,4-DNT 2,6-DNT DNB TNT TNB Tetryl	RDX HMX	PETN NG EGDN DNDMB	HMTD *TATP* *DADP* *H_2O_2 mixtures* *(i.e., airline liquid threats)*	NO_3^- Ammonium Nitrate / Fuel Oil Ammonium Nitrate / Nitromethane Urea Nitrate ClO_3^- *Chlorate/perchlorate variants* *Metal (Al, Mg) powders*

Military Use

Landmines – anti-personnel and vehicles, artillery rounds

Covert operations *(< 10 kg)*

No military applications

Terrorist Events

Common Explosives feature – they yield high pressure and temperature release upon detonation

PHASE - 17
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C. Wynn (MIT LL) – Laser Based Optical Detection of Explosives CRC Press

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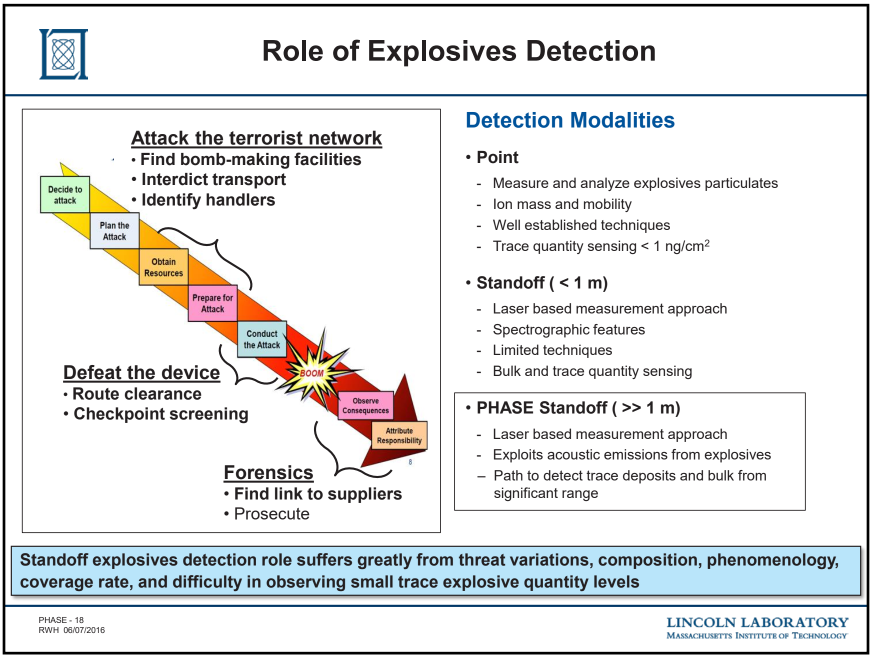

Role of Explosives Detection

Attack the terrorist network
- Find bomb-making facilities
- Interdict transport
- Identify handlers

Defeat the device
- Route clearance
- Checkpoint screening

Forensics
- Find link to suppliers
- Prosecute

Detection Modalities

- Point
  - Measure and analyze explosives particulates
  - Ion mass and mobility
  - Well established techniques
  - Trace quantity sensing < 1 ng/cm^2
- Standoff (< 1 m)
  - Laser based measurement approach
  - Spectrographic features
  - Limited techniques
  - Bulk and trace quantity sensing
- PHASE Standoff (>> 1 m)
  - Laser based measurement approach
  - Exploits acoustic emissions from explosives
  - Path to detect trace deposits and bulk from significant range

Standoff explosives detection role suffers greatly from threat variations, composition, phenomenology, coverage rate, and difficulty in observing small trace explosive quantity levels

PHASE - 18
RWH 06/07/2016

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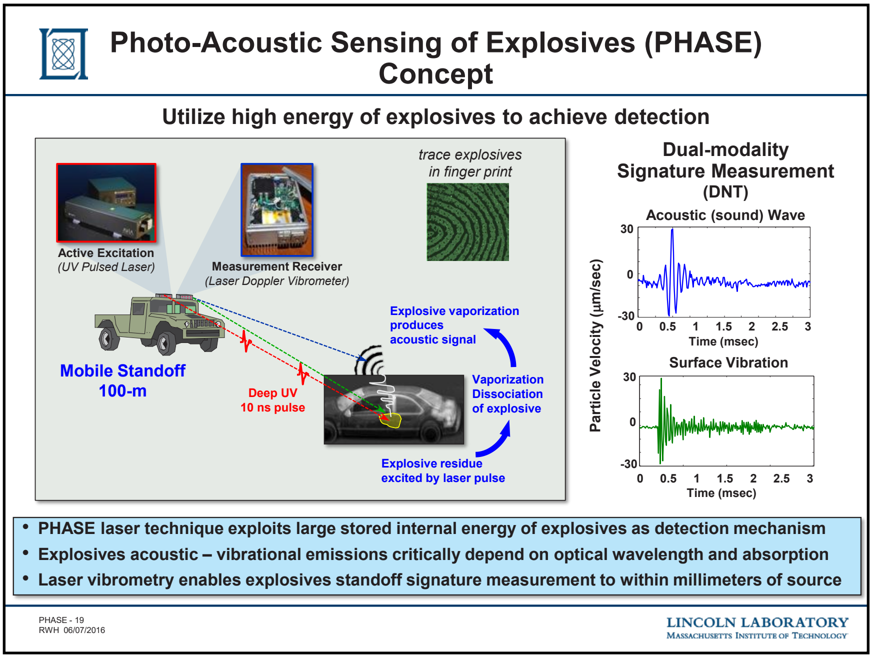

Photo-Acoustic Sensing of Explosives (PHASE) Concept

Utilize high energy of explosives to achieve detection

- **PHASE laser technique exploits large stored internal energy of explosives as detection mechanism**
- **Explosives acoustic – vibrational emissions critically depend on optical wavelength and absorption**
- **Laser vibrometry enables explosives standoff signature measurement to within millimeters of source**

PHASE - 19
RWH 06/07/2016

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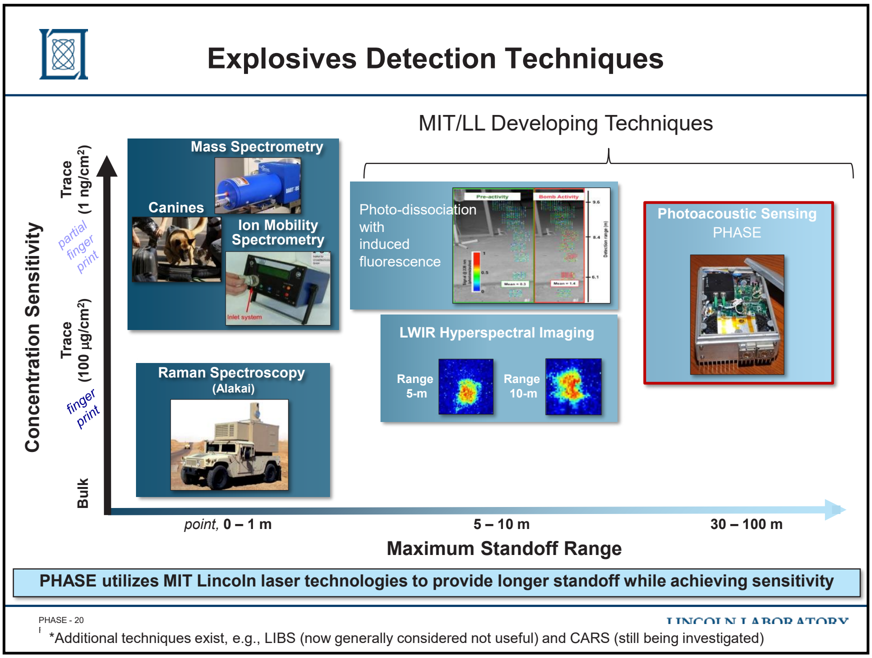

Explosives Detection Techniques

MIT/LL Developing Techniques

PHASE utilizes MIT Lincoln laser technologies to provide longer standoff while achieving sensitivity

PHASE - 20

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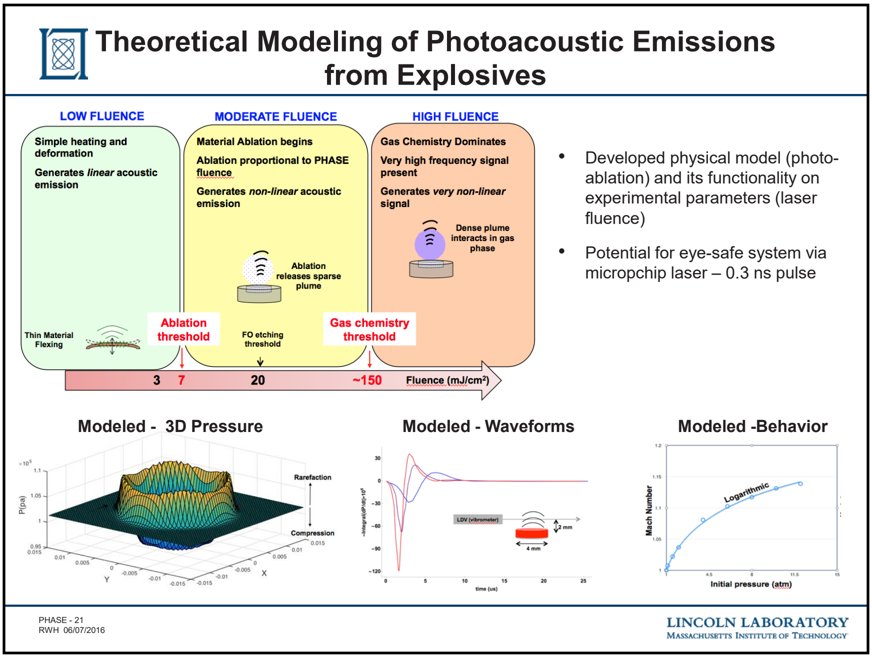
*Additional techniques exist, e.g., LIBS (now generally considered not useful) and CARS (still being investigated)



Theoretical Modeling of Photoacoustic Emissions from Explosives

LOW FLUENCE

Simple heating and deformation

Generates *linear* acoustic emission

MODERATE FLUENCE

Material Ablation begins

Ablation proportional to PHASE fluence

Generates *non-linear* acoustic emission

HIGH FLUENCE

Gas Chemistry Dominates

Very high frequency signal present

Generates *very non-linear* signal

- Developed physical model (photo-ablation) and its functionality on experimental parameters (laser fluence)
- Potential for eye-safe system via micropchip laser – 0.3 ns pulse

Modeled - 3D Pressure

Modeled - Waveforms

Modeled -Behavior

PHASE - 21
RWH 06/07/2016

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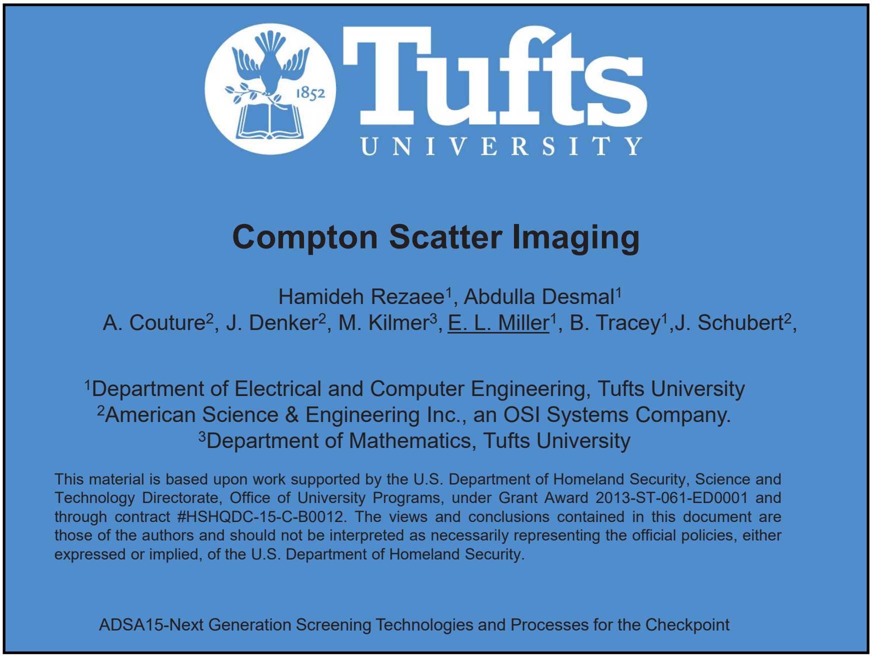
Massachusetts Institute of Technology

16.39 Eric Miller & Brian Tracey: Compton Scatter Imaging



Compton Scatter Imaging

Hamideh Rezaee[1], Abdulla Desmal[1]
A. Couture[2], J. Denker[2], M. Kilmer[3], E. L. Miller[1], B. Tracey[1],J. Schubert[2],

[1]Department of Electrical and Computer Engineering, Tufts University
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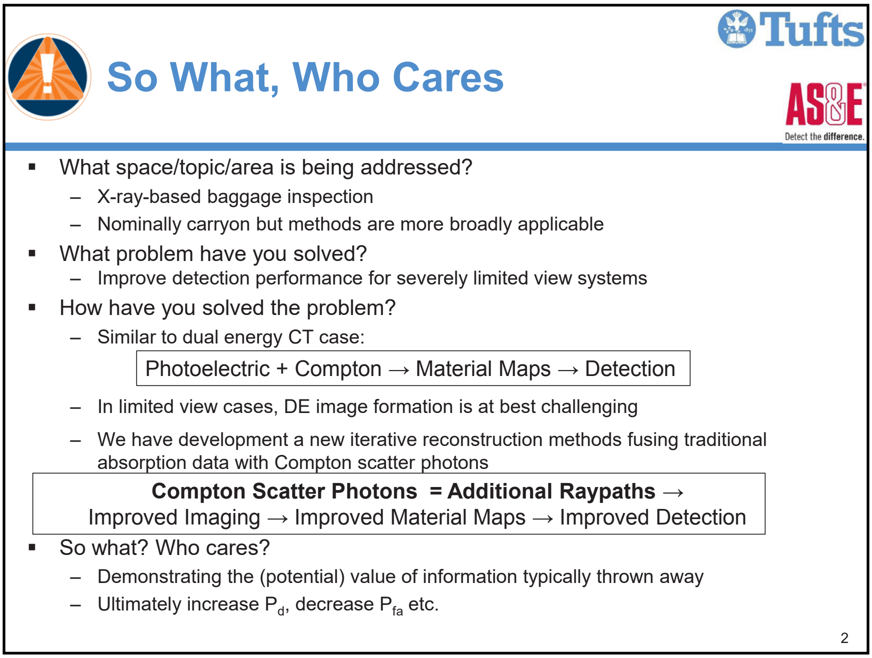
This material is based upon work supported by the U.S. Department of Homeland Security, Science and Technology Directorate, Office of University Programs, under Grant Award 2013-ST-061-ED0001 and through contract #HSHQDC-15-C-B0012. The views and conclusions contained in this document are those of the authors and should not be interpreted as necessarily representing the official policies, either expressed or implied, of the U.S. Department of Homeland Security.

ADSA15-Next Generation Screening Technologies and Processes for the Checkpoint



So What, Who Cares

- What space/topic/area is being addressed?
  - X-ray-based baggage inspection
  - Nominally carryon but methods are more broadly applicable
- What problem have you solved?
  - Improve detection performance for severely limited view systems
- How have you solved the problem?
  - Similar to dual energy CT case:

    Photoelectric + Compton → Material Maps → Detection

  - In limited view cases, DE image formation is at best challenging
  - We have development a new iterative reconstruction methods fusing traditional absorption data with Compton scatter photons

Compton Scatter Photons = Additional Raypaths →
Improved Imaging → Improved Material Maps → Improved Detection

- So what? Who cares?
  - Demonstrating the (potential) value of information typically thrown away
  - Ultimately increase P_d, decrease P_{fa} etc.

The Team

Hamideh Rezaee

Abdulla Desmal

Aaron Couture

Jeff Denker

Misha Kilmer

Eric Miller

Jeff Schubert

Brian Tracey

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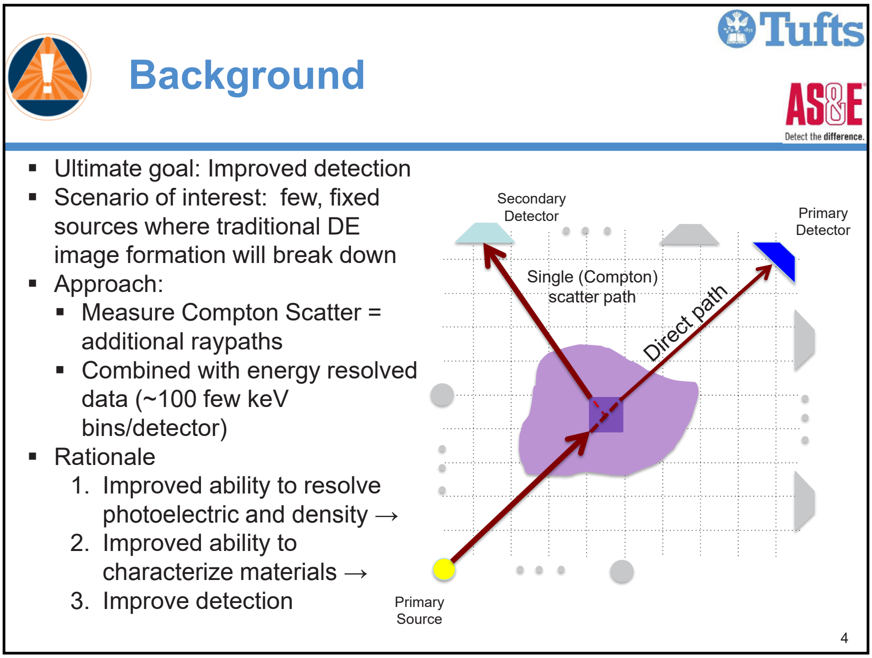
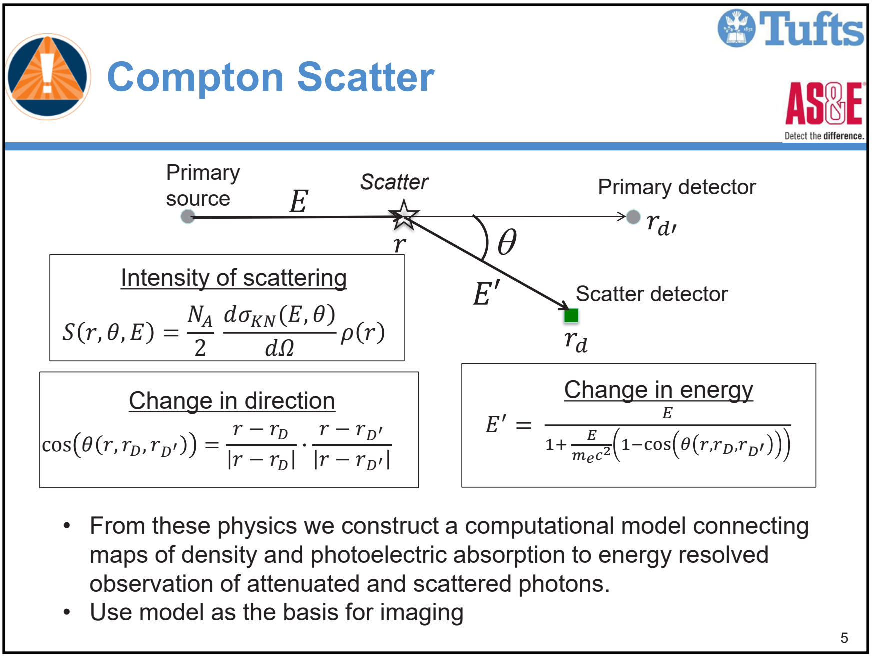


Background

- Ultimate goal: Improved detection
- Scenario of interest: few, fixed sources where traditional DE image formation will break down
- Approach:
  - Measure Compton Scatter = additional raypaths
  - Combined with energy resolved data (~100 few keV bins/detector)
- Rationale
  1. Improved ability to resolve photoelectric and density →
  2. Improved ability to characterize materials →
  3. Improve detection



Compton Scatter

Intensity of scattering

$$S(r,\theta,E) = \frac{N_A}{2}\frac{d\sigma_{KN}(E,\theta)}{d\Omega}\rho(r)$$

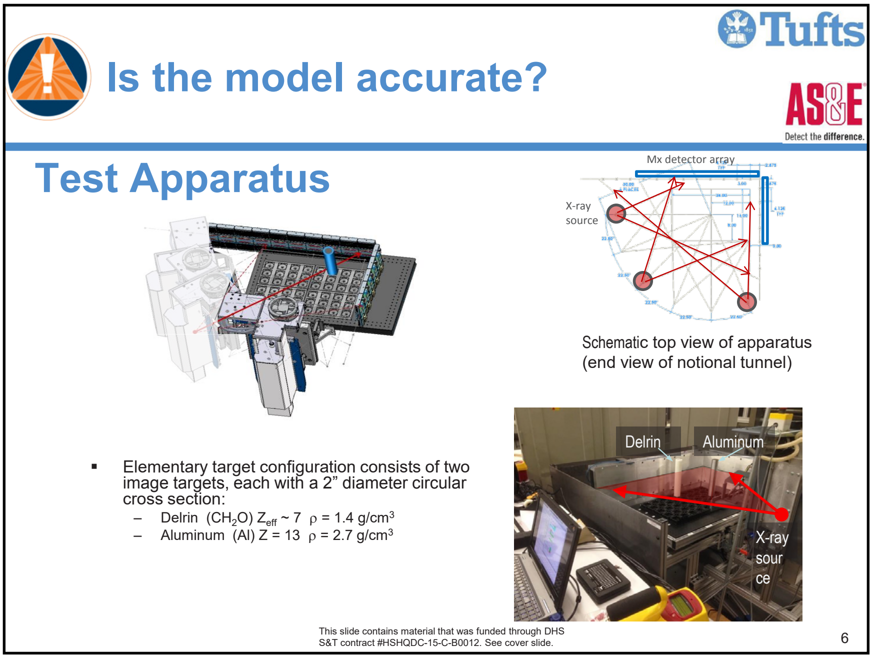
Change in direction

$$\cos(\theta(r,r_D,r_{D'})) = \frac{r-r_D}{|r-r_D|}\cdot\frac{r-r_{D'}}{|r-r_{D'}|}$$

Change in energy

$$E' = \frac{E}{1+\frac{E}{m_e c^2}\left(1-\cos(\theta(r,r_D,r_{D'}))\right)}$$

- From these physics we construct a computational model connecting maps of density and photoelectric absorption to energy resolved observation of attenuated and scattered photons.
- Use model as the basis for imaging



Is the model accurate?

Test Apparatus

Schematic top view of apparatus
(end view of notional tunnel)

- Elementary target configuration consists of two image targets, each with a 2" diameter circular cross section:
  - Delrin (CH$_2$O) $Z_{eff} \sim 7$ $\rho = 1.4$ g/cm^3
  - Aluminum (Al) $Z = 13$ $\rho = 2.7$ g/cm^3

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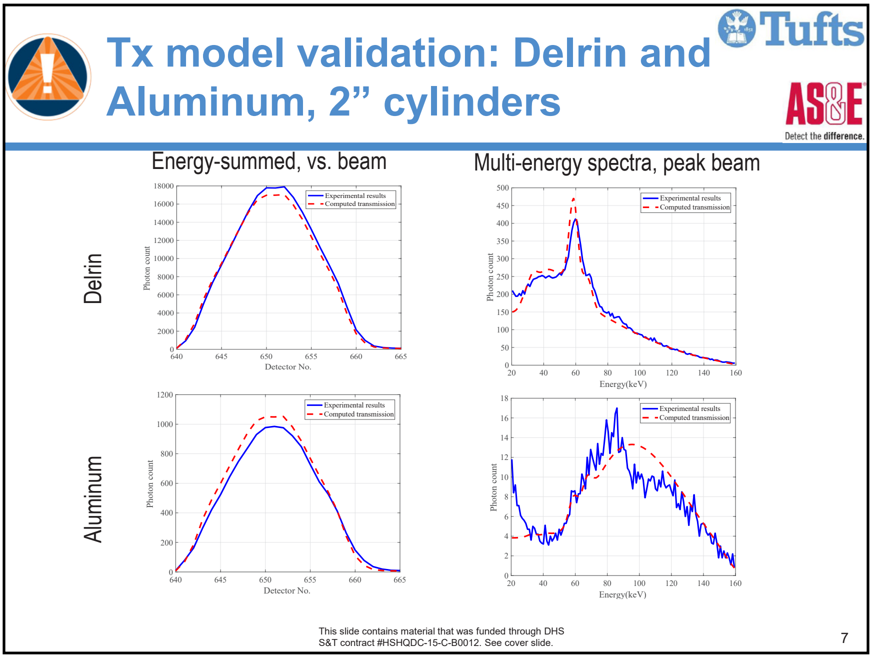

Tx model validation: Delrin and Aluminum, 2” cylinders

Energy-summed, vs. beam

Multi-energy spectra, peak beam

Delrin

Aluminum

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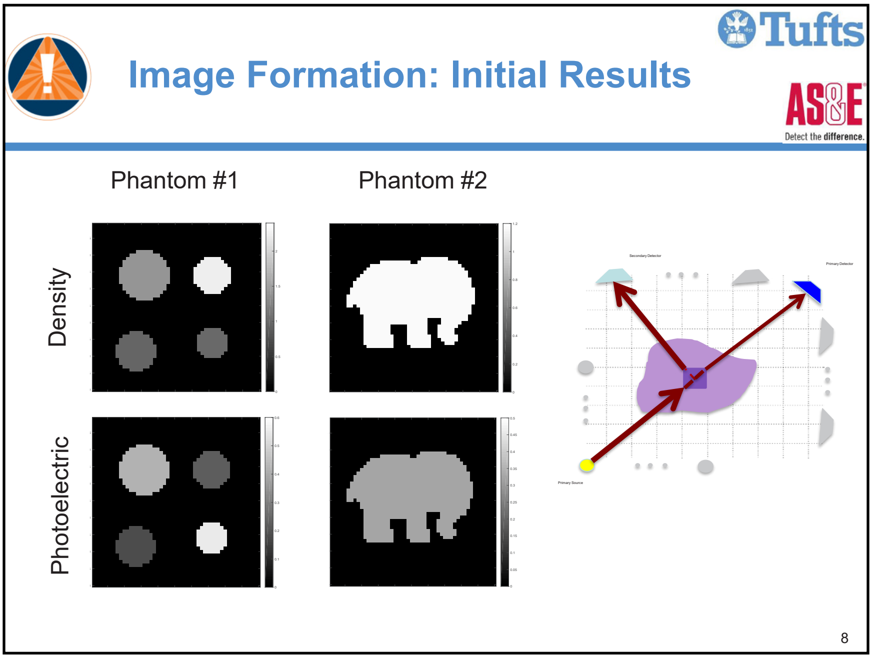


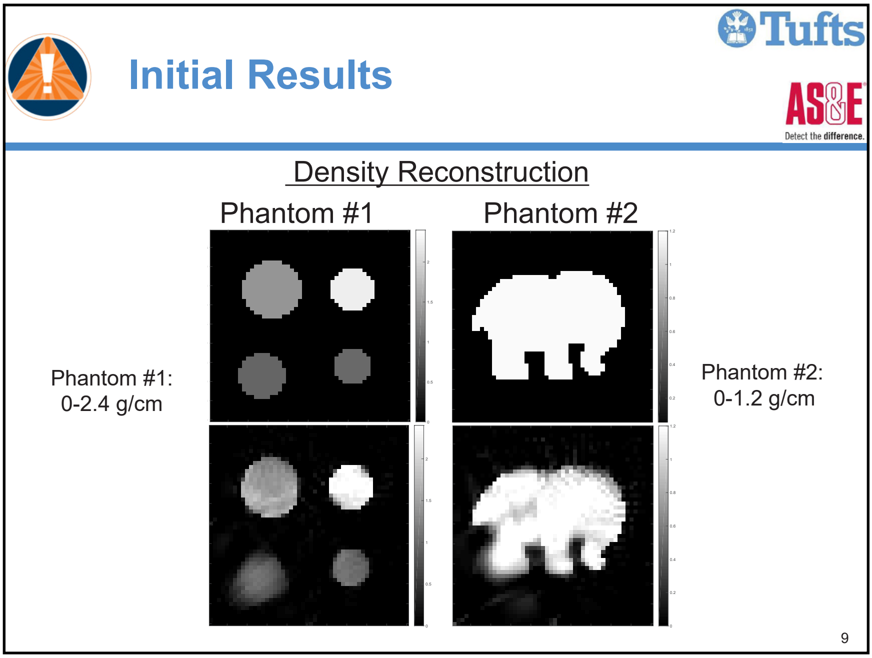
Image Formation: Initial Results

Phantom #1

Phantom #2

Density

Photoelectric



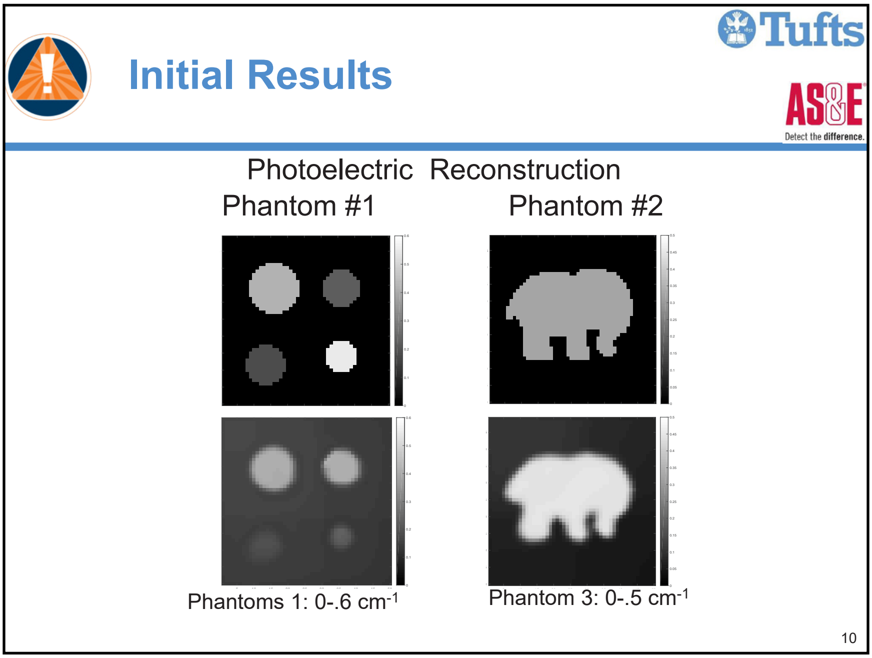
Initial Results

Density Reconstruction

Phantom #1 Phantom #2

Phantom #1:
0-2.4 g/cm

Phantom #2:
0-1.2 g/cm



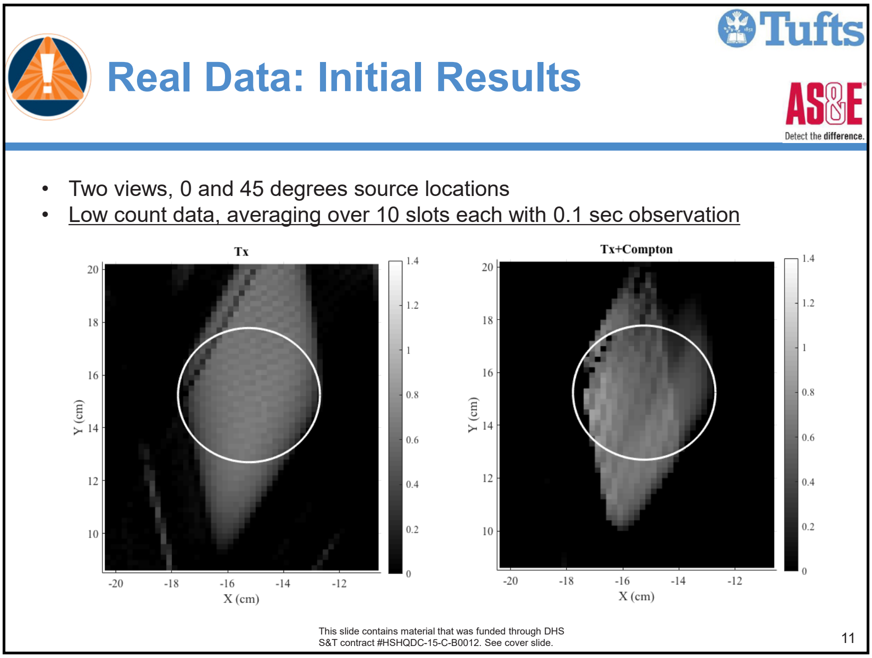
Initial Results

Photoelectric Reconstruction

Phantom #1 Phantom #2

Phantoms 1: 0-.6 cm^{-1}

Phantom 3: 0-.5 cm^{-1}



Real Data: Initial Results

- Two views, 0 and 45 degrees source locations
- Low count data, averaging over 10 slots each with 0.1 sec observation

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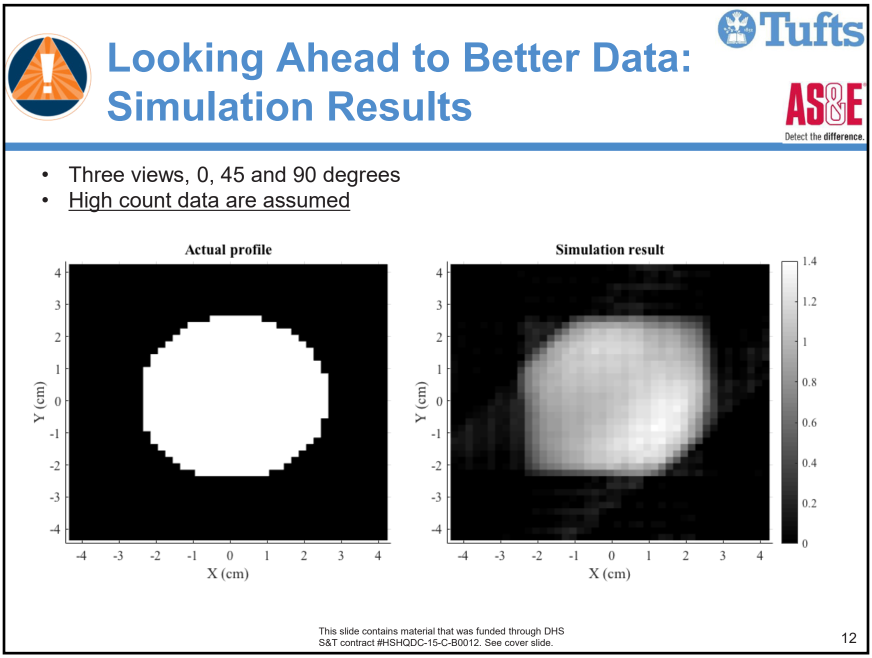

Looking Ahead to Better Data: Simulation Results

- Three views, 0, 45 and 90 degrees
- High count data are assumed

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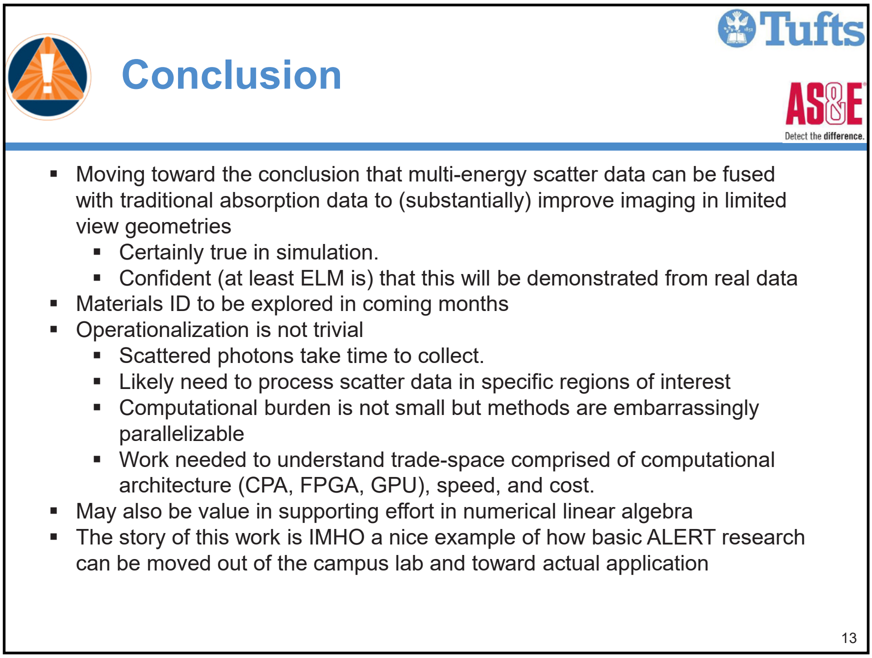
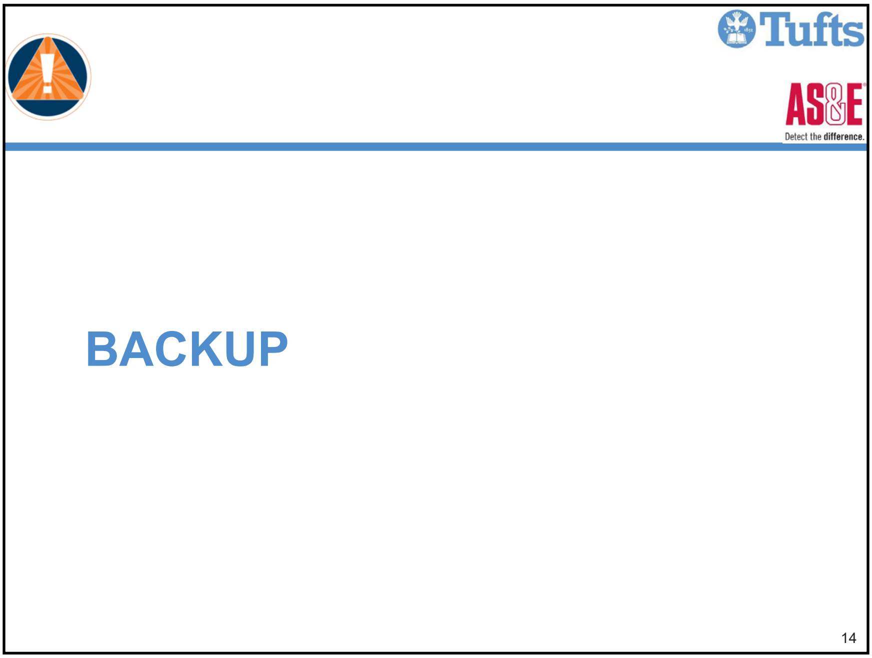


Conclusion

- Moving toward the conclusion that multi-energy scatter data can be fused with traditional absorption data to (substantially) improve imaging in limited view geometries
  - Certainly true in simulation.
  - Confident (at least ELM is) that this will be demonstrated from real data
- Materials ID to be explored in coming months
- Operationalization is not trivial
  - Scattered photons take time to collect.
  - Likely need to process scatter data in specific regions of interest
  - Computational burden is not small but methods are embarrassingly parallelizable
  - Work needed to understand trade-space comprised of computational architecture (CPA, FPGA, GPU), speed, and cost.
- May also be value in supporting effort in numerical linear algebra
- The story of this work is IMHO a nice example of how basic ALERT research can be moved out of the campus lab and toward actual application



BACKUP

Compton Scatter

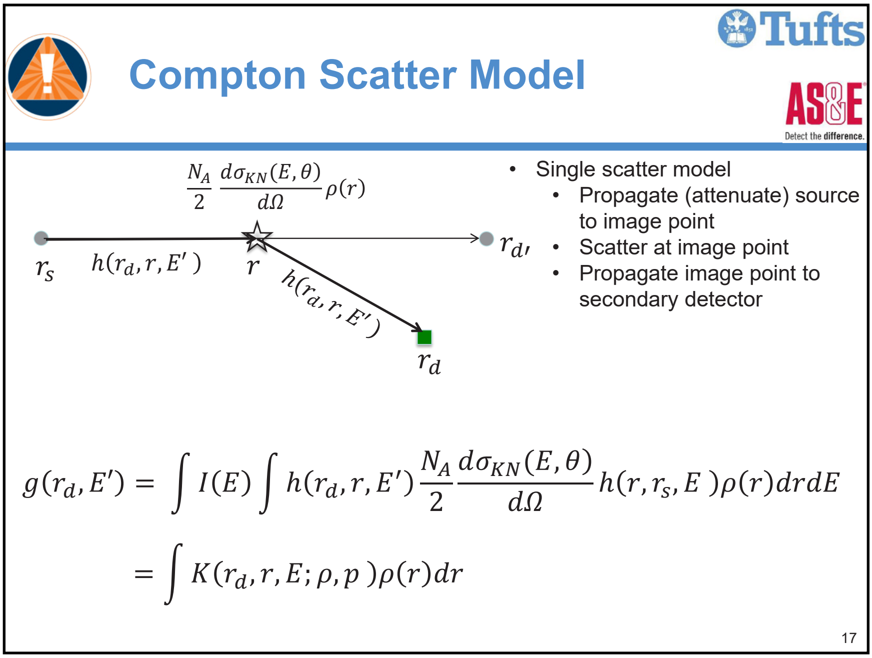
- Hypothesis: Some energy leaving the main bean can be usefully recovered and ultimately improve detection performance
- Dominant process of interest here is Compton Scatter
- Inelastic scattering of an incoming X-ray photon by an electron

---

Discrete Compton Scatter Model

$$g = K(\rho, p)\rho + \mathcal{N}(0, \delta^2)$$

- Data vector aggregates information as a function of
  - Source-Primary Detector pair, $(r_s, r_d,)$
  - Secondary detector: r_d
  - Energy: E'
- Nice structure:
  - Kind of linear in density
  - Will be exploited in processing
- For system with relatively few primary raypaths
  - Compton scatter gives many more “looks”
  - But signal strength lower. Either lower SNR or increased integration time
- Settle for additive white Gaussian noise for now. Poisson later.

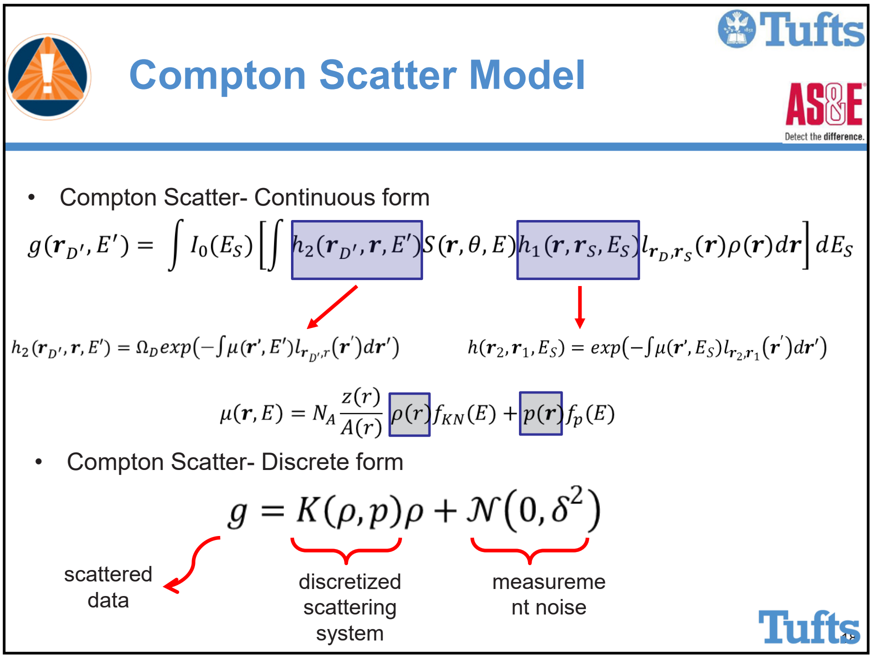


Compton Scatter Model

- Single scatter model
  - Propagate (attenuate) source to image point
  - Scatter at image point
  - Propagate image point to secondary detector

$$g(r_d, E') = \int I(E) \int h(r_d, r, E') \frac{N_A}{2}\frac{d\sigma_{KN}(E,\theta)}{d\Omega} h(r, r_s, E\ )\rho(r)drdE$$

$$= \int K(r_d, r, E; \rho, p\ )\rho(r)dr$$



Compton Scatter Model

- Compton Scatter- Continuous form

$$g(\mathbf{r}_{D'}, E') = \int I_0(E_S)\left[\iint \boxed{h_2(\mathbf{r}_{D'}, \mathbf{r}, E')} S(\mathbf{r}, \theta, E) \boxed{h_1(\mathbf{r}, \mathbf{r}_S, E_S)} l_{\mathbf{r}_D, \mathbf{r}_S}(\mathbf{r})\rho(\mathbf{r})d\mathbf{r}\right] dE_S$$

$$h_2(\mathbf{r}_{D'}, \mathbf{r}, E') = \Omega_D exp(-\int \mu(\mathbf{r}', E') l_{\mathbf{r}_{D'}, r}(\mathbf{r}')d\mathbf{r}')$$

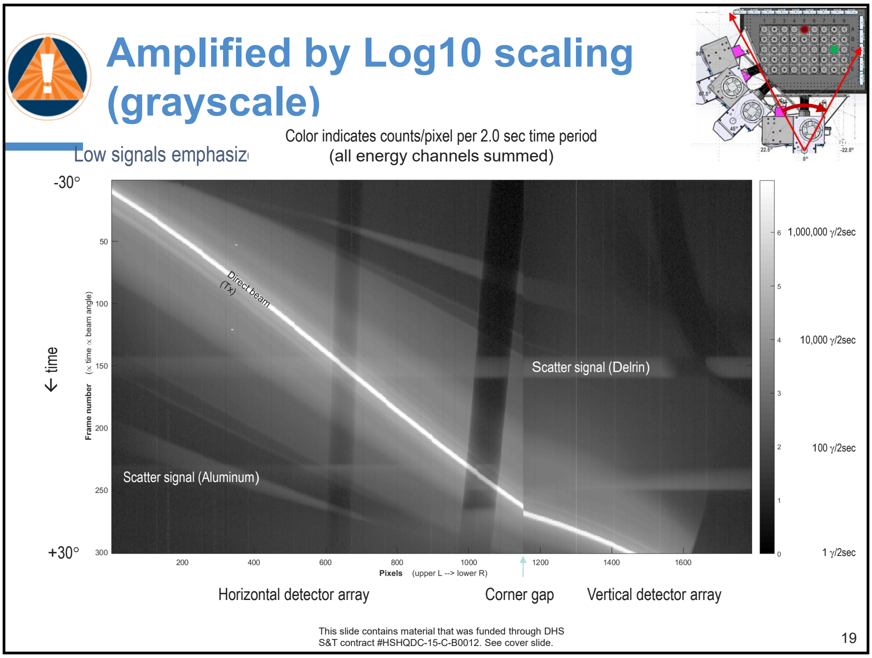
$$h(\mathbf{r}_2, \mathbf{r}_1, E_S) = exp(-\int \mu(\mathbf{r}', E_S) l_{\mathbf{r}_2, \mathbf{r}_1}(\mathbf{r}')d\mathbf{r}')$$

$$\mu(\mathbf{r}, E) = N_A \frac{z(r)}{A(r)} \boxed{\rho(r)} f_{KN}(E) + \boxed{p(\mathbf{r})} f_p(E)$$

- Compton Scatter- Discrete form

$$g = \underbrace{K(\rho, p)}_{\text{discretized scattering system}} \rho + \underbrace{\mathcal{N}(0, \delta^2)}_{\text{measurement noise}}$$

scattered data



Amplified by Log10 scaling (grayscale)

Low signals emphasiz

Color indicates counts/pixel per 2.0 sec time period
(all energy channels summed)

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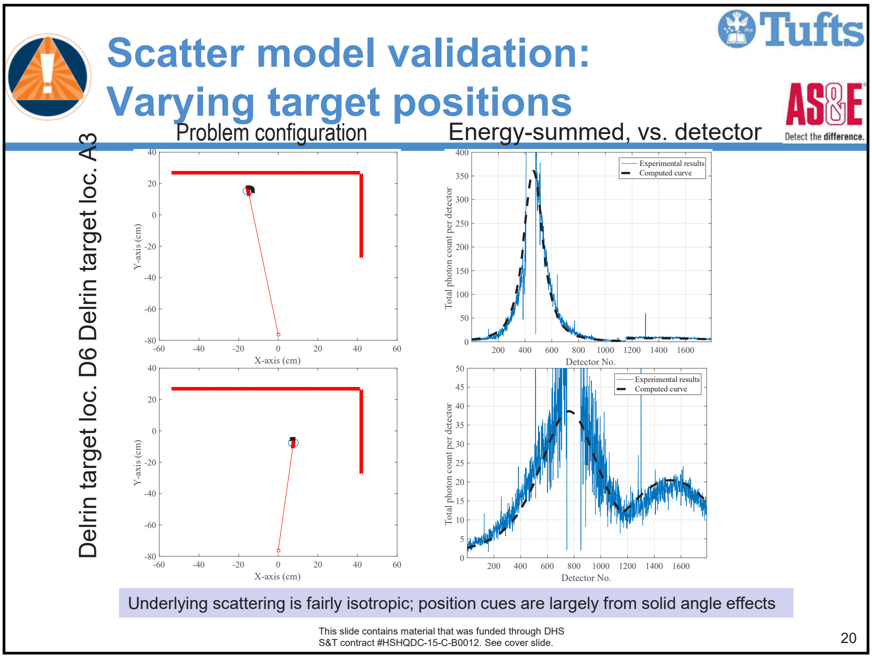

Scatter model validation: Varying target positions

Problem configuration

Energy-summed, vs. detector

Delrin target loc. D6 Delrin target loc. A3

Underlying scattering is fairly isotropic; position cues are largely from solid angle effects

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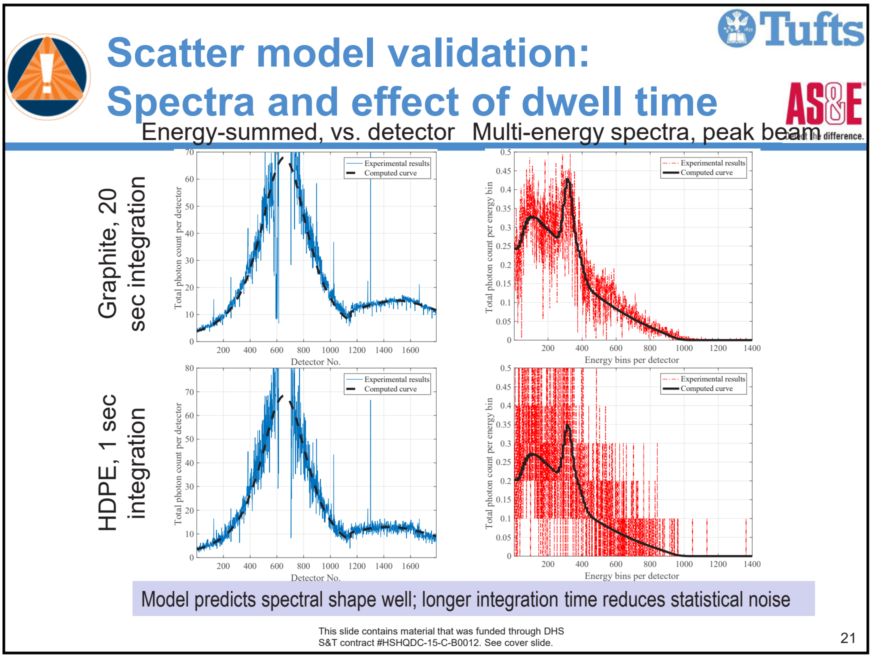

Scatter model validation: Spectra and effect of dwell time

Model predicts spectral shape well; longer integration time reduces statistical noise

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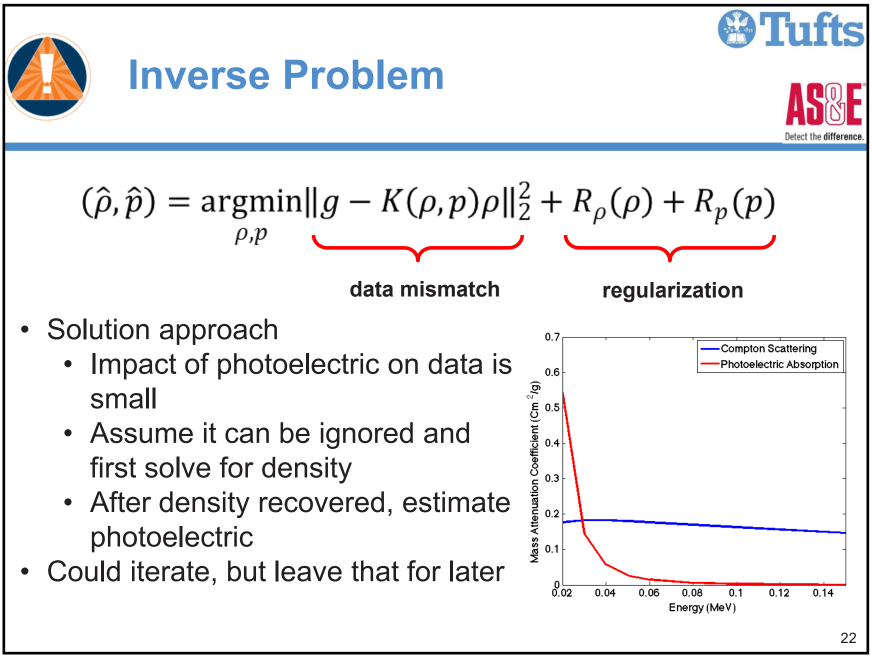
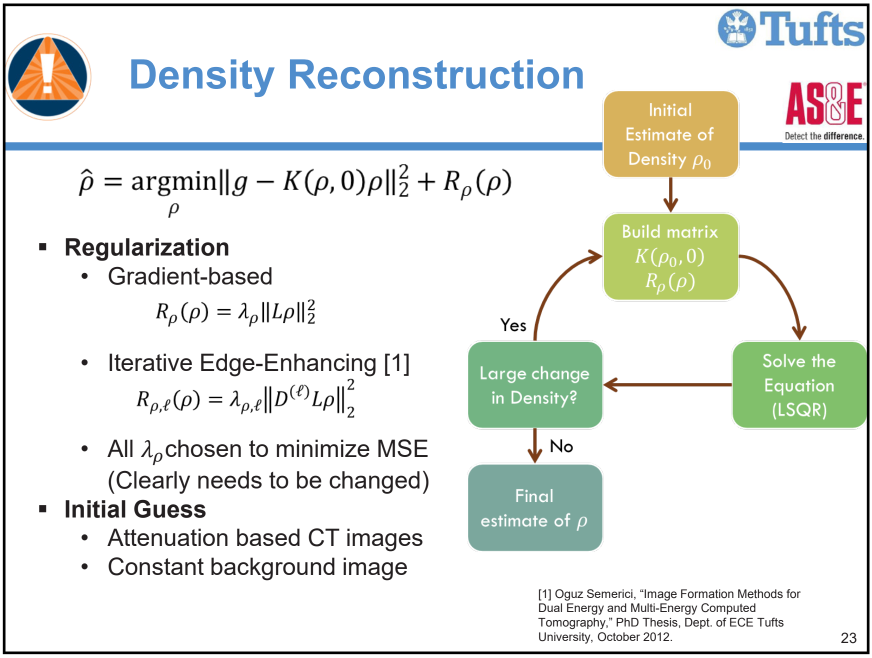


Inverse Problem

$$(\hat{\rho},\hat{p}) = \underset{\rho,p}{\operatorname{argmin}} \underbrace{\|g - K(\rho,p)\rho\|_2^2}_{\textbf{data mismatch}} + \underbrace{R_\rho(\rho) + R_p(p)}_{\textbf{regularization}}$$

- Solution approach
  - Impact of photoelectric on data is small
  - Assume it can be ignored and first solve for density
  - After density recovered, estimate photoelectric
- Could iterate, but leave that for later



Density Reconstruction

$$\hat{\rho} = \underset{\rho}{\text{argmin}}\|g - K(\rho,0)\rho\|_2^2 + R_\rho(\rho)$$

- **Regularization**
  - Gradient-based
    $$R_\rho(\rho) = \lambda_\rho\|L\rho\|_2^2$$
  - Iterative Edge-Enhancing [1]
    $$R_{\rho,\ell}(\rho) = \lambda_{\rho,\ell}\left\|D^{(\ell)}L\rho\right\|_2^2$$
  - All λ_ρ chosen to minimize MSE (Clearly needs to be changed)
- **Initial Guess**
  - Attenuation based CT images
  - Constant background image

Initial Estimate of Density ρ_0

Build matrix $K(\rho_0,0)$ $R_\rho(\rho)$

Solve the Equation (LSQR)

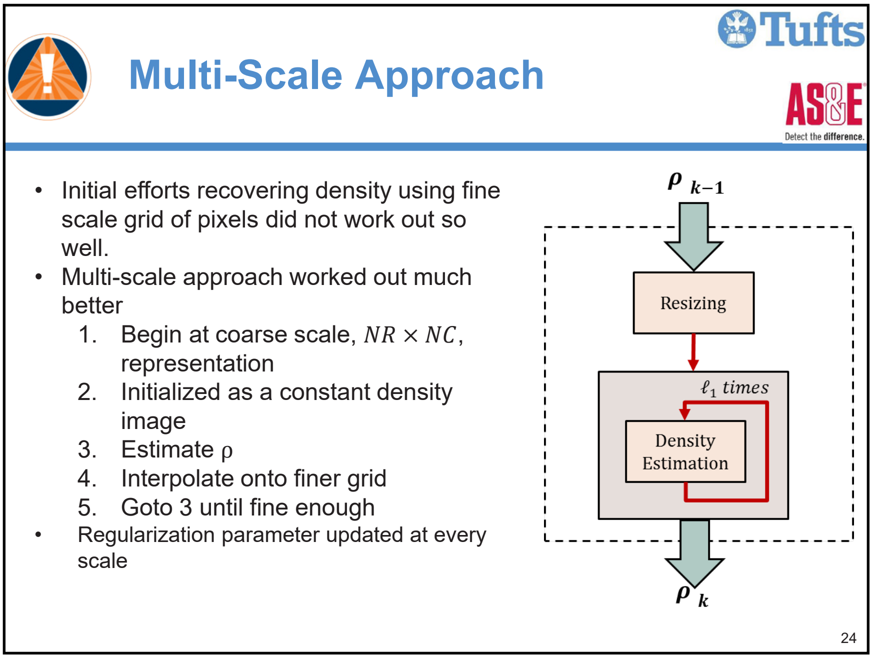
Large change in Density?

Yes

No

Final estimate of ρ

[1] Oguz Semerici, "Image Formation Methods for Dual Energy and Multi-Energy Computed Tomography," PhD Thesis, Dept. of ECE Tufts University, October 2012.



Multi-Scale Approach

- Initial efforts recovering density using fine scale grid of pixels did not work out so well.
- Multi-scale approach worked out much better
  1. Begin at coarse scale, $NR \times NC$, representation
  2. Initialized as a constant density image
  3. Estimate ρ
  4. Interpolate onto finer grid
  5. Goto 3 until fine enough
- Regularization parameter updated at every scale

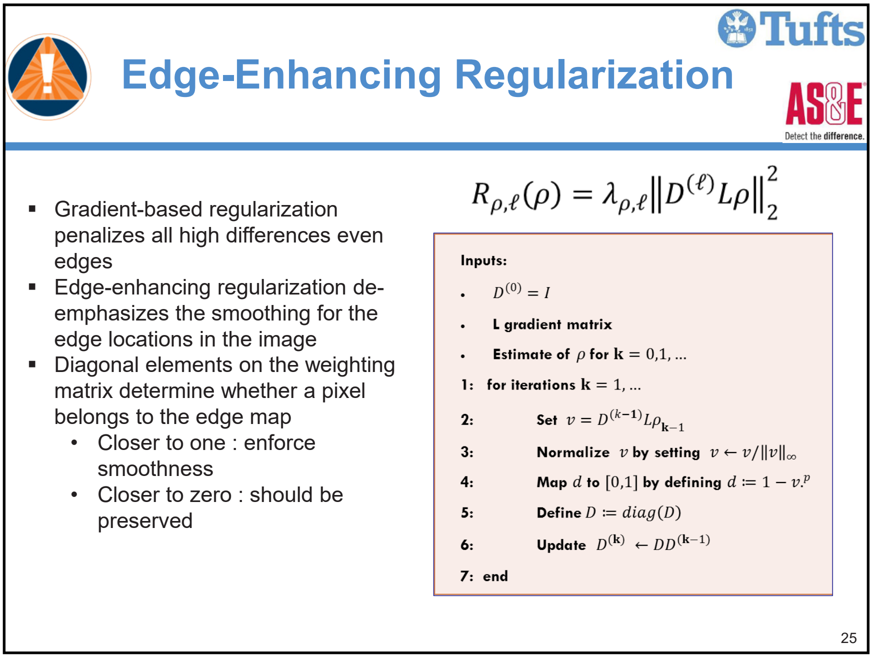
$\boldsymbol{\rho}_{\boldsymbol{k-1}}$

Resizing

ℓ_1 *times*

Density Estimation

$\boldsymbol{\rho}_{\boldsymbol{k}}$

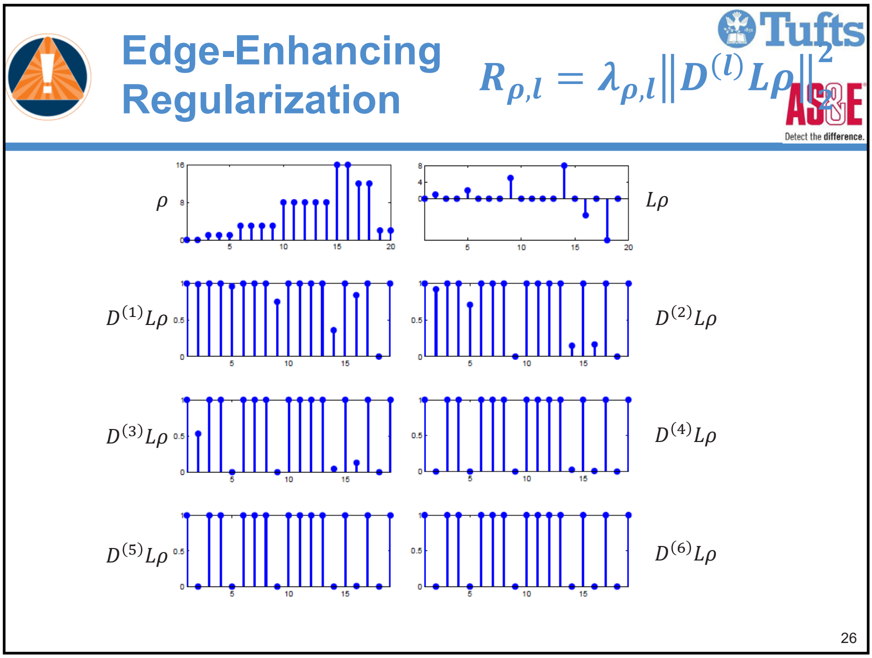


Edge-Enhancing Regularization

- Gradient-based regularization penalizes all high differences even edges
- Edge-enhancing regularization de-emphasizes the smoothing for the edge locations in the image
- Diagonal elements on the weighting matrix determine whether a pixel belongs to the edge map
    - Closer to one : enforce smoothness
    - Closer to zero : should be preserved

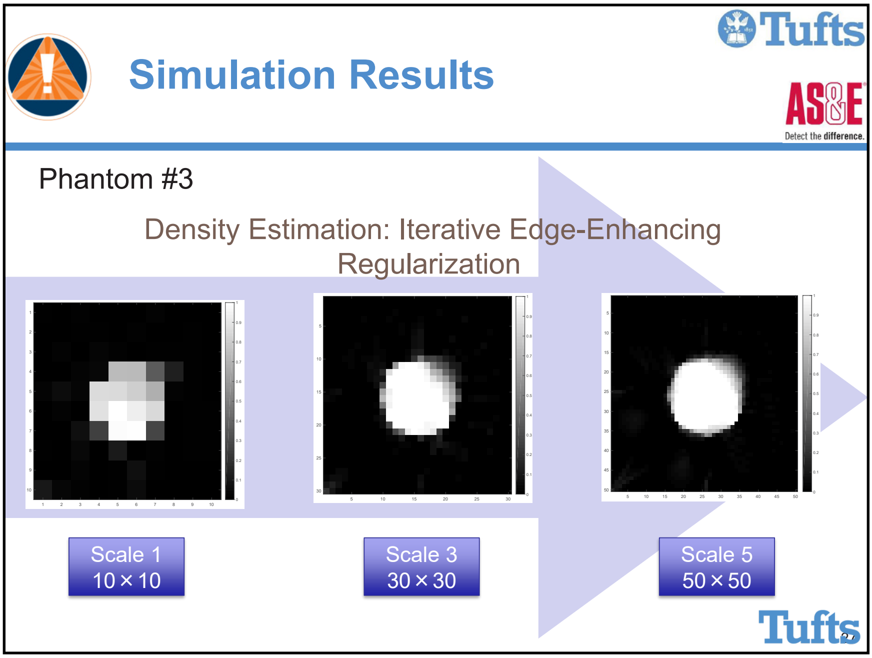
$$R_{\rho,\ell}(\rho) = \lambda_{\rho,\ell}\left\|D^{(\ell)}L\rho\right\|_2^2$$

```
Inputs:
• $D^{(0)} = I$
• L gradient matrix
• Estimate of $\rho$ for $\mathbf{k} = 0,1,\ldots$
1: for iterations $\mathbf{k} = 1,\ldots$
2:         Set $v = D^{(k-1)}L\rho_{\mathbf{k}-1}$
3:         Normalize $v$ by setting $v \leftarrow v/\|v\|_\infty$
4:         Map $d$ to $[0,1]$ by defining $d := 1 - v.^p$
5:         Define $D := diag(D)$
6:         Update $D^{(\mathbf{k})} \leftarrow DD^{(\mathbf{k}-1)}$
7: end
```



Edge-Enhancing Regularization

$$R_{\rho,l} = \lambda_{\rho,l}\left\|D^{(l)}L\rho\right\|_2^2$$



Simulation Results

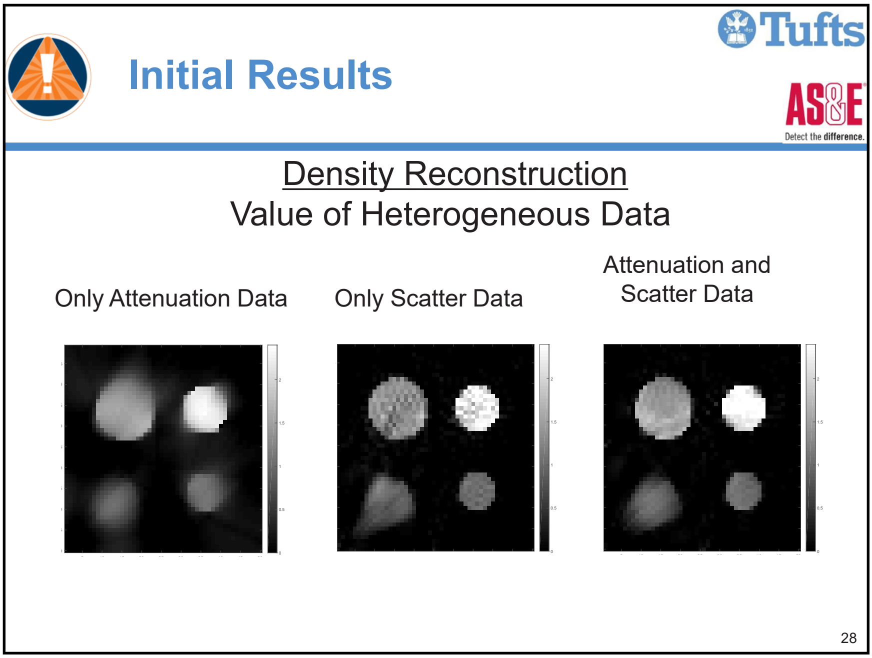
Phantom #3

Density Estimation: Iterative Edge-Enhancing Regularization

Scale 1
10 × 10

Scale 3
30 × 30

Scale 5
50 × 50



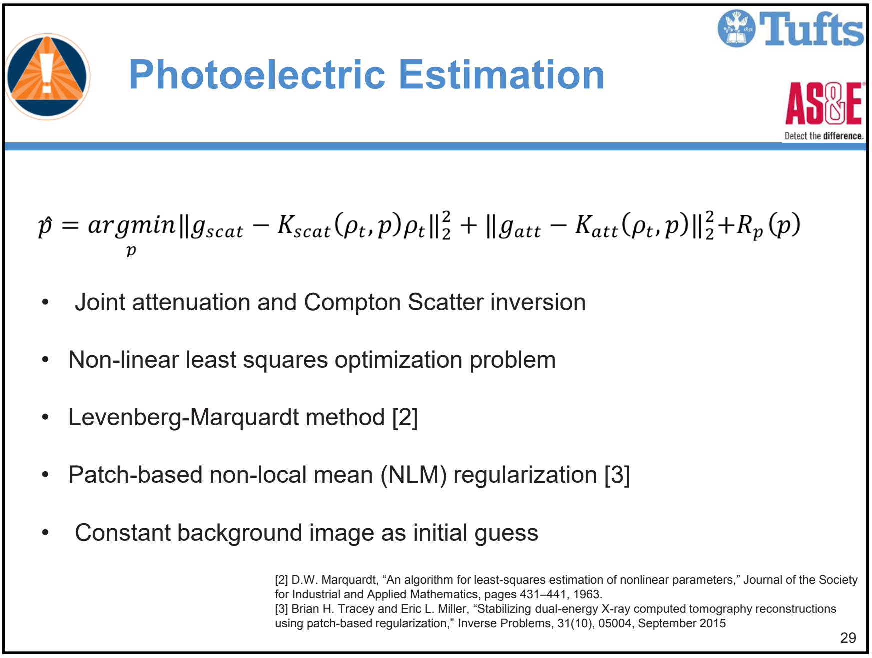
Initial Results

Density Reconstruction
Value of Heterogeneous Data

Only Attenuation Data

Only Scatter Data

Attenuation and Scatter Data

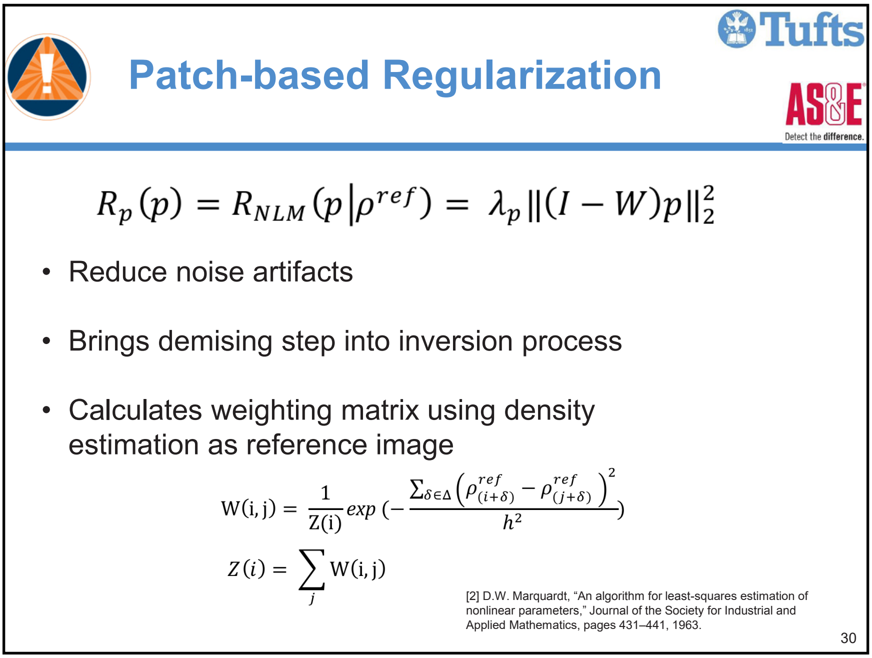


Photoelectric Estimation

$$\hat{p} = \underset{p}{argmin}\|g_{scat} - K_{scat}(\rho_t, p)\rho_t\|_2^2 + \|g_{att} - K_{att}(\rho_t, p)\|_2^2 + R_p(p)$$

- Joint attenuation and Compton Scatter inversion
- Non-linear least squares optimization problem
- Levenberg-Marquardt method [2]
- Patch-based non-local mean (NLM) regularization [3]
- Constant background image as initial guess

[2] D.W. Marquardt, “An algorithm for least-squares estimation of nonlinear parameters,” Journal of the Society for Industrial and Applied Mathematics, pages 431–441, 1963.
[3] Brian H. Tracey and Eric L. Miller, “Stabilizing dual-energy X-ray computed tomography reconstructions using patch-based regularization,” Inverse Problems, 31(10), 05004, September 2015



Patch-based Regularization

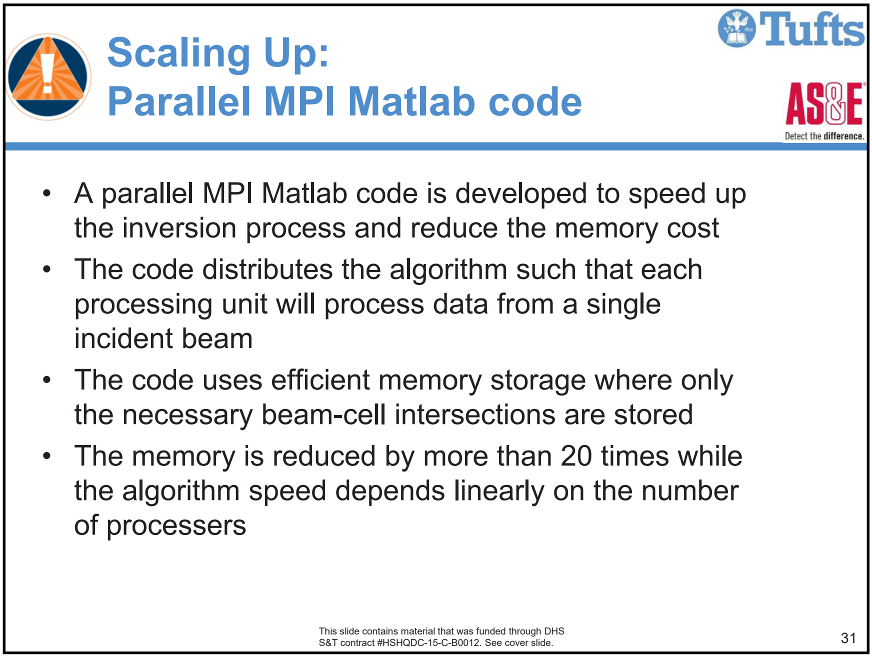
$$R_p(p) = R_{NLM}(p|\rho^{ref}) = \lambda_p\|(I - W)p\|_2^2$$

- Reduce noise artifacts
- Brings demising step into inversion process
- Calculates weighting matrix using density estimation as reference image

$$\mathrm{W(i,j)} = \frac{1}{\mathrm{Z(i)}} exp\,(-\frac{\sum_{\delta\in\Delta}\left(\rho_{(i+\delta)}^{ref} - \rho_{(j+\delta)}^{ref}\right)^2}{h^2})$$

$$Z(i) = \sum_j \mathrm{W(i,j)}$$

[2] D.W. Marquardt, “An algorithm for least-squares estimation of nonlinear parameters,” Journal of the Society for Industrial and Applied Mathematics, pages 431–441, 1963.



Scaling Up:
Parallel MPI Matlab code

- A parallel MPI Matlab code is developed to speed up the inversion process and reduce the memory cost
- The code distributes the algorithm such that each processing unit will process data from a single incident beam
- The code uses efficient memory storage where only the necessary beam-cell intersections are stored
- The memory is reduced by more than 20 times while the algorithm speed depends linearly on the number of processers

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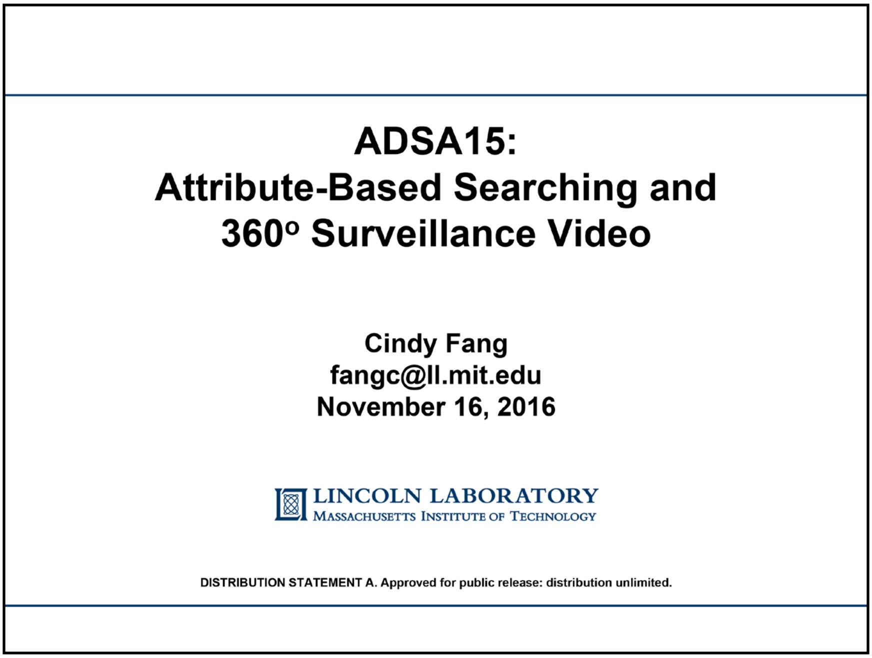
16.40 Cindy Fang: Attribute-Based Searching of 360° Surveillance Video



ADSA15:
Attribute-Based Searching and
360° Surveillance Video

Cindy Fang
fangc@ll.mit.edu
November 16, 2016

LINCOLN LABORATORY
MASSACHUSETTS INSTITUTE OF TECHNOLOGY

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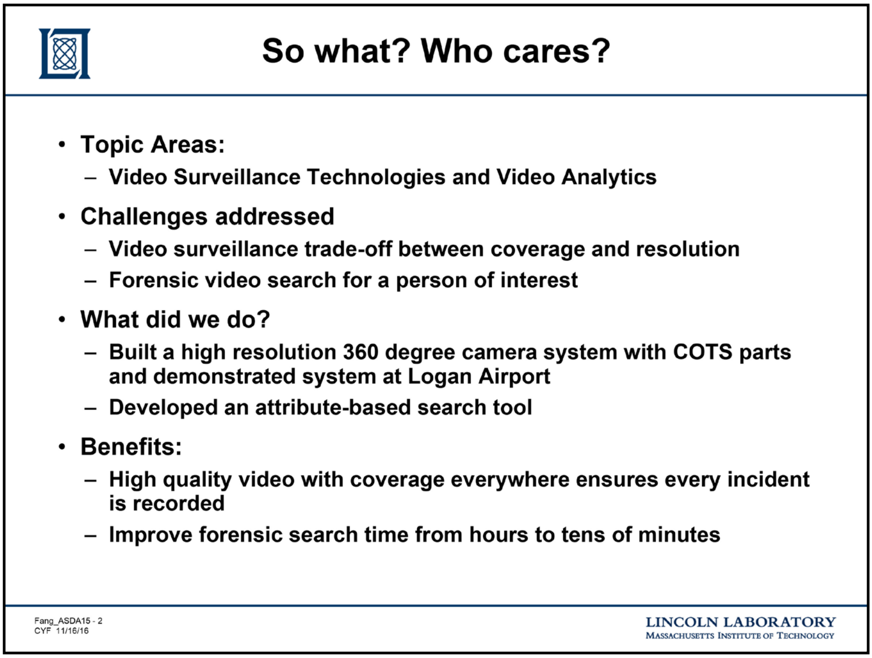

So what? Who cares?

- Topic Areas:
  - Video Surveillance Technologies and Video Analytics
- Challenges addressed
  - Video surveillance trade-off between coverage and resolution
  - Forensic video search for a person of interest
- What did we do?
  - Built a high resolution 360 degree camera system with COTS parts and demonstrated system at Logan Airport
  - Developed an attribute-based search tool
- Benefits:
  - High quality video with coverage everywhere ensures every incident is recorded
  - Improve forensic search time from hours to tens of minutes

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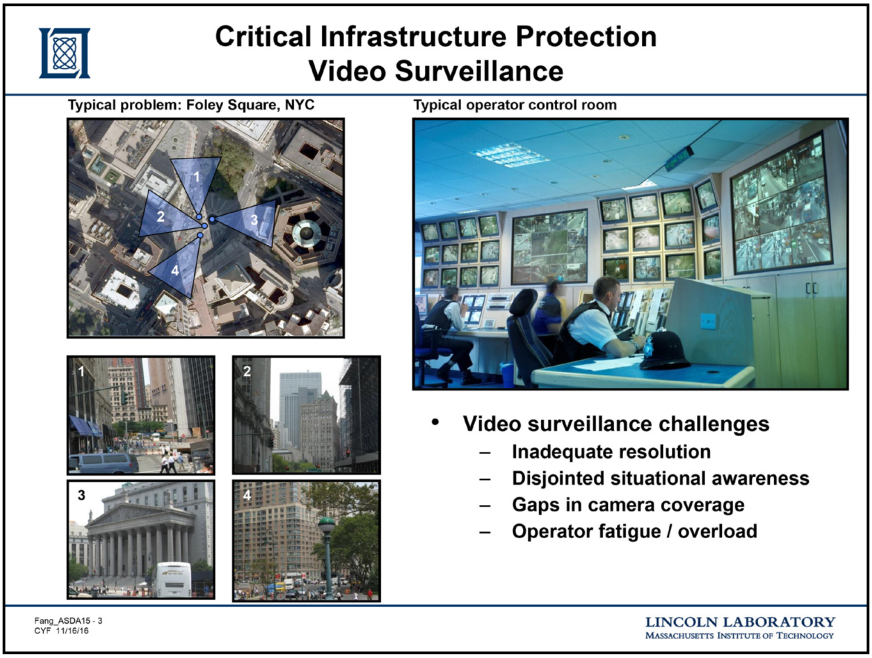
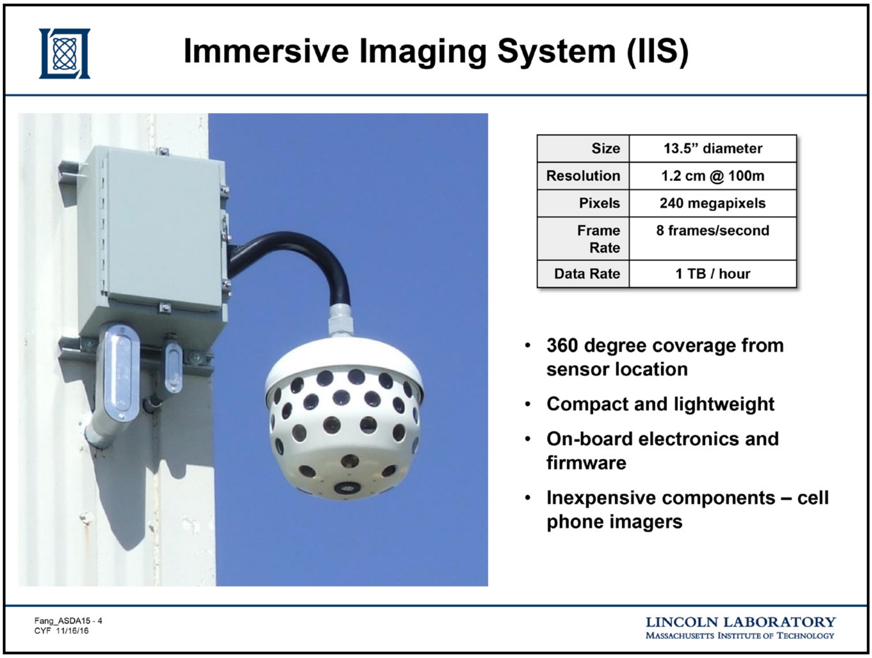


Critical Infrastructure Protection
Video Surveillance

Typical problem: Foley Square, NYC

Typical operator control room

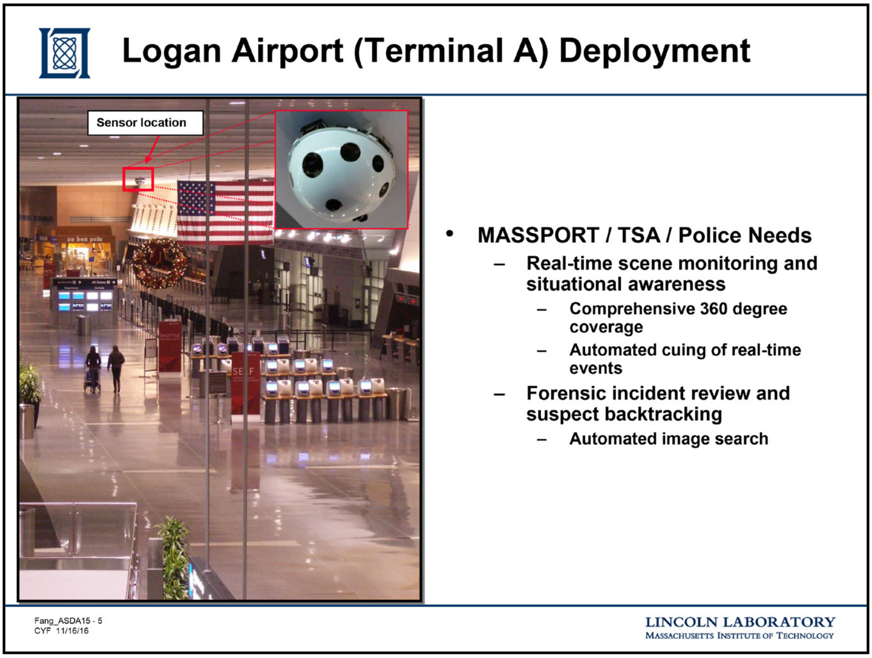
- Video surveillance challenges
  - Inadequate resolution
  - Disjointed situational awareness
  - Gaps in camera coverage
  - Operator fatigue / overload



Immersive Imaging System (IIS)

Size	13.5" diameter
Resolution	1.2 cm @ 100m
Pixels	240 megapixels
Frame Rate	8 frames/second
Data Rate	1 TB / hour

- 360 degree coverage from sensor location
- Compact and lightweight
- On-board electronics and firmware
- Inexpensive components – cell phone imagers



Logan Airport (Terminal A) Deployment

- MASSPORT / TSA / Police Needs
  - Real-time scene monitoring and situational awareness
    - Comprehensive 360 degree coverage
    - Automated cuing of real-time events
  - Forensic incident review and suspect backtracking
    - Automated image search

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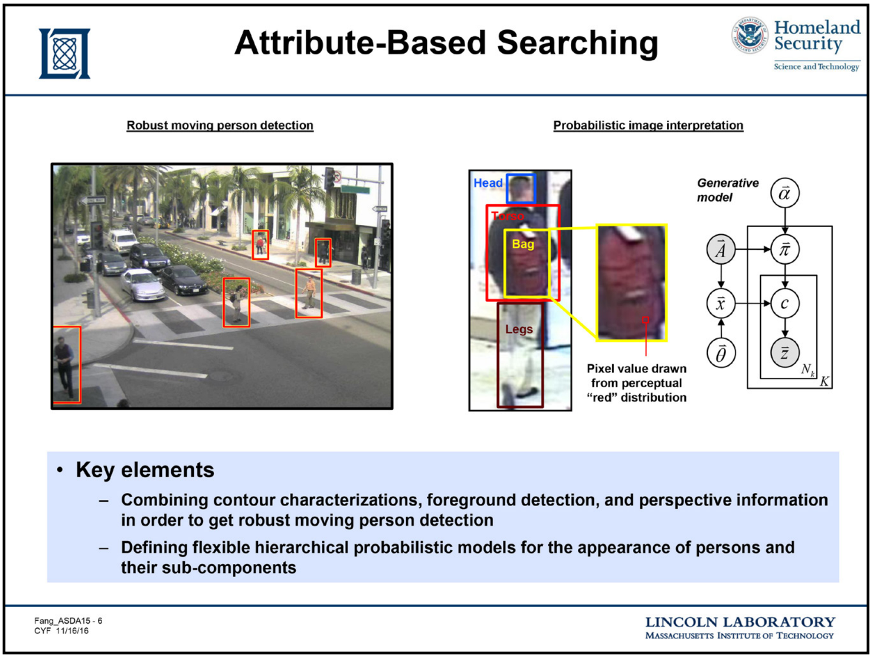

Attribute-Based Searching

Homeland Security
Science and Technology

Robust moving person detection

Probabilistic image interpretation

Pixel value drawn from perceptual "red" distribution

- **Key elements**
  - Combining contour characterizations, foreground detection, and perspective information in order to get robust moving person detection
  - Defining flexible hierarchical probabilistic models for the appearance of persons and their sub-components

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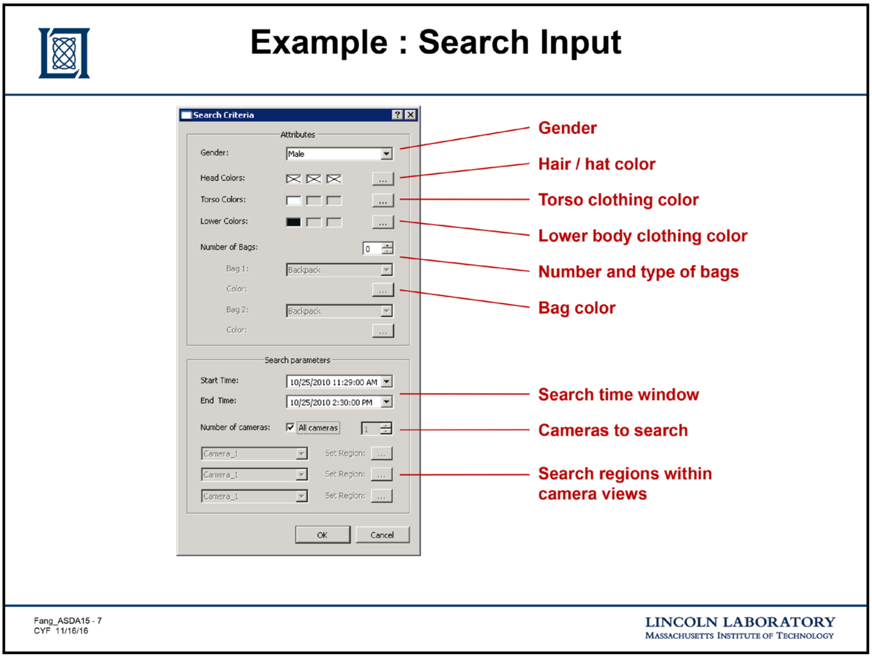

Example : Search Input

Search Criteria

Attributes

Gender: Male

Head Colors:

Torso Colors:

Lower Colors:

Number of Bags: 0

Bag 1: Backpack

Color:

Bag 2: Backpack

Color:

Search parameters

Start Time: 10/25/2010 11:29:00 AM

End Time: 10/25/2010 2:30:00 PM

Number of cameras: ☑ All cameras 1

Camera_1 Set Region:

Camera_1 Set Region:

Camera_1 Set Region:

Gender

Hair / hat color

Torso clothing color

Lower body clothing color

Number and type of bags

Bag color

Search time window

Cameras to search

Search regions within camera views

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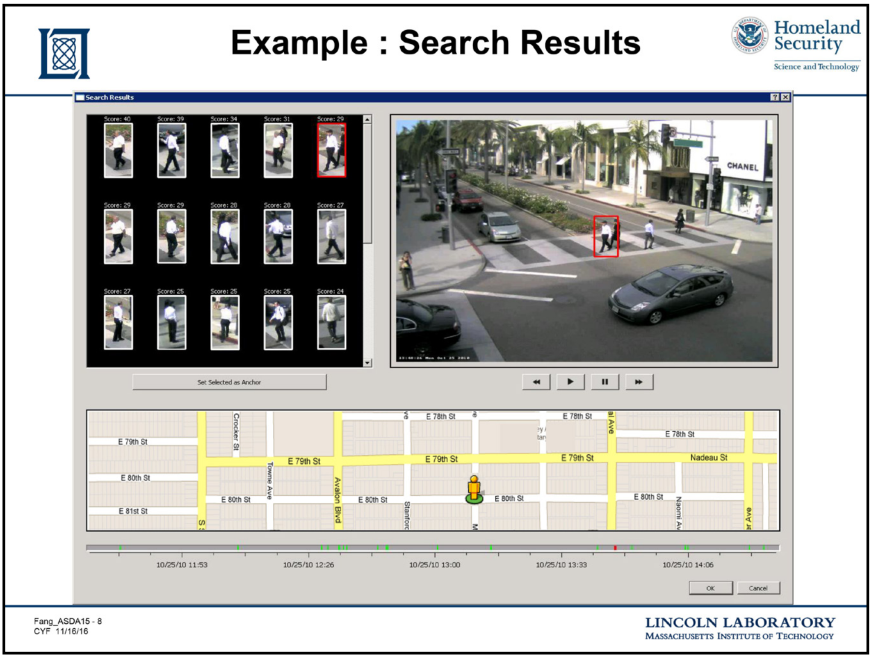

Example : Search Results

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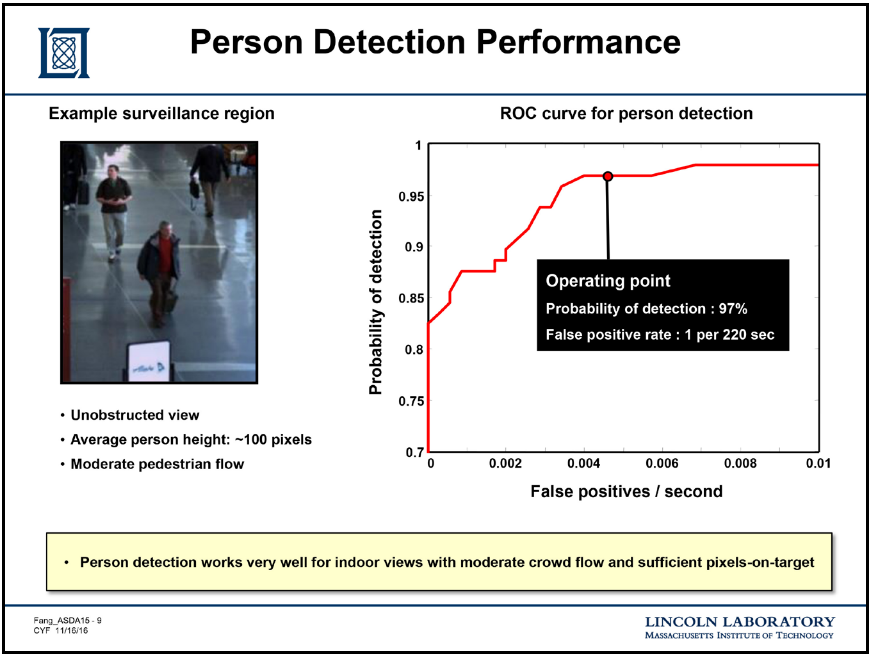

Person Detection Performance

Example surveillance region

- Unobstructed view
- Average person height: ~100 pixels
- Moderate pedestrian flow

ROC curve for person detection

Operating point
Probability of detection : 97%
False positive rate : 1 per 220 sec

- Person detection works very well for indoor views with moderate crowd flow and sufficient pixels-on-target

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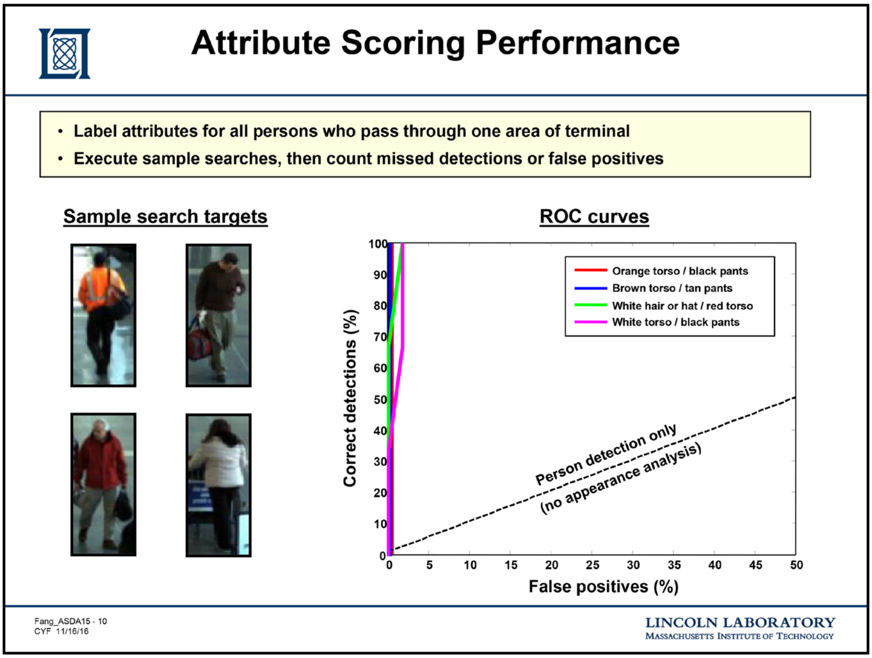

Attribute Scoring Performance

- Label attributes for all persons who pass through one area of terminal
- Execute sample searches, then count missed detections or false positives

Sample search targets

ROC curves

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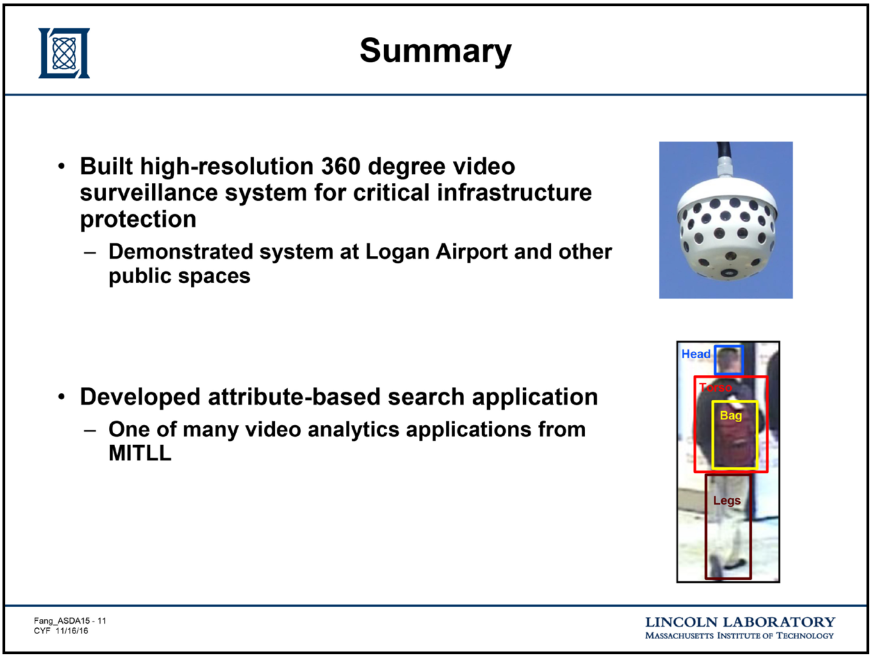

Summary

- **Built high-resolution 360 degree video surveillance system for critical infrastructure protection**
  - **Demonstrated system at Logan Airport and other public spaces**
- **Developed attribute-based search application**
  - **One of many video analytics applications from MITLL**

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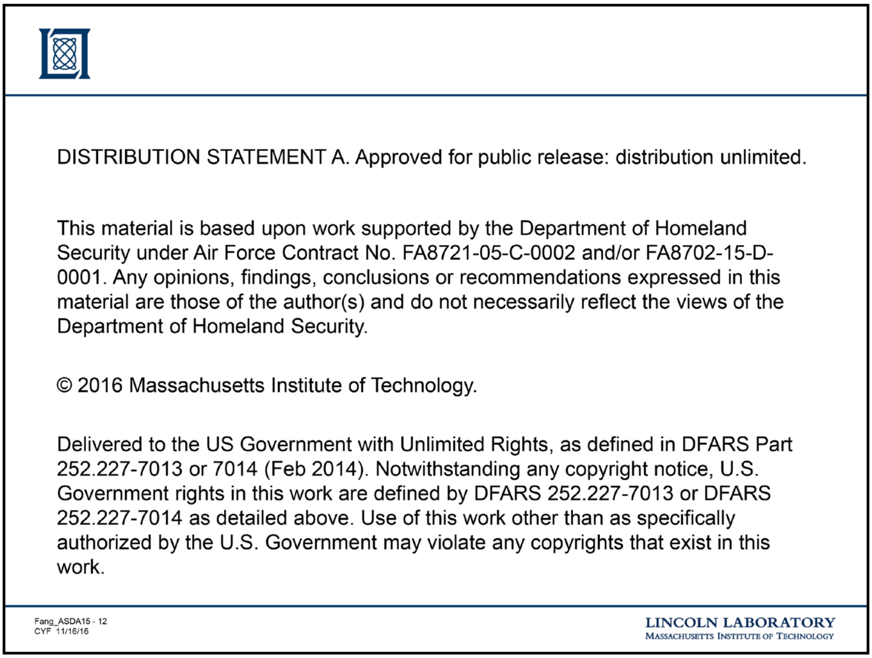

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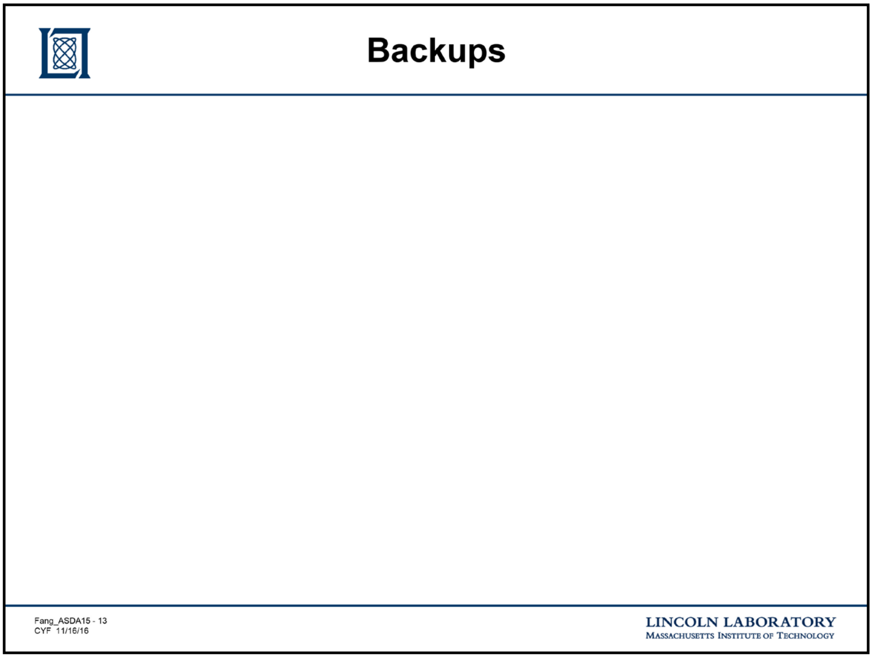

Backups

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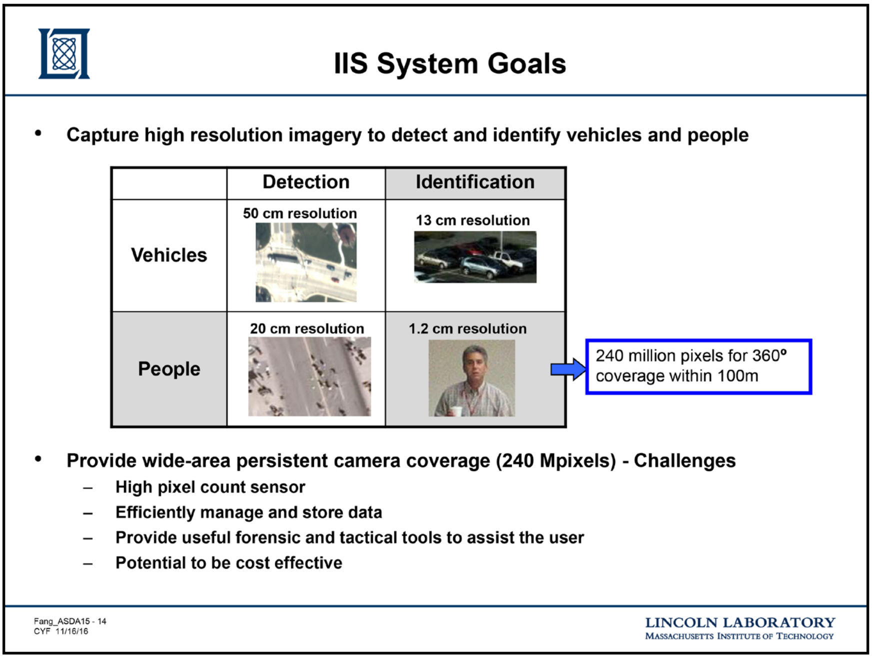

IIS System Goals

- **Capture high resolution imagery to detect and identify vehicles and people**

	Detection	Identification
Vehicles	50 cm resolution	13 cm resolution
People	20 cm resolution	1.2 cm resolution

240 million pixels for 360° coverage within 100m

- **Provide wide-area persistent camera coverage (240 Mpixels) - Challenges**
  - **High pixel count sensor**
  - **Efficiently manage and store data**
  - **Provide useful forensic and tactical tools to assist the user**
  - **Potential to be cost effective**

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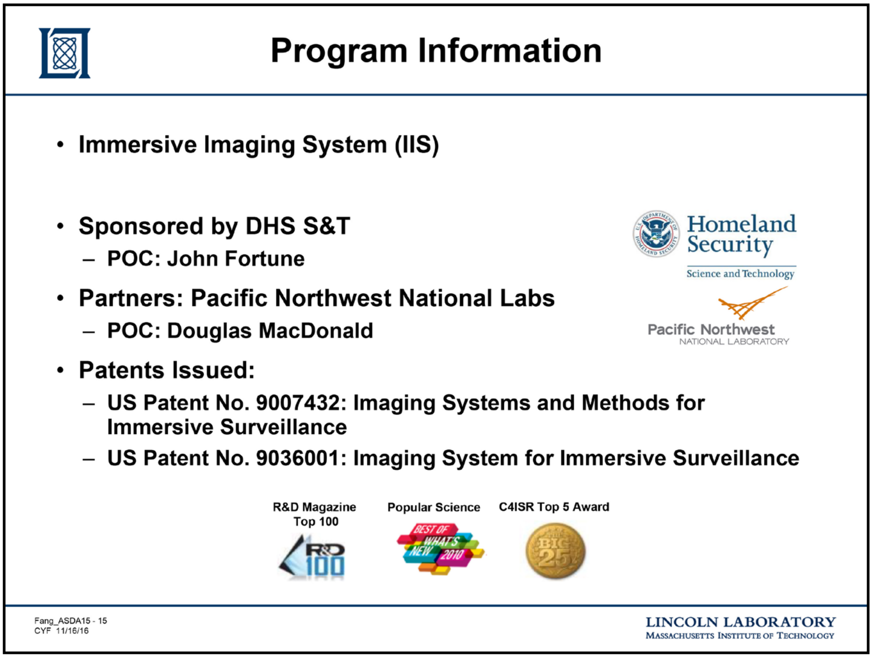

Program Information

- **Immersive Imaging System (IIS)**
- **Sponsored by DHS S&T**
  - **POC: John Fortune**
- **Partners: Pacific Northwest National Labs**
  - **POC: Douglas MacDonald**
- **Patents Issued:**
  - **US Patent No. 9007432: Imaging Systems and Methods for Immersive Surveillance**
  - **US Patent No. 9036001: Imaging System for Immersive Surveillance**

Homeland Security
Science and Technology

Pacific Northwest
NATIONAL LABORATORY

R&D Magazine Top 100

Popular Science

C4ISR Top 5 Award

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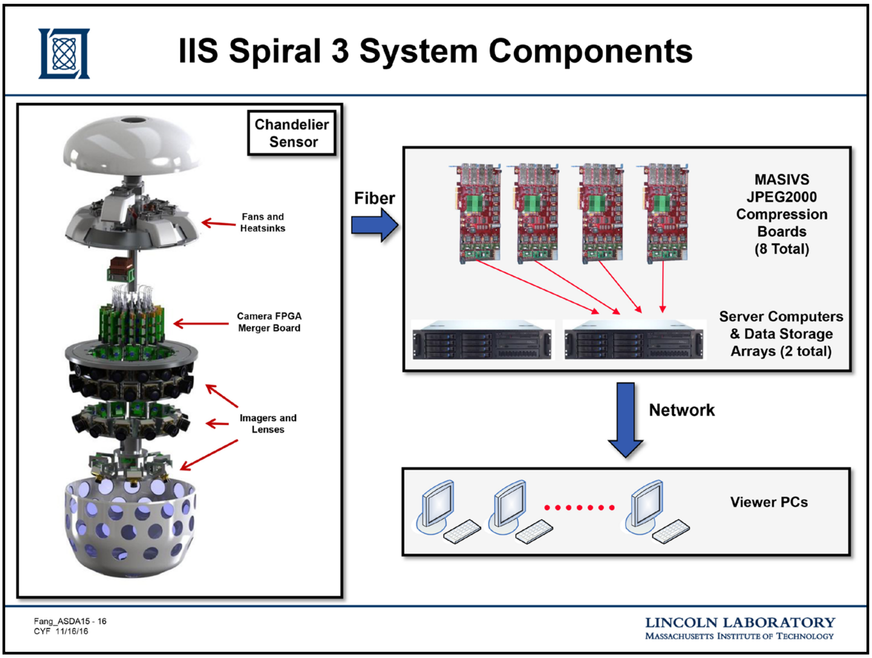

IIS Spiral 3 System Components

Chandelier Sensor

Fans and Heatsinks

Camera FPGA Merger Board

Imagers and Lenses

Fiber

MASIVS JPEG2000 Compression Boards (8 Total)

Server Computers & Data Storage Arrays (2 total)

Network

Viewer PCs

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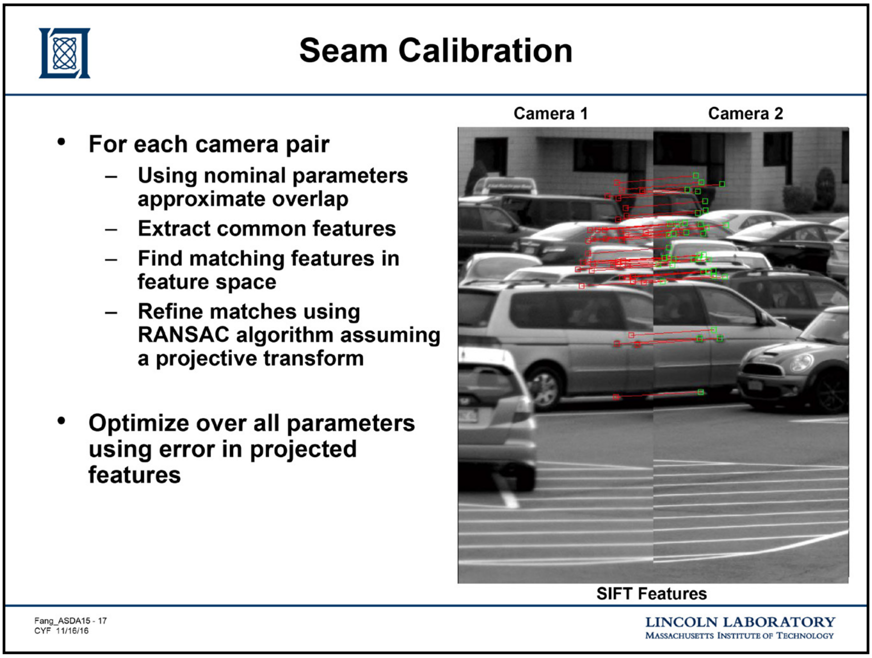

Seam Calibration

- For each camera pair
  - Using nominal parameters approximate overlap
  - Extract common features
  - Find matching features in feature space
  - Refine matches using RANSAC algorithm assuming a projective transform
- Optimize over all parameters using error in projected features

SIFT Features

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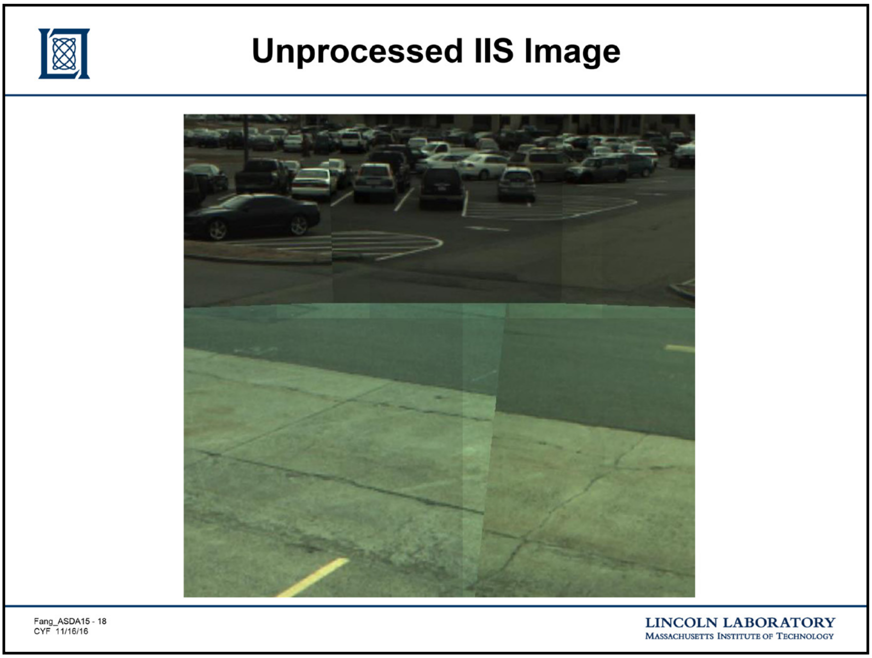

Unprocessed IIS Image

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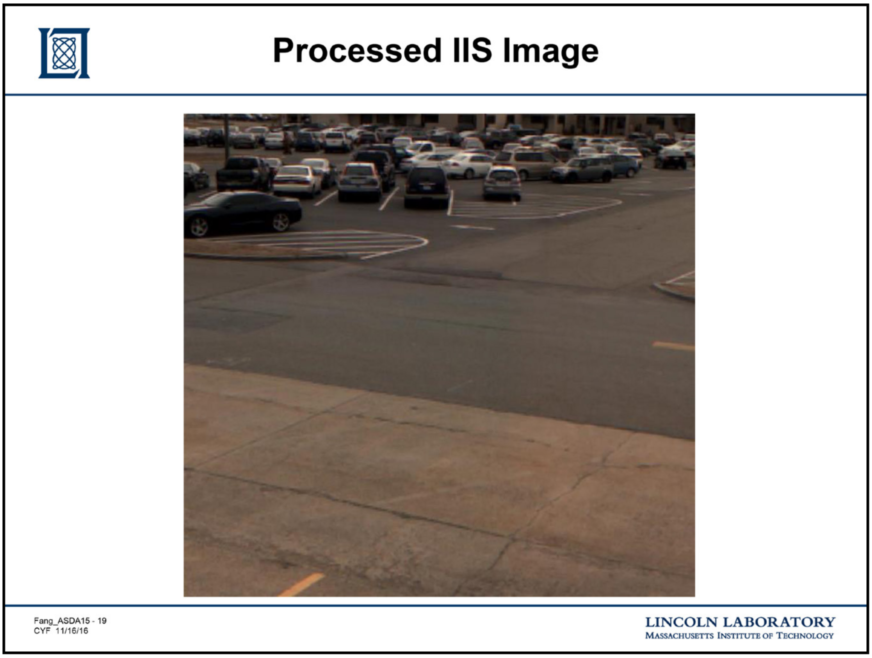
Massachusetts Institute of Technology



Processed IIS Image

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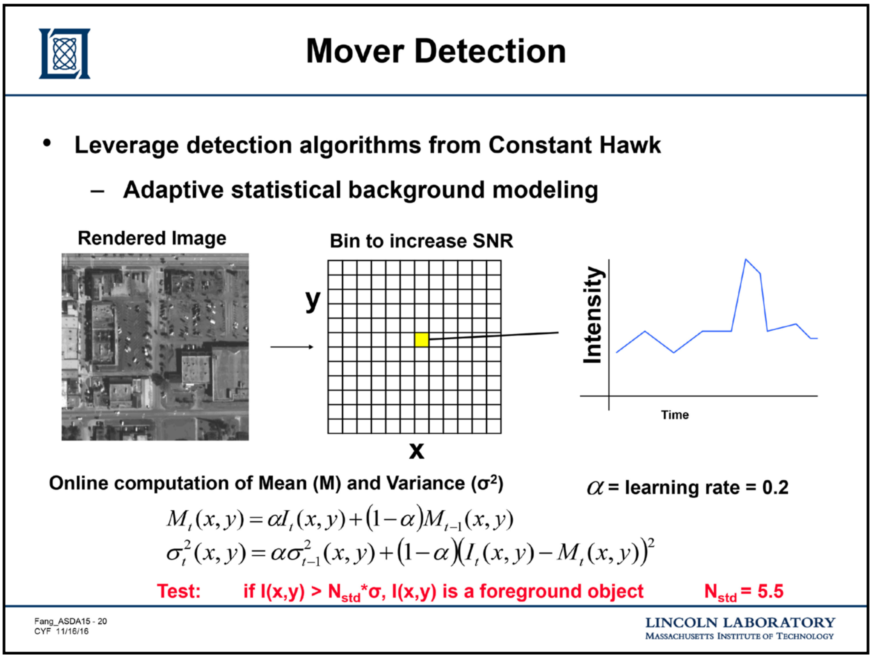

Mover Detection

- **Leverage detection algorithms from Constant Hawk**
  - **Adaptive statistical background modeling**

Rendered Image

Bin to increase SNR

y

x

Intensity

Time

Online computation of Mean (M) and Variance (σ^2)

α = learning rate = 0.2

$$M_t(x,y) = \alpha I_t(x,y) + (1-\alpha)M_{t-1}(x,y)$$

$$\sigma_t^2(x,y) = \alpha\sigma_{t-1}^2(x,y) + (1-\alpha)(I_t(x,y) - M_t(x,y))^2$$

Test: if I(x,y) > N_{std}*σ, I(x,y) is a foreground object N_{std} = 5.5

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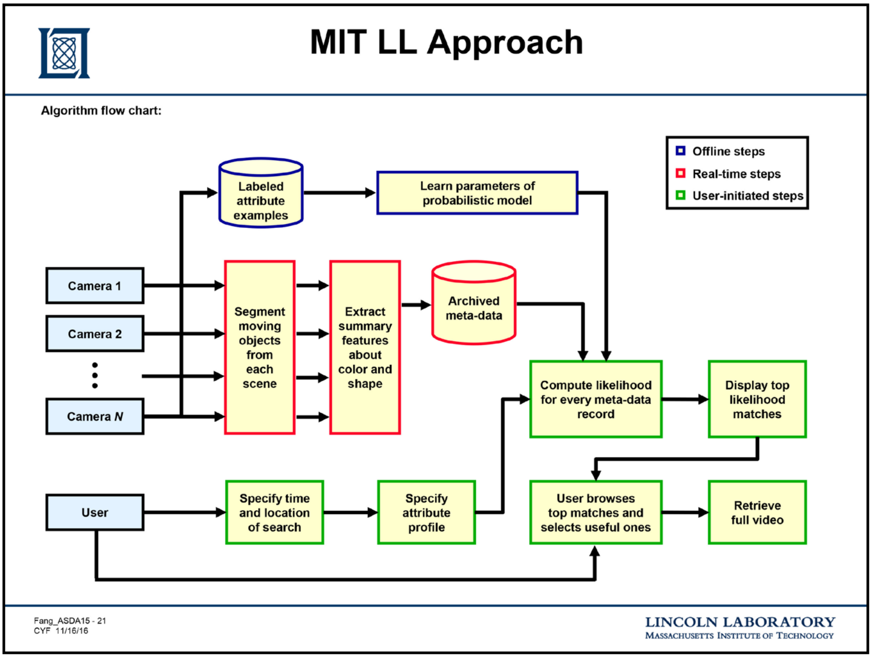

MIT LL Approach

Algorithm flow chart:

- 🟦 Offline steps
- 🟥 Real-time steps
- 🟩 User-initiated steps

Labeled attribute examples

Learn parameters of probabilistic model

Camera 1

Camera 2

Camera *N*

Segment moving objects from each scene

Extract summary features about color and shape

Archived meta-data

Compute likelihood for every meta-data record

Display top likelihood matches

User

Specify time and location of search

Specify attribute profile

User browses top matches and selects useful ones

Retrieve full video

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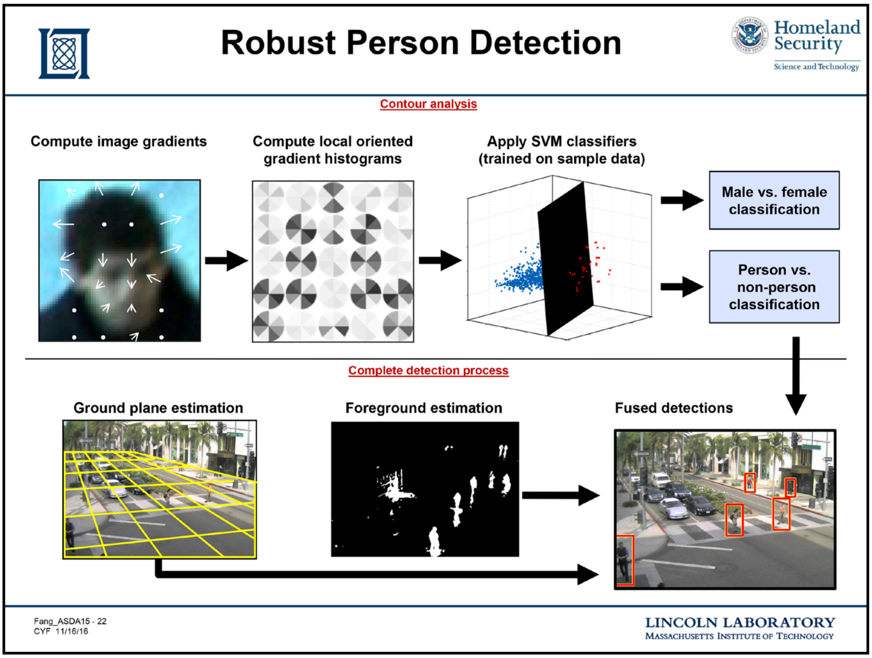
Massachusetts Institute of Technology



Robust Person Detection

Homeland Security
Science and Technology

Contour analysis

Compute image gradients

Compute local oriented gradient histograms

Apply SVM classifiers (trained on sample data)

Male vs. female classification

Person vs. non-person classification

Complete detection process

Ground plane estimation

Foreground estimation

Fused detections

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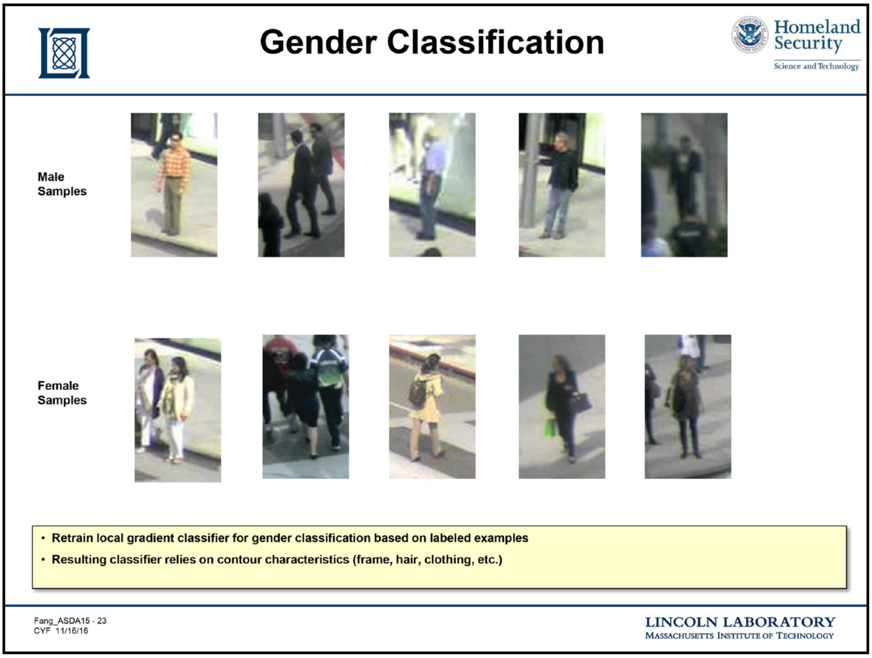
Massachusetts Institute of Technology



Gender Classification

Homeland Security
Science and Technology

Male Samples

Female Samples

- Retrain local gradient classifier for gender classification based on labeled examples
- Resulting classifier relies on contour characteristics (frame, hair, clothing, etc.)

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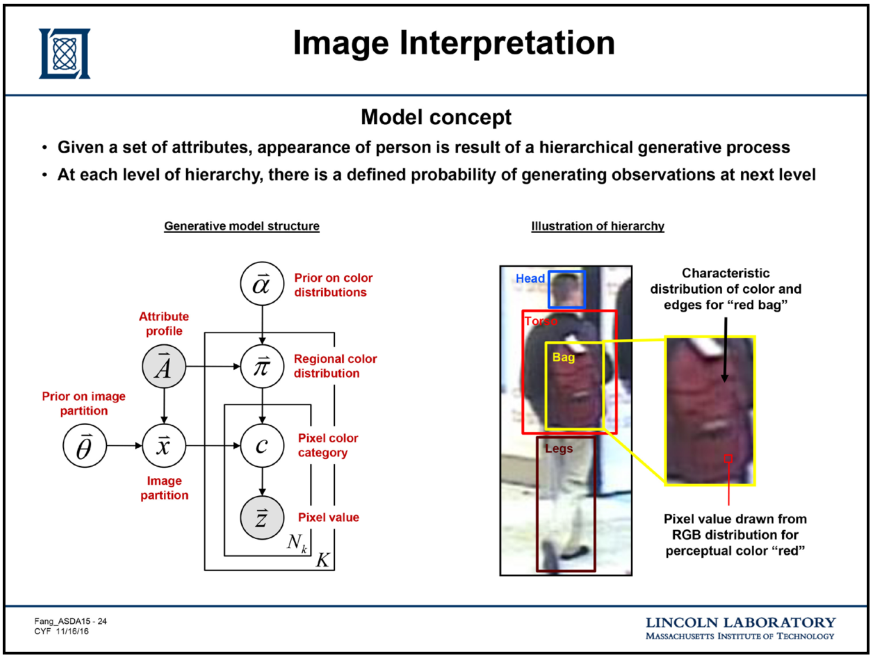

Image Interpretation

Model concept

- Given a set of attributes, appearance of person is result of a hierarchical generative process
- At each level of hierarchy, there is a defined probability of generating observations at next level

Generative model structure

Prior on color distributions $\vec{\alpha}$

Attribute profile $\vec{A}$

Regional color distribution $\vec{\pi}$

Prior on image partition $\vec{\theta}$

Image partition $\vec{x}$

Pixel color category c

Pixel value $\vec{z}$

N_k

K

Illustration of hierarchy

Head

Torso

Bag

Legs

Characteristic distribution of color and edges for “red bag”

Pixel value drawn from RGB distribution for perceptual color “red”

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16.41 Shawn Dagg: CCTV+Video Analytics-Based Passenger Flow Management System

AIRPORTS
OPTIMIZED BY

CROWDVISION

Video-Based Pedestrian Analytics

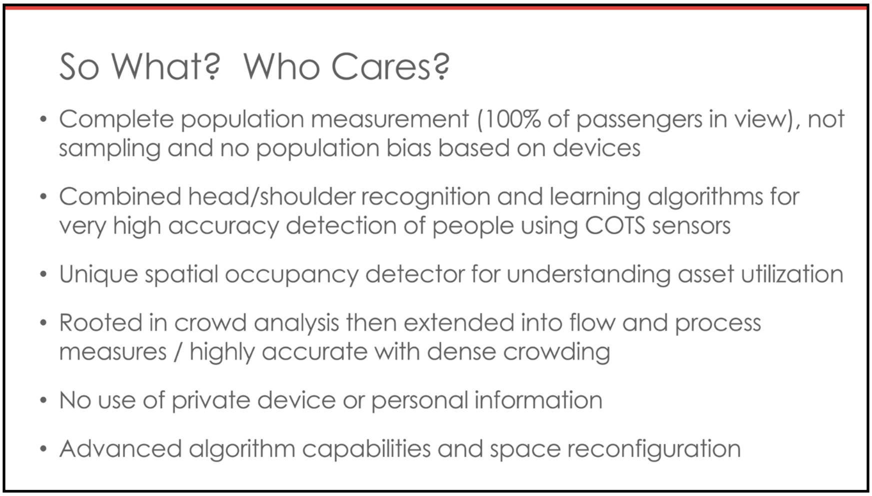
CROWDVISION

Utilizes computer vision technology & advanced data analytics to accurately show where, when and how people movement and waiting occurs

Understand
Queues, occupancy, flows, density, asset utilization, dwell times

Plan
Predict and prepare for demand appropriately

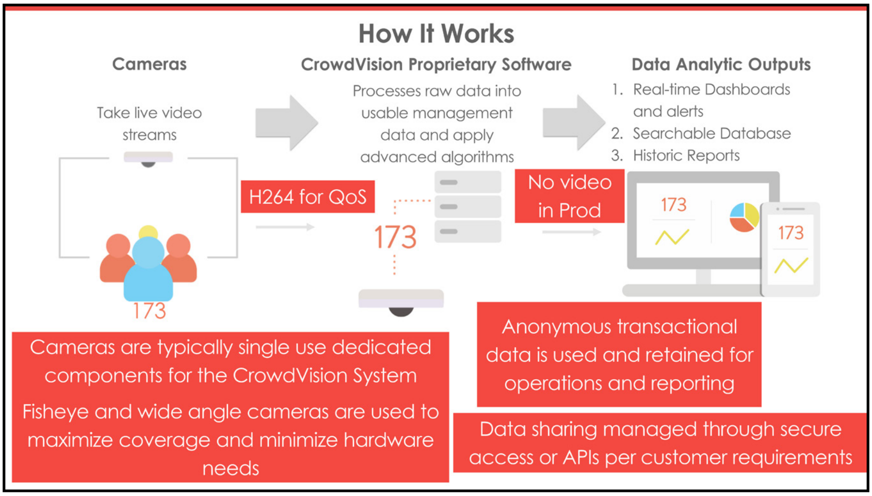
Manage
Increased throughput & maximize utilization in real time



So What? Who Cares?

- Complete population measurement (100% of passengers in view), not sampling and no population bias based on devices
- Combined head/shoulder recognition and learning algorithms for very high accuracy detection of people using COTS sensors
- Unique spatial occupancy detector for understanding asset utilization
- Rooted in crowd analysis then extended into flow and process measures / highly accurate with dense crowding
- No use of private device or personal information
- Advanced algorithm capabilities and space reconfiguration

HOW IT WORKS



How It Works

Cameras

Take live video streams

CrowdVision Proprietary Software

Processes raw data into usable management data and apply advanced algorithms

Data Analytic Outputs

1. Real-time Dashboards and alerts
2. Searchable Database
3. Historic Reports

H264 for QoS

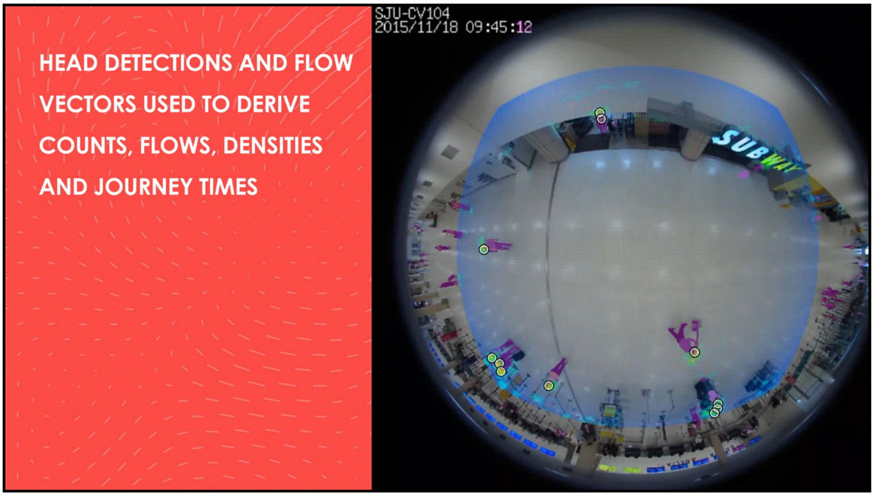
No video in Prod

Cameras are typically single use dedicated components for the CrowdVision System

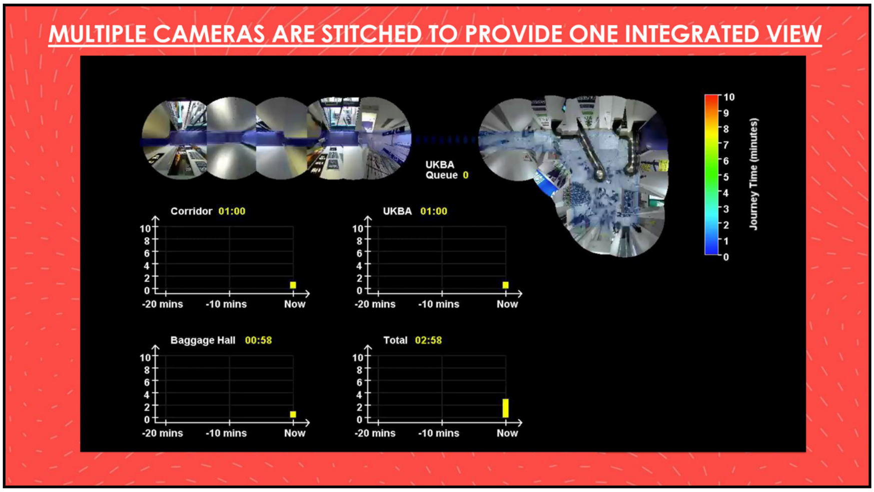
Fisheye and wide angle cameras are used to maximize coverage and minimize hardware needs

Anonymous transactional data is used and retained for operations and reporting

Data sharing managed through secure access or APIs per customer requirements

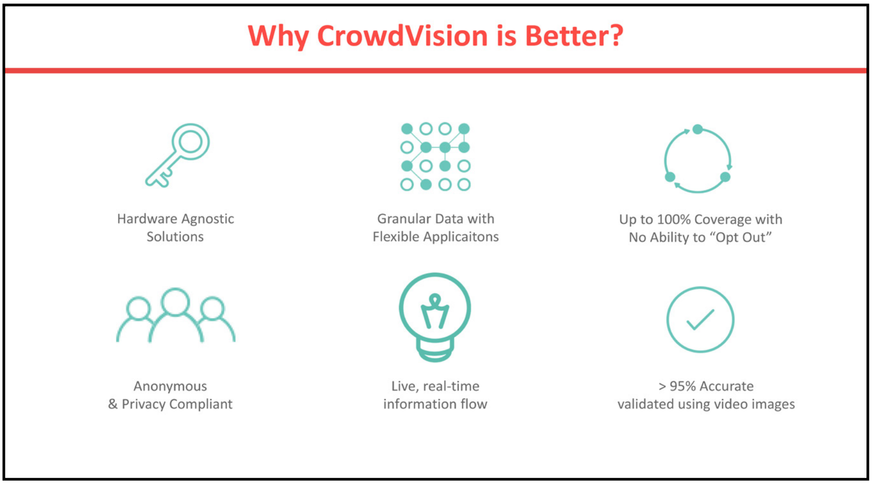


HEAD DETECTIONS AND FLOW VECTORS USED TO DERIVE COUNTS, FLOWS, DENSITIES AND JOURNEY TIMES



MULTIPLE CAMERAS ARE STITCHED TO PROVIDE ONE INTEGRATED VIEW

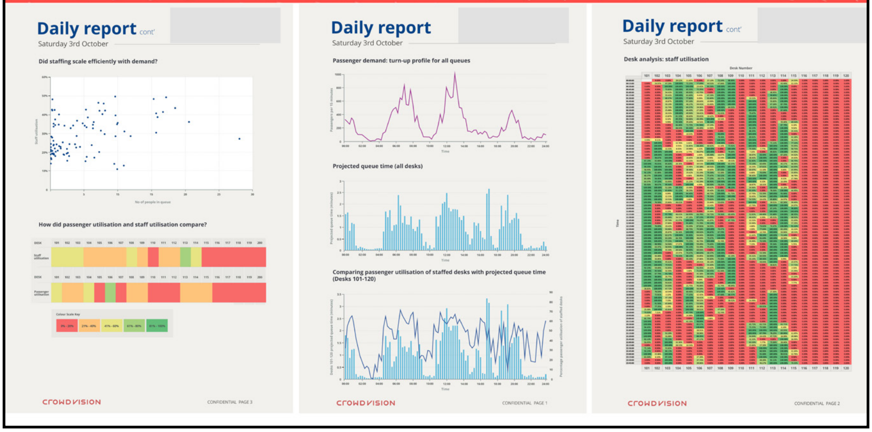
SPATIAL OCCUPANCY DETECTION USED TO DERIVE UTILISATION RATES AND PROCESS TIMES



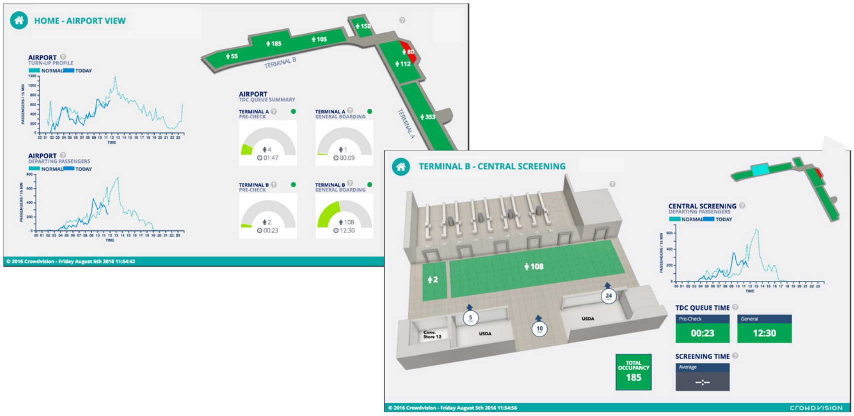
Why CrowdVision is Better?

- Hardware Agnostic Solutions
- Granular Data with Flexible Applicaitons
- Up to 100% Coverage with No Ability to "Opt Out"
- Anonymous & Privacy Compliant
- Live, real-time information flow
- > 95% Accurate validated using video images

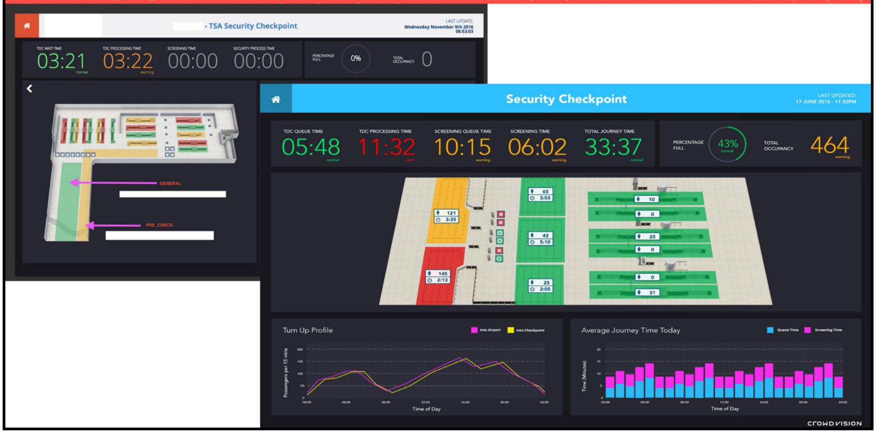
Daily, Weekly, Monthly reports

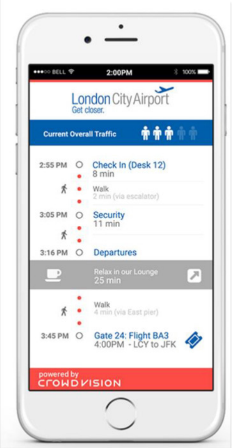


Real Time Dashboards



Real Time Dashboards





2:55 PM ○ Check In (Desk 12)
8 min

Walk
2 min (via escalator)

3:05 PM ○ Security
11 min

3:16 PM ○ Departures

Relax in our Lounge
25 min

Walk
4 min (via East pier)

3:45 PM ○ Gate 24: Flight BA3
4:00PM - LCY to JFK

MOBILE APP INTEGRATION

Early visibility of airport passenger experience

SOLUTIONS PLATFORM

Checkpoints (Check-in, TSA, FIS)

Full Terminal

Planning & Design

Transportation

Crisis Management

Retail & Advertising

OUR CURRENT AIRPORT DEPLOYMENTS

London City Airport
Get closer.

Heathrow
Making every journey better

AEROPUERTO INTERNACIONAL LUIS MUÑOZ MARÍN PUERTO RICO

Edinburgh Airport
Where Scotland meets the world

london stansted airport
PART OF M.A.G

OAMC

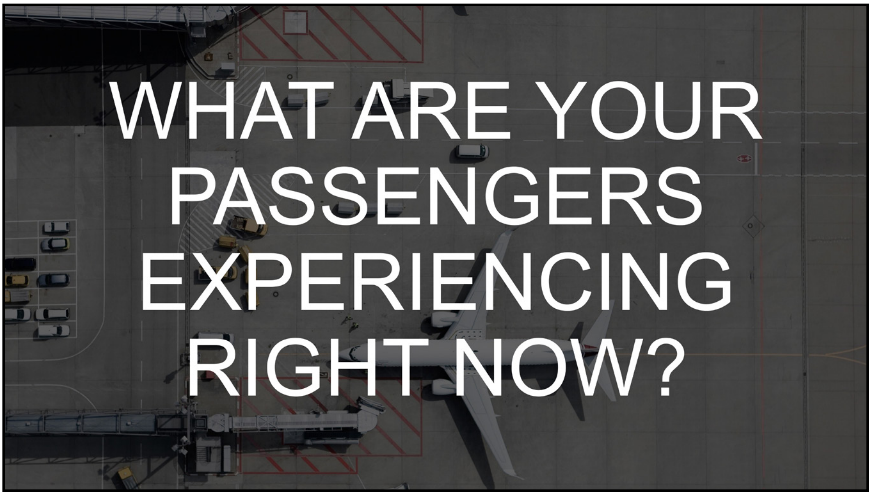
Coming Soon

香港國際機場 HONG KONG INTERNATIONAL AIRPORT

Sydney Airport

CONFIDENTIAL

CONFIDENTIAL



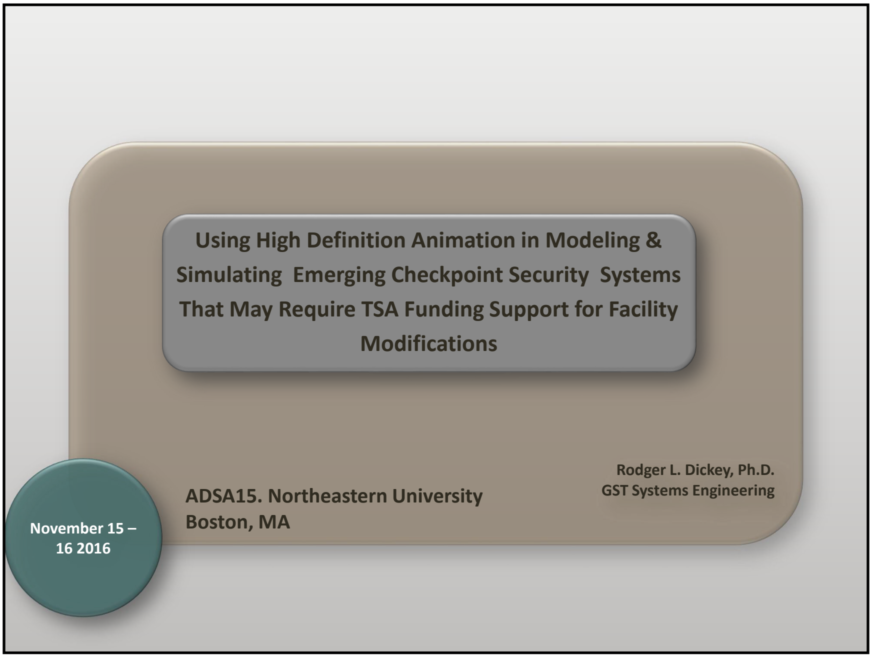
WHAT ARE YOUR PASSENGERS EXPERIENCING RIGHT NOW?

Thank You!

www.crowdvision.com

CROWDVISION

16.42 Rodger Dickey: M&S/HD Animation (Ani-Sim) in Checkpoint Security Technology

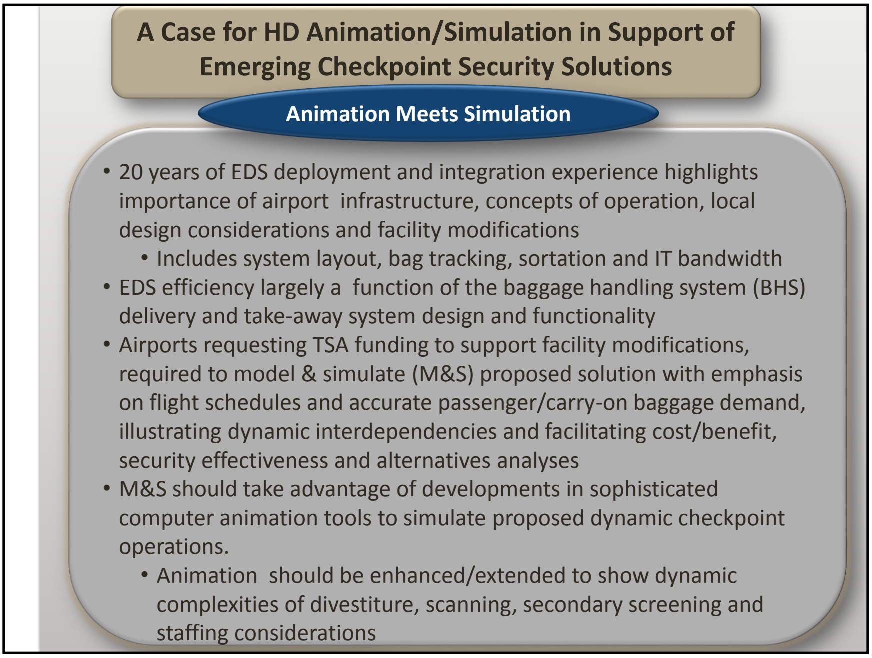


Using High Definition Animation in Modeling & Simulating Emerging Checkpoint Security Systems That May Require TSA Funding Support for Facility Modifications

Rodger L. Dickey, Ph.D.
GST Systems Engineering

ADSA15. Northeastern University
Boston, MA

November 15 – 16 2016

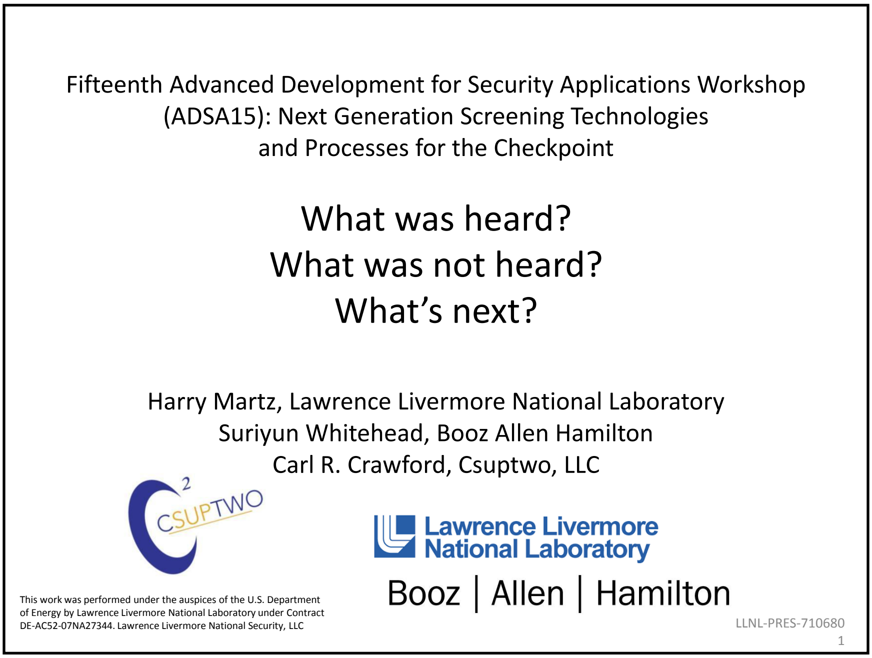


A Case for HD Animation/Simulation in Support of Emerging Checkpoint Security Solutions

Animation Meets Simulation

- 20 years of EDS deployment and integration experience highlights importance of airport infrastructure, concepts of operation, local design considerations and facility modifications
    - Includes system layout, bag tracking, sortation and IT bandwidth
- EDS efficiency largely a function of the baggage handling system (BHS) delivery and take-away system design and functionality
- Airports requesting TSA funding to support facility modifications, required to model & simulate (M&S) proposed solution with emphasis on flight schedules and accurate passenger/carry-on baggage demand, illustrating dynamic interdependencies and facilitating cost/benefit, security effectiveness and alternatives analyses
- M&S should take advantage of developments in sophisticated computer animation tools to simulate proposed dynamic checkpoint operations.
    - Animation should be enhanced/extended to show dynamic complexities of divestiture, scanning, secondary screening and staffing considerations

16.43 Harry Martz, Suriyun Whitehead & Carl Crawford: Summary and Next Steps



Fifteenth Advanced Development for Security Applications Workshop
(ADSA15): Next Generation Screening Technologies
and Processes for the Checkpoint

What was heard?
What was not heard?
What's next?

Harry Martz, Lawrence Livermore National Laboratory
Suriyun Whitehead, Booz Allen Hamilton
Carl R. Crawford, Csuptwo, LLC

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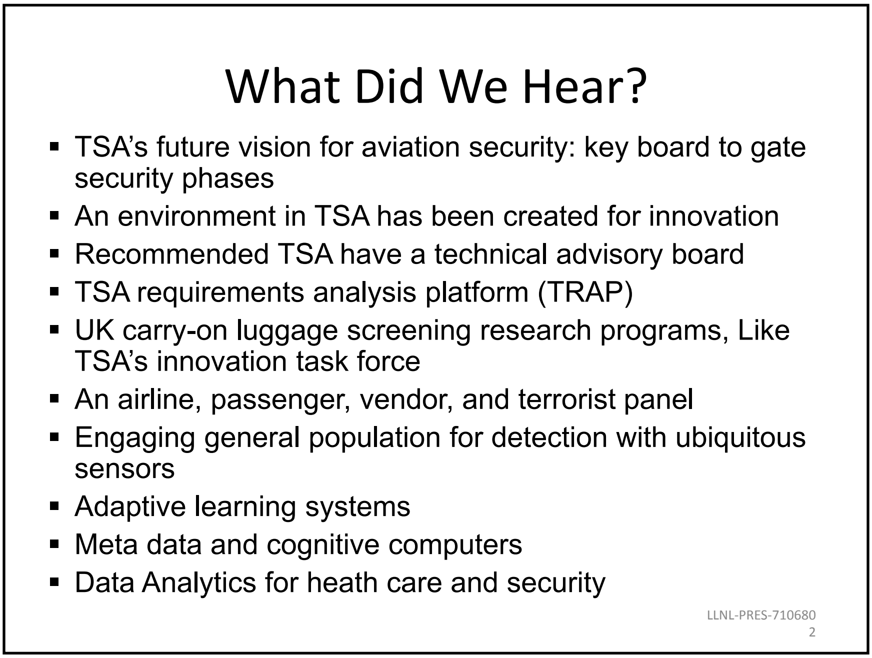
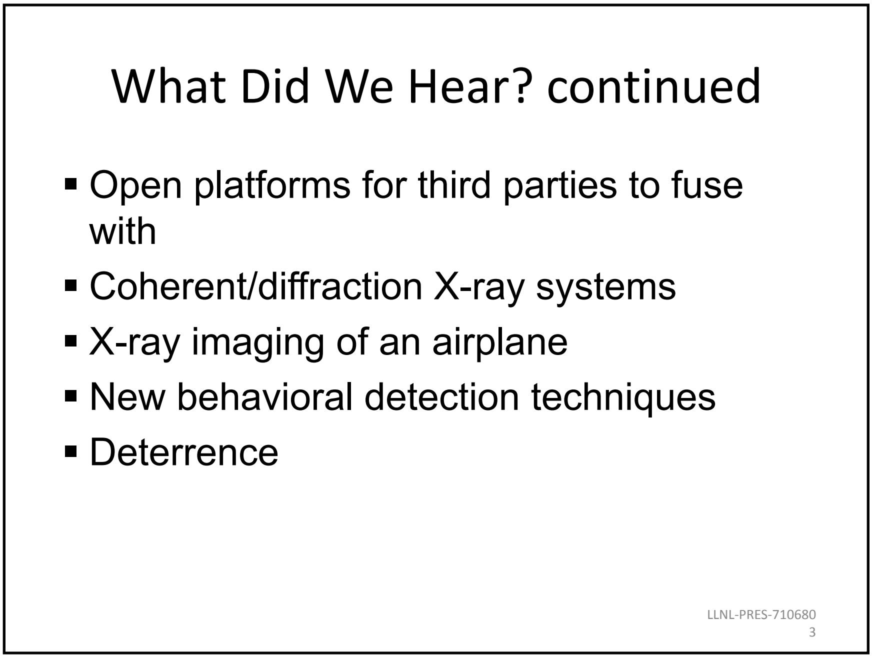


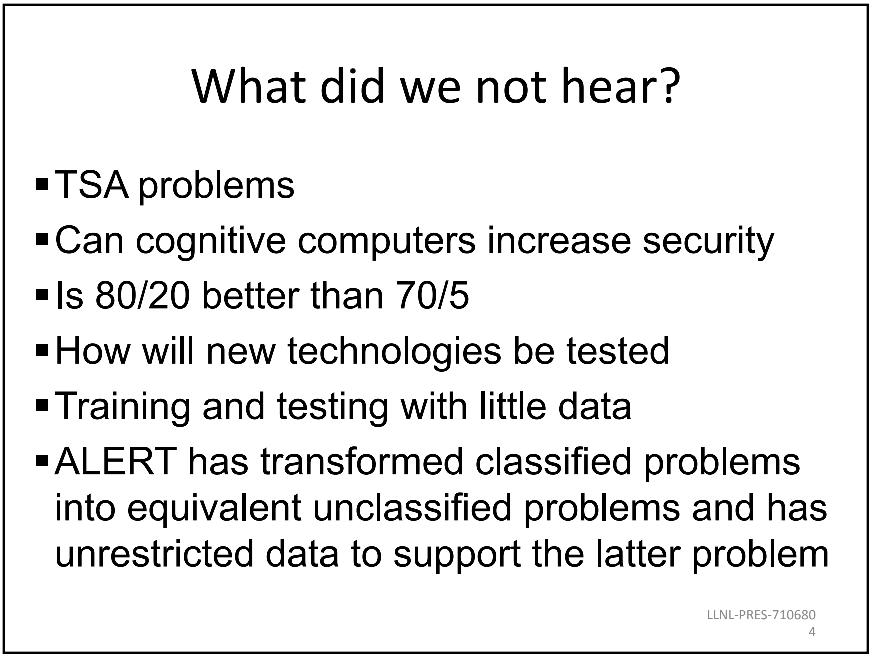
What Did We Hear?

- TSA's future vision for aviation security: key board to gate security phases
- An environment in TSA has been created for innovation
- Recommended TSA have a technical advisory board
- TSA requirements analysis platform (TRAP)
- UK carry-on luggage screening research programs, Like TSA's innovation task force
- An airline, passenger, vendor, and terrorist panel
- Engaging general population for detection with ubiquitous sensors
- Adaptive learning systems
- Meta data and cognitive computers
- Data Analytics for heath care and security



What Did We Hear? continued

- Open platforms for third parties to fuse with
- Coherent/diffraction X-ray systems
- X-ray imaging of an airplane
- New behavioral detection techniques
- Deterrence

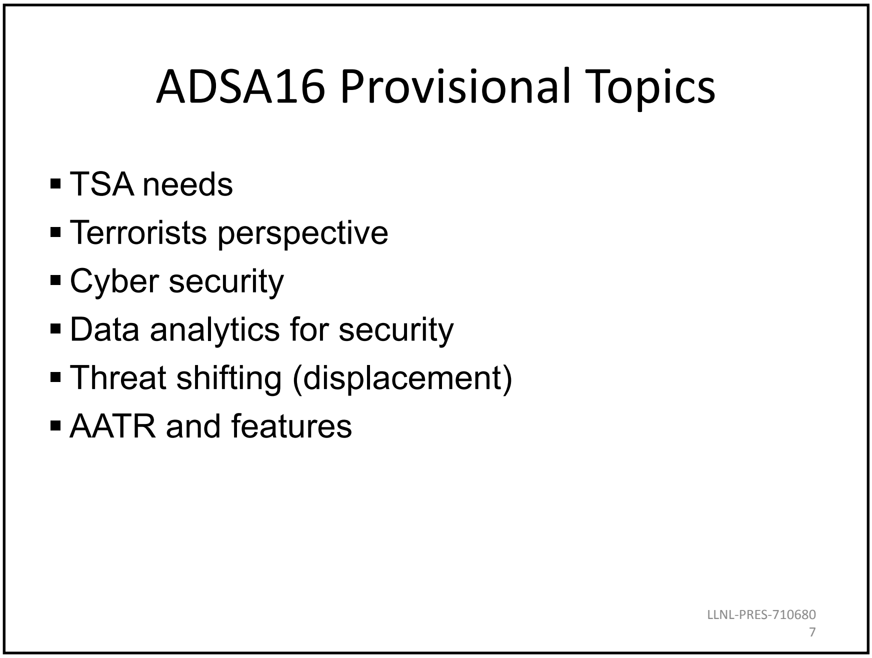


What did we not hear?

- TSA problems
- Can cognitive computers increase security
- Is 80/20 better than 70/5
- How will new technologies be tested
- Training and testing with little data
- ALERT has transformed classified problems into equivalent unclassified problems and has unrestricted data to support the latter problem

Additional Audience Comments on "What We Heard or Did Not Hear"

What Can Be Done To Solve the Checkpoint Problem?



ADSA16 Provisional Topics

- TSA needs
- Terrorists perspective
- Cyber security
- Data analytics for security
- Threat shifting (displacement)
- AATR and features

ALERT
AWARENESS AND LOCALIZATION
OF EXPLOSIVES-RELATED THREATS

Awareness and Localization of Explosives-Related Threats

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