Strategic Study
Workshop Series

Advanced Development for Security Applications

Addressing the Requirements for Different Stakeholders in Transportation Security

ADSA16
May 2017 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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ADSA16 WORKSHOP

Addressing the Requirements for Different Stakeholders in Transportation Security

Hosted by ALERT: Awareness and Localization of Explosives-Related Threats

a Department of Homeland Security (DHS) Center of Excellence

May 2 - 3, 2017

17th Floor, East Village, Northeastern University

1. Executive Summary

A workshop entitled "Addressing the Requirements for Different Stakeholders in Transportation Security" was held at Northeastern University (NEU) in Boston on May 2-3, 2017. This workshop was the sixteenth in a series dealing with advanced development for security applications (ADSA16).

The theme of this workshop was chosen in order to support the U.S. Department of Homeland Security's (DHS) objective of improving the performance of existing technologies as well as 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 workshop addressed the requirements for the following stakeholders:

- TSA
- Airlines
- Passengers
- Vendors
- Terrorists

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

- Developing a single technology that can satisfy TSA's future requirements may by improbable or impossible. This solution is also denoted as a silver bullet.
- TSA should consider allocating funds to support augmenting existing technologies using the following methods:
    - Developing technologies that can be fused with existing technologies; and
    - Acquiring additional information to change how technologies are applied to passengers and divested items. This information may be used to perform the following tasks:
        - Reduce screening resources on minimum risk passengers; and
        - Provide statistical information on the contents of divested items.
- Acquire best practices from the protection of non-aviation venues, such as malls and sports stadiums.

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 DHS Science & Technology Directorate (S&T), in coordination with the Transportation Security Administration (TSA), have the objectives for 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 developments. 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 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.

ADSA16 was held on May 2-3, 2017 at NEU. The workshop was entitled "Addressing the Requirements for Different Stakeholders in Transportation Security."

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 workshop addressed the requirements for the following stakeholders:

- TSA
- Airlines
- Passengers
- Vendors
- Terrorists

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

4.2 What Did We Hear?

We heard about the following topics:

- Dialogue about the relationship between manufacturers and TSA: We need additional methods to incentivize development of advanced technologies.
- Silver bullet: It may exist in emerging technologies; however, it may be improbable.
- ADSA brings stakeholders together: Alternative funding may be required if ALERT's funding ends.
- The amount of risk TSA is willing to take: More discussion is required on the meaning of "risk."
- International markets for global aviation security: We need to align U.S. and foreign requirements.
- Systems engineering and technology development process: We need to balance TSA specifications and opportunities for innovation.
- Cyber security: We heard TSA requirements but need to have discussion on what it takes to achieve those requirements.
- Predicting terrorist's targets: Strong leaders do not want to attack civilian targets. Can a history of events be used to affect the performance of detection systems?
- Macro security: Assuming that there is no silver bullets, we can get more out of existing technologies, in part, by using additional data on passen-

gers and their divested items.

- Requirements-based design: The security field may need different background in leadership.
- Former insider looking back on the security field:
    - o Insider view
        - We lost track of the mission, and only low-risk development was allowed.
        - Diminishing returns occur when more time is spent doing lab testing. We have to get equipment into the airports early. Until then, you don't really know how well it's going to work.
    - o Outsider view
        - For industries not selling to TSA
        - OEMs invest massively in remote connectivity, data gathering and analysis, etc., which increases risk.
        - We can run secondary software in the background for R&D then DT&E, and get into the field early and often.
    - o Recommendations to TSA
        - Allow longer term and higher risk R&D.
        - The government should continue to fund third parties and let the market play out.
        - There needs to be incentive to take some risk.
        - We need to get back into startup mode.
- Manufacturers panel:
    - o There needs to be clearly defined requirements that focus on what you really need. Also, there needs to be improved government and vendor relationships as well as relationships with academia.
    - o We need to streamline intellectual property agreements, and need templates for them.
    - o Planning and funding are unpredictable.
    - o Testing:
        - The requirements should be tiered.
        - What can manufacturers do to address re-occurring issues encountered repeatedly in multiple testing cycles?
        - What can we do to ease the testing burden, and how and where should we test?

- What should TSA do to ensure that cost-effective TSE meets current and emerging needs?
  - The DoD acquisition lifecycle guarantees a procurement pipeline, while TSA's typically does not.
  - Manufacturers should not expect the government to be your sugar daddy.
- A view from third parties:
  - TSA acquisitions and development for TSA has been confusing.
  - Need some lucky guesses if you don't have access to classified information,
  - Need to learn to fail early and fail fast
  - TSA wants us to succeed and provides useful help and we should welcome it.
- Airline and airport perspectives panel:
  - Passengers want a seamless experience. They don't want to talk to anyone.
    - A hassle-free experience includes choices via kiosks, tag your own bags, etc.
    - Passengers like to do things themselves and at their own pace.
  - Airlines want things to be safe, secure, fast, smooth, and simple.
  - Airline employees are screened in collaboration with airports and local authorities.
  - Communication is the responsibility of the government. They should be explaining policy changes.
  - We collaborate, demonstrate, and assess.
  - For the airport ecosystem, we use six sigma metrics.
- For airline data collection and dissemination of security-related information, the following is used:
  - Incident command center and social media
  - Being proactive and never reactive, in part using interviews
  - Track and trend customers, crew members, etc. (not profiling)
  - Respond to subpoenas only, otherwise no data sharing
- Cargo update:
  - 2010 had 100% screening; certified cargo screening program
  - Certified shipper; risk-based strategies

  - R&D needs: Cheap, fast (20 skids/hour), low-cost large aperture, and heterogeneous cargo
- Aviation security in Israel compared to the U.S.:
  - In Israel, they screen cars entering airport, and use profiling and interrogation.
  - You may miss your flight.
- Summary of future X-ray systems: We need more information on XRD.
- Specification of Jell-O: It is a hard problem. We need academics to help.
- Regions of responsibilities, transfer functions, and simulants: We need more discussion on how to incorporate these methods.
- Mall of America security:
  - There is a necessity for interviewing and behavior detection. We can possibly do a study to determine why that is successful here but not what TSA found out.
  - See something, say something: What is out of the ordinary for your environment?
- Screening/security at large venues: They use agent-based modeling and simulation.
- Weapons ATR: Eventually, we will need 100,000+++ images, especially if deep learning is used. Also, how will ground truth be established for so many images?
- Visual analytics for security applications: We need to learn how to collect and use big data.
- Dual energy decomposition:
  - There are many possible spaces, but what is best?
  - We need vendors to get involved.
  - We need specifications for transfer functions.
- Iterative low-dose CT with deep learning (neural networks) for medical imaging: We need to assess for artifact reduction for security CT.
- Realistic simulations of baggage: How do we use this to augment training ATRs and testing?
- DICOS:
  - There is a need for discussion around impediments to deployment.
  - We need input and participation from manufacturers, researchers, etc.
  - Manufacturers participate to make sure we get it right and under-

stand it, including interoperability. We need to deploy ASAP to DT&E, fix bugs, etc.

- o This opens up the market and will increase sales.

4.3 What Did We Not Hear?

We did not hear enough about the following topics:

- Prohibited items at the check point are more than just guns and knives.
- What is the role of the lobbyist?
- Who are the engineering leaders?
- What is the B tour (negatives/holes) on private security?
- How can you speed up deployment, checkpoint, etc.?
- It is not clear how out-of-the-box technologies apply.
- How do we handle the 5%/year increase in passenger load?
- Which is better: Educating vs. sorting passengers?
- What does risk mean, how do we manage it, and how do we communicate it?
- How does TSA learn from DoD, NIH, NSF, FDA, etc.? What is appropriate for TSA?
- How do we detect insider threats?

4.4 ADSA17

The following topics should be considered for ADSA17 and other ADSA workshops, in addition to the topics listed in Section 4.3.

- TSA needs
- Terrorists' perspectives
- 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, LLNL, for reviewing the final report
- Mara Winn, TSA; Keith Goll, TSA; and Emel Bulat, NEU, for finding participants for the airline panel
- Deanna Beirne, NEU; Melanie Smith, NEU; and the Polo Club of Boca Raton for creating a poster for the workshop

The workshop would not have been a success without the participants and 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, LLNL
- Michael Silevitch, NEU

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, NEU

Minutes were taken by:

- Suriyun Whitehead, Booz Allen Hamilton

Logistics for the workshop were led by:

- Melanie Smith, NEU

Other logistics were handled by:

- Sara Baier, NEU
- Deanna Beirne, NEU
- Kristin Hicks, NEU
- Tiffany Lam, NEU
- 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/ADSA16_Presentations.

8. Appendix: Agenda

8.1 May 2, 2017 - Day 1

TIME	TOPIC	SPEAKER	AFFILIATION
Introduction			
7:30	**Registration/Continental Breakfast**		
8:30	Welcoming Remarks - ALERT	Carey Rappaport	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
TSA/DHS Perspectives			
8:55	Panel Discussion - Perspectives, Advanced Topics, Cybersecurity	Keith Goll Mara Winn Jeffrey Quinones Domenic Bianchini	TSA TSA TSA TSA
9:50	Cybersecurity	Tim Smith	TSA
10:15	**Break**		
Terrorist Perspectives			
10:45	Yes, We Can Now Predict Terrorist Targets	Max Abrahms	NEU
Thomas Kuhn's Paradigm Shift Perspectives			
11:10	Macro Security	Matthew Merzbacher	Smiths Detection
Vendor Perspectives – I			
11:35	Requirement-Based Design	Bernard M. Gordon	Photo Diagnostic Systems, Inc.
12:00	Former Inside Looking Back from the Outside	Piero Landolfi	Tesla
12:20	**Lunch**		
Vendor Perspectives – II			

TIME	TOPIC	SPEAKER	AFFILIATION
1:15	Panel Discussion	Matthew Merzbacher Shiva Kumar Steven Urchuk Kristofer Roe Joseph Paresi Andrew Foland	Smiths Detection Rapiscan Analogic Smiths Detection Americas Integrated Defense and Security Solutions L3-Communications
1:55	Stratovan's Perspective as Being a Third-Party Vendor and Recent Stratovan Involvement	David Wiley	Stratovan
2:20	**Break**		
Airline and Airport Perspectives			
2:50	Panel Discussion	Stephanie Vargas John Niebling Dan Weber Peter Boynton	JetBlue Airlines JetBlue Airlines Alaska Airlines NEU
3:45	Collection and Dissemination of Security-Related Information	Lisa Asaro	JetBlue Airlines
Other Users Perspectives			
4:00	Can a Death-Predicting Algorithm Improve Healthcare?	Carl Crawford	Csuptwo, LLC
4:25	Cargo Update	Allan Collier	TSA
4:50	Aviation Security in Israel Compared to the United States	Avi Cagan	Self
Emerging Hardware Perspectives - II			
5:15	Future X-ray System Concepts: Approaches and Issues	David Castañón	Boston University
Self-Reflective Perspectives			
5:40	ADSA + Related Projects - Past, Present and Future	Laura Parker	DHS
6:05	**Adjourn**	Carl Crawford	Csuptwo, LLC

8.2 May 3, 2017 - Day 2

TIME	TOPIC	SPEAKER	AFFILIATION
7:30	**Registration/Continental Breakfast**		
8:00	Call to Order	Carl Crawford	Csuptwo, LLC
Deployment Perspectives			
8:05	Specification of a Jell-O Detector	Matthew Merzbacher	Smiths Detection
8:30	Regions of Responsibilities, Transfer Functions and the Role of Simulants	Harry Martz	Lawrence Livermore National Laboratory
Venue Protection Perspectives			
8:55	Security at the Mall of America	Ashly Helser	Mall of America
9:20	Screening/Security at Large Venues	Fred Roberts	Rutgers University
9:45	**Break**		
Algorithm Perspectives - II			
10:15	Weapons Detection	Rohit Patnaik	Capture
10:40	Dual Energy Decomposition Methods for Accurate Material Discrimination	Harry Martz	Lawrence Livermore National Laboratory
11:00	Basis Material Decomposition	Rob Klueg Christopher Smith Ron Krauss Joseph Palma Alex Demasi	DHS DHS DHS Battel Signature Science
11:25	Iterative Low-dose CT Reconstruction with Deep Neural Networks	Quanzheng Li	Massachusetts General Hospital
11:50	Visual Analytics for Security Applications	David Ebert	Purdue University
12:15	DICOS 2A and the TSL/DHS Database	Doug Bauer	Global Security Technologies
12:35	Realistic Simulations of Baggage	Taly Gilat-Schmidt	Marquette University
12:55	**Lunch**		
Emerging Hardware Perspectives			
2:30	Explosive Trace Detection - Emerging Technologies	David Atkinson	Pacific Northwest National Laboratory
2:55	**Break**		

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	Carey Rappaport	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 fifteen workshops, including their final reports, can be found at: www.northeastern.edu/alert/transitioning-technology/strategic-studies.

10. Appendix: List of Participants

NAME		AFFILIATION
Max	Abrahms	Northeastern University
Omar	Alkofahi	American Science & Engineering, Inc.
Lisa	Asaro	JetBlue Airlines
David	Atkinson	Pacific Northwest National Laboratory
Nadine	Aubry	Northeastern University
Paris	Babaheidarian	Boston University
Sara	Baier	Northeastern University
Douglas	Bauer	Global Systems Technologies
John	Beaty	Northeastern University
Moritz	Beckmann	XinRay Systems LLC
Deanna	Beirne	Northeastern University
Nick	Bianchini	Department of Homeland Security
Kurt	Bistany	Morpho Detection
Charles	Bouman	Purdue University
Douglas	Boyd	TeleSecurity Sciences, Inc.
Peter	Boynton	Northeastern University
Toby	Breckon	Durham University
Emel	Bulat	Northeastern University
Avi	Cagan	University of Rhode Island
Donald	Cahoon	Transportation Security Administration
David	Castañón	Boston University
Michael	Chan	MIT Lincoln Laboratory
Michael	Chandarlis	Transportation Security Administration
Somrita	Chattopadhyay	Purdue University
Michelle	Clark	MIT Lincoln Laboratory
Allan	Collier	Transportation Security Administration
Andrew	Cox	Department of Homeland Security
Carl	Crawford	Csuptwo, LLC
Marianne	DeAngelus	MIT Lincoln Laboratory

NAME		AFFILIATION
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Marcy	Donnelly	Department of Homeland Security
Jacques	Doremus	Multixdetection
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Bruno	Faviero	Synapse Technology
Artem	Filipenko	Bruker Detection Corporation
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Amanda	Fond	Department of Homeland Security
Mark	Frank	University of Buffalo
Jeffrey	Gates	Presco
Simanta	Gautam	Synapse Technology
Stan	German	Charles River Analytics, Inc.
Simon	Godber	HALO X-ray Technologies
Graeme	Goldsworthy	Goldsworthy, Stolk & Associates
Keith	Goll	Transportation Security Adminstration
Brian	Gonzales	Micro-X Ltd
Bernard	Gordon	Photo Diagnostic Systems, Inc.
Chris	Green	ScanTechIBS
Joel	Greenberg	Duke University
Otto	Gregory	University of Rhode Island
Adam	Grosser	Redlen Technologies, Inc.
Joseph	Han	Morpho Detection
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Ashly	Helser	Mall of America

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Joseph	Palma	Battelle
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John	Parmeter	Sandia National Laboratories
Rohit	Patnaik	Capture, LLC
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Ed	Rao	Transportation Security Administration
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Pooja	Ravichandran	Northeastern University
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Cameron	Ritchie	Morpho Detection
Fred	Roberts	Rutgers University
Kristofer	Roe	Smiths Detection

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Jeff	Schubert	American Science and Engineering, Inc.
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Michael	Silevitch	Northeastern University
Sergey	Simanovsky	Analogic Corporation
Sondre	Skatter	Morpho Detection
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Melanie	Smith	Northeastern University
Tim	Smith	Transportation Security Administration
Serge	Soloviev	Reveal Imaging Technologies, Inc.
Samuel	Song	TeleSecurity Sciences, Inc.
Michael	Sossong	Decision Sciences International Corporation
Rich	Stoddard	Morpho Detection
Jonathan	Stone	Analogic Corporation
Dan	Strellis	Rapiscan Systems
Dan	Taylor	E3 Federal Solutions, LLC
David	Taylor	Department of Homeland Security
Eric	Thacker	Airlines for America (A4A)
Jason	Thornton	MIT Lincoln Laboratory
Brian	Tracey	Tufts University
Hoke	Trammell	Morpho Detection
Steve	Urchuk	Analogic Corporation
Alex	Van Adzin	BMG Ventures
Stephanie	Vargas	JetBlue Airlines

NAME		AFFILIATION
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Mara	Winn	Transportation Security Adminstration
Mark	Witinski	Pendar Tech
Dong Hye	Ye	Purdue University

Note: The list of participants reflects the individuals that checked-in for either Day 1 or Day 2 of ADSA16. Any errors are due to the editors of this report and not to the participants themselves.

11. Appendix: Presenter Biographies

Max Abrahms

Dr. Max Abrahms is a professor of political science and public policy at Northeastern University, a member at the Council on Foreign Relations, a senior fellow at George Washington University's Center for Cyber and Homeland Security, a fellow at the Observer Research Foundation in India, and on the editorial board at the journal Terrorism and Political Violence. His terrorism research challenges the conventional wisdom. Abrahms is also a frequent terrorism analyst in the media, especially on the consequences of terrorism, its motives, and the implications for counterterrorism strategy. Previously, he has been awarded fellowships and financial backing from the Center for International Security and Cooperation at Stanford University, the Empirical Studies of Conflict project at Princeton University and Stanford University, the Dickey Center for International Understanding at Dartmouth College, the Combating Terrorism Center at West Point Military Academy, the Moshe Dayan Center at Tel Aviv University, the economics department at Bar Ilan University, the political science department at Johns Hopkins University, and the Belfer Center at Harvard University. On Twitter, @MaxAbrahms has become a major source of terrorism news and analysis. Abrahms presents his terrorism research to academic audiences throughout the world like Harvard, MIT, Stanford, and St. Andrews, as well as at venues such as MENSA, TED-X Hollywood, the National Counterterrorism Center, and other government gatherings. He has a forthcoming book with Oxford University Press on why the conventional wisdom on terrorism is wrong.

Lisa Asaro

Lisa Asaro currently services as JetBlue Corporate Security Blue Watch Manager. She is directly responsible for Corporate Securities primary point of contact and focal point for the entire JetBlue Operation, known system wide as Blue Watch. Her responsibilities include managing a team that operates a real time reporting center regarding various types of security incidents including but not limited to assessing potential threats, in flight disturbances, suspicious activities, regulatory compliance, workplace violence/active shooter, and problem solving. Blue Watch is considered JetBlue's first point of contact for all crewmembers security concerns company wide and principle liaison for local, state and government agencies both foreign and domestic.

Lisa comes to JetBlue with extensive experience in various security positions derived from the New York City Police Department (21 years), Delta Air Lines Corporate Security (10 years and lastly Air Serve Corporation a security business partner for American Airlines (2 years).

David Atkinson

David Atkinson is a senior research scientist and manages the explosives detection R&D portfolio at the Pacific Northwest National Laboratory. Dr. Atkinson holds a Ph.D. in analytical chemistry from Washington State University, under the advisement of Herb Hill. He has worked in trace chemical detector development in the DOE National Laboratory complex over the last 25 years, with a specific emphasis on explosives detection. He has participated in all aspects of R&D with respect to explosives detection, from performing fundamental research, to doing testing/evaluation, to deploying equipment in the field and training end users. He has worked for decades with the Federal Aviation Administration (FAA) and then the Department of Homeland Security (DHS) on applying detection instrumentation to aviation security. He was the co-chair of the 2011 Gordon Research Conference on Detecting Illicit Substances and is a co-founder and co-chair of the annual Trace Explosives Detection Workshop.

Nadine Aubry

Dr. Nadine Aubry is University Distinguished Professor and Dean of the College of Engineering at Northeastern University. She has made research contributions to fluid mechanics, including low-dimensional models of turbulent flows and novel microfluidics methods and devices. She is a member of the National Academy of Engineering (NAE) and was recently inducted into the American Academy of Arts and Sciences (AAAS). She is a fellow of the National Academy of Inventors (NAI), the American Physical Society (APS), the American Society of Mechanical Engineers (ASME), the American Association for the Advancement of Science (AAAS) and the American Institute of Aeronautics and Astronautics (AIAA). She currently serves as President of the International Union of Theoretical and Applied Mechanics (IUTAM), Section Secretary of the NAE mechanical engineering section, Chair of the NAE's Frontiers of Engineering Education (FOEE) committee, and member of the International Council for Science (ICSU), the NAE committee on Center-Based Engineering Research (CBER), the NAE Membership Policy Committee (MPC), the NAE Bernard M. Gordon

Prize for Innovation in Engineering and Technology Education selection committee, the National Academy of Science (NAS) U.S. National Committee on Theoretical and Applied Mechanics (USNC/TAM), and the AAAS Engineering Section executive committee. Former leadership positions include Chair of USNC/TAM and Chair of the APS Division of Fluid Dynamics (DFD). She is the recipient of the 2017 G.I. Taylor Medal of the Society of Engineering Science (SES). Prior to joining Northeastern, she was Head of Mechanical Engineering at Carnegie Mellon University where she had been named Lane Distinguished Professorship and University Professor. She grew up in France and holds a Diplôme d'Ingenieur from Institut National Polytechnique Institute (INP) Grenoble, a Diplome d'Etudes Approfondies (D.E.A.) from Université Grenoble Alpes (both in Mechanical Engineering in 1984), and a Ph.D. from the Sibley School of Mechanical and Aerospace Engineering at Cornell University in 1987.

Doug Bauer

Dr. Douglas Bauer is the Emeritus Program Executive for Basic Research within the Explosives Division of the Science and Technology Directorate at the Department of Homeland Security (DHS). Dr. Bauer holds engineering degrees from Cornell and Carnegie Mellon Universities (where he received his PhD), a law degree from Georgetown University Law Center, and a theology degree from Virginia Theological Seminary. He served in the U.S. Navy as a line officer aboard surface ships, including service in DESERT STORM, and is now retired as a naval Captain.

Since 2012, Dr. Bauer has been a research associate at the University of Connecticut (UCONN). He is counselling students and faculty on how to more successfully transition research into commercial usage - either in DHS components or in the economy, generally. He has written about ten case studies on different technology transitions and the lessons to be learned for success. Dr. Bauer has presented seminars on DHS research priorities and acquisition policies and written on the relationship between university research and economic growth and jobs. He is also participate in the UCONN Technology Incubation Program (TIP), an initiative of the Economic Development Office, evaluating start-up company projects and advising on how to improve the prospects for commercialization. Dr. Bauer consults as a subject matter expert (SME) on threat detection technologies and practices in assignments with Quasars for various federal agencies.

Domenic Bianchini

Domenic "Nick" Bianchini joined the Transportation Security Administration (TSA) in September 2002. He currently serves as the Deputy Director for the Mission Analysis Division in the Office of Requirements and Capabilities Analysis. He previously served as Division Director for the Checkpoint Technology Division. His experience includes supporting airports in the deployment, integration, and lifecycle management of aviation screening technology for over 15 years. He maintains a significant role in working with international partners to align performance requirements and capabilities in the US and abroad. He has held numerous industry IT and Program Management certifications from Cisco, Microsoft, DHS S&T Level III, and Project Management Professional (PMP).

Peter Boynton

Peter Boynton is CEO of the George J. Kostas Research Institute for Homeland Security and Professor of the Practice at Northeastern University. He was previously Commissioner of Emergency Management and Homeland Security for the state of Connecticut, appointed by both democratic and republican Governors and twice confirmed by the Connecticut General Assembly. While Commissioner, he oversaw three Presidential disaster declarations, supported the response to the H1N1 outbreak, established the state intelligence fusion center, and developed a statewide emergency response framework.

Boynton served as an officer in the U.S. Coast Guard, retiring at the rank of Captain. He was a Director on the White House National Security Council staff, was the senior Coast Guard Officer at the U.S. Department of State, served as Captain of the Port and was Commanding Officer of three Coast Guard cutters. Following his Coast Guard service, Peter was appointed Federal Security Director for TSA at Bradley International Airport in Connecticut. In 18 months, he led the airport, the second largest in New England, from the worst rated to among the top ten TSA operations in the eastern U.S.

Peter Boynton has served on numerous boards, most recently the national Board of Directors for the Military Officers Association of America and has testified before the U.S. Congress on emergency management and homeland security issues. He has a Master's Degree from Harvard and an ocean engineering degree from the U.S. Coast Guard Academy. He was previously Chair of the Connecticut Pilot Commission, and holds an unlimited Master's License for ocean-going vessels of any tonnage.

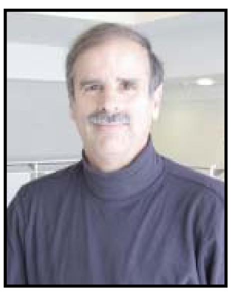
Avi Cagan

Dr. Avi Cagan received his B.Sc. degree in Chemical Engineering from Ben-Gurion University (Be'er Sheva, Israel) and M.Sc. in Chemical Engineering degree from the Technion, Israel Institute of Technology (Haifa, Israel) and his Ph.D. in chemistry from Arizona State University (Tempe, AZ, USA)

Dr. Cagan conducted research, leading the explosives detection team, at the Biodesign Institute OF Arizona State University for 7 years. He was a research Scientist (2006–2008), an Assistant Research Professor (2008-2012). He continues his research in the Chemistry Department at New Mexico State University since then as a Research Professor and works as a Sub-contractor of the Chemistry Department of University of Rhode Island.

Dr. Cagan's main activities involve applications of novel analytical techniques for the detection and analysis of hidden explosives. He published over 15 papers on explosives detection.

David Castañón



David A. Castañón is Professor of Electrical and Computer Engineering at Boston University, and a member of the Division of Systems Engineering. He received his PhD from MIT in Applied Mathematics in 1976. Before joining Boston University in 1990, he was Chief Scientist of ALPHATECH, Inc., in Burlington, MA. He has served in numerous positions for the IEEE Control Systems Society, including President in 2008. He has been a member of the Air Force Scientific Advisory Board, and has served in IEEE as member and Chair of the Society Review Committee, Chair of the Conference Publications Committee, and is currently a member of the IEEE Conference Committee. At Boston University, he has served as Department Chair and co-director of the Center for Information and Systems Engineering. He serves as thrust leader for ALERT in the area of video analytics and signature analysis. His research interests are in the areas of stochastic control, estimation, optimization, and inverse problems.

Allan Collier

Allan Collier is Air Cargo Branch Manager within the TSA Intermodal Division. His Branch is responsible for risk based outreach that supports capability gap and requirements development in collaboration with internal and external stakeholders and his team develops and updates technology components of Standard Security Programs for the Office of Requirements and Capabilities Analysis. Allan has served with TSA Headquarters Staff since August 2003 in a number of Air Cargo related positions including: Branch Chief of the Technology, Analysis and Development, Acting Assistant Director for All Cargo Air Carriers and Principle Security Inspector for Air Cargo Inspections. Prior to joining TSA, Allan served 20 years of honorable military service in the United States Marine Corps with a primary focus on helicopter flying assignments, acquisition, and safety. Allan is a graduate of Texas A&M University with an Engineering degree and holds a Master of Science in Management degree from Troy State University.

Carl R. Crawford

Carl Crawford is president of Csuptwo, LLC, a technology development and consulting company in the fields of medical imaging and explosive detection for Homeland Security. He has been a technical innovator in the fields of computerized imaging for more than thirty years. His technology has resulted in 90 U.S. Patents. 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, dual energy imaging and automated threat detection algorithms. Dr. Crawford has a PhD in electrical engineering from Purdue University. He is a Fellow of the IEEE and a Fellow of the American Association of Physicists in Medicine (AAPM).

David Ebert

David Ebert is the Silicon Valley Professor of Electrical and Computer Engineering at Purdue University, a Fellow of the IEEE, and director of the Visual Analytics for Command Control and Interoperability Center (VACCINE), the Visualization Science team of the Department of Homeland Security's Command Control and Interoperability Center of Excellence. Ebert performs research in visual analytics, volume rendering, illustrative visualization, and procedural abstraction of complex, massive data. He is the recipient of the 2016 IEEE Computer Society vgTC Technical Achievement Award for seminal contributions in visual analytics. He has been very active in the visualization community, serving as Editor in Chief of IEEE Transactions on Visualization and Computer Graphics, serving as IEEE Computer Society Vice President and the IEEE Computer Society's VP of Publications, and successfully managing a large program of external funding to develop more effective methods for visually communicating information.

Andrew Foland

Andrew Foland is an Engineering Fellow in the Advanced Development group at L-3 Technologies, where he has worked for the past 12 years. He has been responsible as lead scientist for the development of two fielded security X-ray CT products, led collaborations with third parties, and contributed across the breadth of L-3 products. He holds a number of patents in X-ray and imaging technology in the US and abroad. Previously, as a physics professor at Harvard, he was a PI at Fermi National Lab, authored one book, and authored or coauthored over two hundred articles on experimental physics, detectors, and statistical analysis of data. He has been an A.P. Sloan Fellow. He holds a Ph.D. in physics from Cornell University.

Keith Goll

Mr. Keith Goll has been with Transportation Security Administration from its inception. He is currently a Senior Technical Advisor in the TSA Office of Requirements and Capability Analysis (ORCA) and has been recently named as the Acting Executive Director for Requirements. In that role, he is responsible for leading the effort to centralize requirements for the agency, ensuring alignment with DHS Joint Requirements

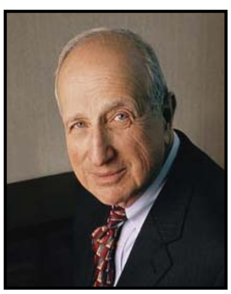
Council (JRC) and leading TSA implementation of DHS Joint Requirements Integration Management System (JRIMS). Mr. Goll is also leading efforts to establish a high level system architecture for TSA. In addition, he recently led the development of TSA's Five Year Technology Investment Plan in response to the Transportation Acquisition Reform Act. Mr. Goll is also co-chairman of the Aviation Security Advisory Committee, Security Technology subcommittee. He's held various leadership roles within the now defunct Office of Security Capabilities, including responsibility for technology deployment, test and evaluation, business operations and life cycle support.

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.

Bernard M. Gordon



Bernard M. Gordon is considered "the father of high-speed, analog-to-digital conversion," and has been responsible for extraordinary breakthroughs in signal translation, medical and security tomography, and other high-precision instrumentation.

Bernie founded three pioneering technology companies – Epsco Incorporated, Analogic Corporation, NeuroLogica Corporation, and is the current Chairman of Photo Diagnostic Systems. He and his teams have been responsible for dozens of engineering achievements, securing many hundreds of patents worldwide.

For his profound contributions to his profession and society, Bernie received the National Medal of Technology from President Ronald Reagan in 1986 and was elected to the National Academy of Engineering in 1991.

Bernie's impact on engineering education and use-inspired research at universities is similarly profound. He and his wife Sophia established the Gordon Institute for Engineering Leadership at Northeastern University, and since the early 1990s have distributed substantial sums to train outstanding engineers and scientists and to support other educational and medical initiatives.

Ashly Helser

Ashly Helser has been employed at Mall of America since 2006, beginning her career as a part of the Risk Assessment and Mitigation (RAM) unit, MOA's behavior detection specialists within the Security Department. Overseeing the RAM unit, Ashly played an integral part in the continued development of the program until 2012 when she transitioned to Emergency Management to focus on Emergency Action Planning, which included the lockdown procedures for over 500 tenants, security communications, and access control. Ashly returned to the Special Operations Unit at MOA in 2014 and currently manages the RAM program, explosive detection K9 teams, and security intelligence analyst, while maintaining her role in emergency management.

Ashly holds a degree in Law Enforcement and a Bachelors of Science degree in Security Management. Ashly has spoken for a number of universities and organizations on topics such as behavior detection, private security, proactive security measures for shopping malls, and emergency management.

Mall of America is North America's largest entertainment and retail complex that attracts over 42 million visitors each year.

Shiva Kumar

Based in Sunnyvale, California, Shiva Kumar is the Vice President of Engineering & Technology, Rapiscan Systems and also serves as the General Manager/President of Rapiscan Laboratories and has served in this capacity since March 2007. He is responsible for building, leading and managing all parts of the R&D and Engineering organization. Mr. Kumar has over thirty years of experience in Engineering, General Management, Operations, Manufacturing and Program Management.

Piero Landolfi

Piero Landolfi is Director of Technical Operations at Tesla, where he leads a number of technology initiatives in the Tesla Service organization and contributes to accelerating the world transition to sustainable energy. Prior to joining Tesla, Piero spent over 19 years in the homeland protection industry, working for Morpho Detection/GE Homeland Protection/Invision, where he held a number of roles, including manager of the image processing team, program manager of the CTX 9800 and ultimately Sr. Director of Engineering.

Piero holds a master degree in Physics from the University of Rome La Sapienza and holds 9 patents in the field of Computed Tomography and baggage inspection.

Quanzheng Li

Quanzheng Li is an Associate Professor of Radiology at Massachusetts General Hospital, Harvard Medical School. He received his M.S. degree from Tsinghua University in 2000, and his Ph.D degree in Electrical Engineering from the University of Southern California (USC) in 2005. He did his post-doctoral training at USC from 2006 to 2007, and was a Research Assistant Professor from 2008 to 2010. In 2011, he joined the Radiology Department at Massachusetts General Hospital in Boston where he is currently the director of image reconstruction and artificial intelligent program in Gordon Center and a principle investigator at Center for Clinical Data Science. Dr. Li is the recipient of 2015 IEEE Nuclear and Plasma Sciences Society (NPSS) early achievement award. He is an associate editor of IEEE Transaction on Image Processing and editorial board memeber of Theronostics. His research interests include image reconstruction methods in PET, SPECT, CT and MRI, and data science in health and medicine.

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.

Matthew Merzbacher

Dr. Matthew 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.

Dr. Matthew Merzbacher 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.

Joseph S. Paresi

Joe Paresi is the Founder, Chairman and Chief Executive Officer of Integrated Defense and Security Solutions, IDDS, which has developed the DETECT™ 1000, an advanced, fully automated explosive detection systems for carry-on baggage worldwide security market. The DETECT™ 1000, which utilizes Three-dimensional Computer Tomography (CT) technology, has successfully completed TSA Certification Testing with the Highest Automated Explosive Detection Performance while also maintaining the Lowest False Alarm Rate ever achieved. Presently the system is deployed in Internationally and in the spring at US Airports by the TSA. Prior to IDSS, Mr. Paresi was the Co-founder and Executive

Vice President of L-1 Identity Solutions, Inc., the largest supplier of multi-biometric solutions, credentials and credentialing systems as well as specialized classified support to the U.S. Directorate for National Intelligence (DNI). L-1 was sold in 2011 for $1.6B to Safran of France. Prior to L-1, Mr. Paresi served as Corporate Vice President of Product Development at L-3 Communication Corporation and President and Founder of L-3 Security & Detection Systems. Mr. Paresi led the development and deployment of the L-3 eXaminer 3DX 6000 TSA Certified Explosive Detection System and the ProVision Millimeter-wave Body Scanners. Mr. Paresi also served as Corporate Director of Technology for Lockheed Martin and Loral Corporations. Mr. Paresi holds a Bachelor and Master's Degree in Electrical Engineering, an MBA in Finance, Program Management Degree from the U.S. Department of Defense and is Top Secret/Special Compartmental Information (TS/SCI) clearance eligible.

Laura Parker

Laura Parker is a Program Manager in the Homeland Security Advanced Research Projects Agency/Explosives Division of the Science and Technology Directorate at the Department of Homeland Security as well as the Program Manager for the ALERT Center of Excellence, a DHS-sponsored consortium of universities performing research that address explosive threats lead by Northeastern University.

Laura manages a portfolio of projects focused on the next generation of explosives trace detectors, several projects on algorithm development for improved explosives detection as well as working with ALERT on a wide range of explosives research and education projects. 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 Ph.D. in chemistry from the Pennsylvania State University.

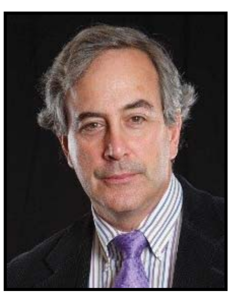
Rohit Patnaik

Rohit Patnaik is the President and CTO of Capture LLC. – a company that develops algorithm software for various applications. Mr. Patnaik has more than 25 years of experience developing algorithms in the areas of Computer Vision, Machine Learning/Classification, and Artificial Intelligence for various diverse applications that involve imaging such as 3D X-ray (Both axial and planar tomography), Muon Tomography and AIT backscatter systems among others. He has wide experience on projects in various industries including security, medical, NDT, and semi-conductors. Mr. Patnaik has several patents granted and pending related to finding objects in cargo, extracting features, estimation of depth in x-ray, removal of artifacts in x-ray reconstructions.

Jeffrey Quinones

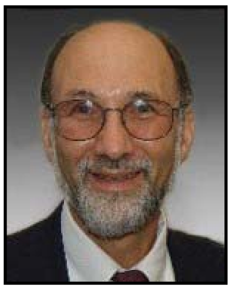
Jeff Quinones is a leader in security technology development and procurement at the Transportation Security Administration (TSA). Jeff is a subject matter expert in explosive detection system implementation. Jeff started his career at the Department of Defense, working R&D with Night Vision and Electronic Sensor Directorate. He later joined TSA as a contractor, where he provided technical, program management, system engineering, and procurement consulting for TSA's Electronic Baggage Screening Program (EBSP). Jeff later re-joined the federal workforce and joined EBSP as a Contracting Officer Technical Representative Manager for all Explosive Detection System manufacturers. He was promoted to Equipment Branch Manager within EBSP, where he leads strategic initiatives to procure and deploy next generation technologies and manages the system engineering lifecycle of Explosive Detection System technology. Jeff is now part of the new Office of Requirement and Capability Analysis where he continues to mature the technology readiness levels of various security aviation applications and capability injects to enhance TSA's mission for security effectiveness and suitability since 2005. Jeff earned his undergraduate degree in Electrical Engineer from Virginia Commonwealth University with concentrations in Physics and Computer Engineering.

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.

Fred Roberts



Fred Roberts is a Distinguished Professor of Mathematics at Rutgers University and Director of the Command, Control, and Interoperability Center for Advanced Data Analysis (CCICADA), a DHS University Center of Excellence. For 16 years he directed DIMACS, the Center for Discrete Mathematics and Theoretical Computer Science, an original National Science Foundation Science and Technology Center.

Roberts has served as co-chair of the NJ Universities Homeland Security Research Consortium, on the HHS Secretary's epidemiology modeling group, the NJ Governor's Health Emergency Preparedness Advisory Council and the NJ Domestic Security Preparedness Task Force Planning Group.

Roberts has authored four books, over 185 scientific articles, and edited 21 books, on homeland security, energy, decision making, mathematical psychology, measurement, and epidemiology. His homeland security research interests include large venue security, resource allocation, container inspection, border security, behavioral responses to disasters, maritime cyber security, and homeland security aspects of global environmental change.

Professor Roberts has received the Commemorative Medal of the Union of Czech Mathematicians and Physicists, the Distinguished Service Award of the Association of Computing Machinery Special Interest Group on Algorithms and Computation Theory, the NSF Science and Technology Centers Pioneer Award, is a Fellow of the American Mathematical Society, and received an honorary doctorate from the University of Paris-Dauphine.

Kristofer Roe

Dr. Kristofer Roe is currently Director, Products and Technology for Smiths Detection, Inc., based in Edgewood, Maryland. In this position, Dr. Roe is responsible for technology research and development in the areas of people screening, carry-on and checked baggage systems, high energy imaging systems, and air cargo imaging systems for Smiths Detection Inc. In this role, Dr. Roe leads a multidisciplinary team responsible for engineering development activities, research programs, and product certification efforts.

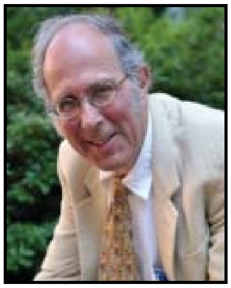
Dr. Roe is currently the principal investigator for funded programs in the area of coded aperture imaging and deep learning algorithm research funded by the Department of Homeland Security. Dr. Roe serves on the Smiths Detection Scientific advisory board, focused on research opportunities with the US Government and partnerships with US-based universities and companies. Dr. Roe has been awarded four international patents with others pending for security technologies related to his work in the field. In addition to his work at Smiths Detection, Dr. Roe serves as a member and former Chair of the Alumni Advisory Council for the Electrical and Computer Engineering Department at the University of Delaware. Dr. Roe earned his Ph.D., MSEE, and BSEE degrees from the University of Delaware.

Taly Gilat Schmidt

Taly Gilat Schmidt, Ph.D., is an associate professor of Biomedical Engineering at Marquette University and Medical College of Wisconsin. Her research interests include medical imaging system design, optimization, and reconstruction. Dr. Schmidt earned an undergraduate degree in Electrical Engineering from the University of Illinois at Urbana Champaign, after which she was employed in the Edison Engineering Program at GE Healthcare.

Dr. Schmidt received her M.S. and Ph. D. in Electrical Engineering from Stanford University. She directs the Medical Imaging Systems Laboratory at Marquette University, which has conducted research funded by the NIH, GE Healthcare, and the Department of Education.

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).

Steven N. Urchuk

Over the last two decades, Dr. Steven 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.

Stephanie Vargas

Stephanie Vargas began her career in the aviation sector in 2006 when she joined American Eagle Airlines, a subsidiary of American Airlines. She was a Compliance Coordinator at LaGuardia Airport in New York and was promoted to Regional Manager of Safety and Compliance for the Northeast Region where she oversaw sixteen cities including Canada. After seven years with American Eagle she moved over to JetBlue

Airways as the Supervisor of Security Compliance under Corporate Security. A role she has held for the past four years. She is a Certified Quality Auditor under the American Society for Quality (ASQ). She is an active member of the Women in Flight corporate responsibility chapter at JetBlue focusing on developing opportunities for individuals in the industry. She has dedicated this year to focusing on her passions of traveling, cooking and dance.

Dan Weber

Dan Weber has worked in the airline industry since 1999. Since 2003, he has worked in Alaska Airlines' Aviation Security department, where he is currently a Supervisor. The Aviation Security department supports both Alaska Airlines and Horizon Air and is responsible for interpretation and implementation of security regulations, liaison with TSA, FBI, Transport Canada, and other government agencies, and oversight of the airline's security processes. Dan's specific focus areas include security incident response, cargo security, private charter security, and security of off-airport check-in operations. Founded in 1932, Alaska Airlines serves over 100 destinations in the U.S., Canada, Mexico, Costa Rica, and Cuba. Alaska Airlines operates 153 Boeing 737 aircraft. Regional sister carrier Horizon Air operates 52 Bombardier Q400 aircraft. Sky West also operates CRJ-700 and Embraer E175 aircraft on behalf of Alaska Airlines. Alaska Airlines network stretches from Adak, Alaska to Havana, Cuba and from Boston, Massachusetts to Kauai, Hawaii.

Suriyun Whitehead

For over 15 years, Mr. Suriyun Whitehead has been involved in the force protection and aviation security domains, leading the delivery of solutions addressing a wide variety of technical and programmatic challenges. Mr. Whitehead is developing program initiatives for the Transportation Security Administration Office of Acquisition and Program Management (OAPM) and Office of Requirements and Systems Analysis (ORCA) in the areas of vendor-neutral airports, standardized integration and user interfaces for screening technology, third party development of automated threat detection and recognition algorithms, screening performance validation, and Checked Baggage screening systems requirements. He also supported the Department of Homeland Security Science and Technology Directorate, Explosives Division where he enabled the DHS objective to supplement the capabilities and capacities of aviation security vendors, driving the development of the Digital Imaging and Communication for Security (DICOS) standard, expanding the marketplace of screening capabilities, and strengthening the detection of an increased population of homemade explosives. Mr. Whitehead was a staff lead systems engineer with the Boeing Company providing service through PhantomWorks, Homeland Security and Services, and Mission Systems. He was responsible for the design and deployment of scalable multi-tiered solutions for security command and control, asset visualization and threat assessment services for US Department of Defense, US Department of State, and private sector commercial customers.

David Wiley

David Wiley founded Stratovan Corporation in 2005. He has over 25 years of software experience and has led numerous successful commercial software product efforts. To Stratovan, he brings extensive knowledge in the computer industry spanning hardware, software and services in the medical, life sciences and security industries.

Under David's direction, Stratovan has revolutionized how software is designed, built and provided to physicians and surgeons to better address the needs of the medical imaging industry. He also spearheaded the company's strategic expansion into the airport security industry, winning a two contracts with the TSA in 2013 to develop a DICOS SDK and an ATR for EDS.

David earned his B.S., M.S., and Ph.D. in Computer Science at the University of California, Davis, and served as a post-doctoral researcher for three years at UCD. He has published over 30 peer-reviewed publications in journals, conference proceedings and books. He is also the author of seven US-issued and other pending patents for new software technologies.

Mara Winn

Mara Winn is the Manager of the Solutions and Process Integration Branch of the Innovation Task Force (ITF) within the Office of Requirements and Capabilities Analysis (ORCA) in 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. She 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.

Ms. Winn joined TSA is 2014 and has served roles in Deployment and Logistics and Mission Analysis Divisions. 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.

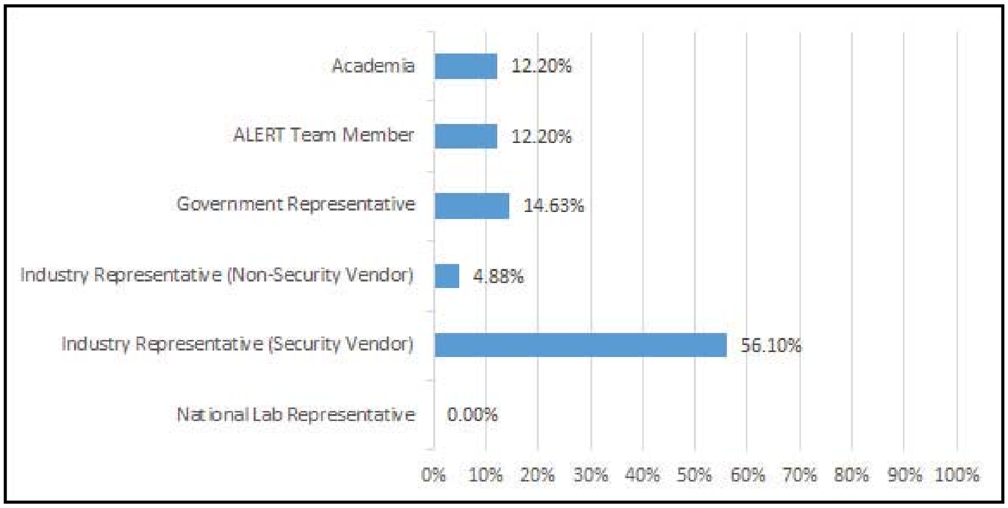
12. Appendix: Questionnaire

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.

1. What is your relationship to ALERT?
2. Which technologies discussed during this workshop show promise for improving the checkpoint?
3. Which emerging technologies were not discussed at the workshop for improving the checkpoint?
4. What are your comments about macro-security?
5. What comments do you have on the TSA, vendor, and airline panel discussions?
6. What did you like and dislike about this workshop?
7. Do you have any recommendations for future ADSA workshop topics?
8. What would you like to see changed for future workshops?
9. Please rate your overall satisfaction with the topics and focus of the ADSA16 presentations and discussion.
10. Please rate your overall satisfaction with the format of the ADSA workshops.
11. What other comments on the workshop do you have?

13. Appendix: Questionnaire Responses

Question 1: What is your relationship to ALERT?



Respondents: 41

Skipped: 3

Academia – 12.20%

ALERT Team Member –12.20%

Industry Representative (Security Vendor) – 56.10%

Industry Representative (Non-Security Vendor) – 4.88%

Government Representative – 14.63%

National Lab Representative – 0%

Individual responses for “Other” category:

- “Airline Associate”
- “TSA”
- “Speaker not from the industry”
- “FFRDC representative”

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

Respondents: 37

Skipped: 7

Individual responses:

- "CT Technology."
- "The continuing development of Open Source protocols (such as DICOS) to facilitate the interface and exchange of information between vendors and government. In particular, this will allow skills and expertise from other fields to input to security issues faced by the industry."
- "CT technology."
- "Checkpoint CT."
- "Emerging Explosives Detection by David Castanon, Boston University - only briefly discussed the following: a. CT at the checkpoint, multi-Energy Tomography, photon counting. b. X-Ray Diffraction (XRD) imaging and Tomography. Needs more details."
- "CT, DICOS."
- "X-ray CT detection."
- "DECT."
- "CT Scanners High Definition/Walk-By AIT."
- "Multi-energy x-ray detectors for explosives and other solid and liquid threats detection in bags, tablets and laptops."
- "X-Ray diffraction, CT."
- "1- Computer Vision 2- CT Scanners 3- Luggage Tracking."
- "Sensor fusion and open architecture for passenger experience improvement and detection performance."
- "New HW platforms deep learning."
- "Diffraction."
- "Discussions with airlines."
- "CT at checkpoint was discussed, as well as 3rd party ATRs."
- "Adaptive ATR, Deep Learning CT Reconstruction."
- "Multi-system approaches."

- "Combining technologies together."
- "Trace emerging technologies."
- "Not many new technologies were discussed. The focus seemed to be CT at the checkpoint."
- "CT, multi-spectral scanners, networking the devices (and in general treating scanners as IoT devices), and the OTAP program and opening up the scanners as platforms for 3rd party software and algorithmic providers."
- "CT x-ray, STIP, enhanced AIT algorithm development."
- "ATR algorithms, advanced materials/diffraction analysis, baggage simulation."
- "CT."
- "CT and X-ray diffraction."
- "CT."
- "CT, new trace, other ideas both mechanical and non-mechanical. Jello scenario was good."
- "Checkpoint CT, Integrated Checkpoint."
- "None."
- "All of them. Most intriguing were technologies that could leverage the vast amount of information already available to DHS/TSA. Xray, ETD, CT... they are taking millions of measurements every day, and the data is dumped. Aggregating the data, using deep/machine learning, might significantly help risk management even if only meta-data was used. This advance could be done in parallel with advances in sensing technology that increases Pd and Pfa."
- "Behavioral observation. CT."
- "Machine learning, deep learning, neural networks, trace, CT."
- "CT for EDS and Mass Spec for Trace."
- "Optimal fusion of different technologies is in my view the best way to improve the checkpoint. Different technologies are available that all have some short comings. Similar to a multi-layer security approach we need to intelligently combine the available solutions to provide the best security possible. I think there is still room for improvement using the available technologies. Similar on efficiency of the checkpoint. The passenger experience can probably be improved by streamlining the process."
- "CT, XRD."

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

Respondents: 22

Skipped: 22

Individual responses:

- "ASL, CT Technology in detail."
- "X-Ray Diffraction (XRD) either implemented as a stand-alone system (as implemented, for example, by Morpho Detection), or as an add-on to CT. The diagnostic capability of the CT baggage scanner can be significantly improved by adding several multi-energy detectors strategically placed in critical locations of the scanner. We envision an architecture that uses a CT main unit to highlight the area of interests to the diffraction arm in such a way that quick additional diffraction analysis helps in making the decision whether the area of interests is threat or not. We anticipate that this additional hardware will only moderately increase the cost of the machine but increase the detection capability in a very significant way (by at least 2x). Some threat/non-threat materials present as indistinguishable under transmission imaging (to within the CT accuracy and natural material variability). X-ray diffraction can provide additional signatures that allow for material identification, thereby helping to reduce the false alarm rate and improving the joint system performance."
- "NONE."
- "Adaptive CONOPS can have a significant impact."
- "Mass Spec."
- "- Higher Sensitivity Semiconductor Components (beyond CdTe) - High Resolution, Fast Data Converters of Future (resolution)."
- "Material specific based technologies (x-ray diffraction, neutron, quadrupole resonance), newer trace techniques. Yes there were some overview talks on some of these but there was not depth to them and some of the information provided was not accurate."
- "Updates to current platforms that TSA/DHS are not using."
- "More orthogonal sensor fusion discussions."
- "AIT technologies were not featured this time."
- "Perimeter security."

- “More focus on combining systems together.”
- “Non-contact trace or vapor detection.”
- “Biometric and other identity and “curb-to-gate” solutions.”
- “Body scanners.”
- “QR, combination of QR and X-ray technologies that have potential application for both CBP and TSA.”
- “Design and airport/airline fiscal responsibility. Their passengers their customers should be chipping in such as in Europe.”
- “AIT millimeter wave.”
- “Automated behavior/intent identification: emotion detection, people tracking, anomalous behavior detection, surveillance and counter-surveillance detection.”
- “Xray diffraction.”
- “How to include meta or intelligence data and optimize the screening based on this information..”
- “Optical.”

Question 4: What are your comments about macro-security?

Respondents: 20

Skipped: 24

Individual responses:

- “Needs acceptance from regulators.”
- “NO COMMENTS.”
- “Surveillance cameras and automatic activity recognition of suspicious situations in public places..”
- “Interesting concept, I don’t see a future where it can be implemented - too many privacy issues, difficult to take metadata and make it actionable and useful.”
- “I need to be educated further to comment.”
- “None.”
- “Was interesting to hear.”
- “The more, the better!”
- “I am not sure I still fully understand the con-ops for this as yet.”
- “I didn’t understand the premise or the talk.”
- “N/A.”
- “Interesting. I would like to learn more.”
- “I don’t have any.”
- “The concept of macro security was well articulated regarding performance trade-offs on emerging threats of HMEs. Application of neural network in detecting HMEs should be presented as a case study detailing complexity of the problem. Will follow-up with presenters.”
- “Should be used more to avoid replication of efforts and drive a better product faster in the development of new emerging technology.”
- “Need more data fusion on aspects of the traveler.”
- “Presented very well. Interesting updates and concepts.”
- “It is key. We have focused on the specific detectors and identification technologies. It is important to look at security from the system of systems perspective and, using a risk based approach, apply the best technology in a system to achieve optimal performance.”

- "Widespread laptop bans on planes are not a long term solution."
- "I think that Matt made a good point to during his presentation and we have to look at the bigger picture to find an optimized solution. We have to be able to challenge current practices and methods."

Question 5: What comments do you have on the TSA, vendor, and airline panel discussions?

Respondents: 32

Skipped: 12

Individual responses:

- "TSA information on current interests and directions is vital for vendor understanding of what is needed and when."
- "Excellent format, hope they will continue."
- "Good idea. Interesting added perspectives. Also need to involve and include airport authorities. Good to have the Mall of America presentation."
- "Very helpful. It is good to see increased collaboration between the TSA, airlines and airports."
- "Very useful, will only get better in future years as everyone gets more comfortable"
- "Very interesting. The inputs from airlines are new and improve our understanding of the their requirements."
- "Jet Blue/Alaska were very informative. Regretful that the rest did not show up or contributed as much."
- "TSA panel was informative, vendor panel was defensive, airline panel was interesting because they provided a new perspective."
- "Good to hear the perspectives."
- "Interesting."
- "Timely, needs to be more in-depth discussions."
- "The airline panel was outstanding. Panels offer an opportunity for people and groups to participate who don't feel that they have something to present."
- "They are helpful to understand different perspectives from stakeholders."
- "TSA - need to present a long-term "wish list" Vendors and airlines presented very well. It would be interested to have a global airline present to see the differences in security globally. The ADSA airline panel was very US centric - hey "the feds do it.""
- "Very useful. Glad the TSA attended."

- "Great panel, add different passenger carriers and add all-cargo carriers."
- "The vendor panel was not really that useful; six or seven representatives all saying the same thing and the same thing that we have been hearing during very many of the ADSA meetings The airline discussions were interesting, but even the airlines deferred the security device decision to the TSA. So, although they are affected, they are not the real users or customers. It is not clear how much influence they have in guiding the TSA's plans. The members of the TSA panel, unlike past TSA representatives, consisted of those at or near the level of "influencers". Their opinions and insights were important. Maybe ADSA is not the proper forum for commitments and decision and meaningful interactive discussions, but, alas, there does not seem to be any mechanism for real give and take."
- "I thought the panels were great. The vendor panel was very engaging both within the panelists and between the panel and the audience. The TSA panel was more of a one-at-a-time presentation, and could've benefited from a moderator or some pre-set engaging topics to discuss."
- "The discussion of the IPT activities was very interesting. Good back and forth between vendors and TSA/S&T on challenges. Airline panel was okay but a larger carrier rep would have helped."
- "Very interesting. Worth continuing."
- "Airline panel discussion was the best. Others were good."
- "Needed more articulation of technical and programmatic issues on trade-offs on cost and performance of current and screening. Interesting recent congressional hearings and GAO reports identified the need for collaborative cost-shared efforts between industry and TSA on pilot projects and technology assessment evaluation studies."
- "Vendor panel was useful in conveying vendor concerns to the TSA."
- "I like discussion panels, I think the questions should be submitted ahead of time so deeper discussion into specific problems could be prepared for. I also like the impromptu as it drives individual thought in the room."
- "Closer interaction of TSA and vendors with better communications is clearly needed."
- "Across the board, the consensus seems to be that TSA is moving too slow within the whole process. Too bloated, too many divisions, too many people and process. This inhibits innovation, rapid development and deployment. This was very clear from the vendors, and affects the airlines of course."
- "Good panels to have. But too often the discussion boils down to policy

and procedure issues. I think that might be better handled at other industry forums. This one should be more on the technical side on how the 3 work together to improve security operation, where the gaps are, etc. Proposed solutions or ideas."

- "Was great to see the airlines there."
- "Want to hear more."
- "Vendors were a little ungracious or even bellicose; TSA a bit defensive and uncompromising."
- "I think it was a very good idea and I would like to see these at future events as well."
- "Excellent discussions that provided much needed insight into the end-user's needs and mindset. Highly encourage you to continue inviting airlines and other end-users to the meeting."

Question 6: What did you like and dislike about this workshop?

Respondents: 33

Skipped: 11

Individual responses:

- "Room acoustics made the use of a microphone mandatory and this stifleed open debate."
- "Like the interactive nature of ADSA"
- "Too rushed. Not enough break time to discuss and network."
- "The technical content and interaction were good. It would have been good to have more international input."
- "I like that there were many industry partners in the workshop, however, unfortunately, not so many people from academia and very few students."
- "Liked the different viewpoints, sometimes I felt the agenda was a bit forced."
- "NETWORKING."
- "I did like the quality of the attendees, the way the presentation and the discussions were conducted, the format (2 days)."
- "Well planned and covered a wide spectrum of safety and security matters."
- "Liked the opportunities for deep dive interactions with others and the opportunity to learn more about some technologies. Dislike the size. I think it has gotten too big and small group workshop feel is lost."
- "Like: Interactions with attendees Dislike: Repetition of topics."
- "Liked meeting Diversity of People, the Location, Orga. Disliked nothing."
- "I liked most of the talks, but some seemed to be geared to inviting friends and not directly on topic."
- "Like: diversity of participants, diversity of topics Dislike: discussion dominated by "old guard" participants who feel compelled to comment on everything due to the format / expectations of the meeting."
- "I like networking opportunity with vendors. Technical depth in the talk can be improved."
- "Like: breakfasts + venue + talks dislike: nothing."
- "Room was probably too big, and the discussions seemed a little forced/

monopolized by only a few folks."

- "Great gathering of issues, ideas, collaboration, awareness, and networking. Dislike nothing."
- "I liked that the format encouraged real discussion and engagement."
- "Good discussion forum. Opportunities for networking on the margins."
- "The get better and better. But I think the size has reached a level where breaking up into subgroups for at least part of the two days to discuss focused topics would be more effective."
- "Like: Workshop encouraged aggressive enquiry on technical and programmatic issues. Dislike: Somehow both industry and Govt. representative were hesitant to voice frank assessment on some issues for the fear of offending and being misconstrued by the other side."
- "Nothing."
- "Discussion about things that no one has control such as government processes, those should be addressed to an arena of people who can address the problem, not just complain about the problem."
- "Good discussions."
- "Like: Format of presentations, clear and concise. The attendance from the stakeholder organizations. The openness. Dislike: Not much, it was prepared and organized well."
- "Well presented. The innovative part."
- "1- Very poor and lax time keeping 2- Not following the agenda, and moving the timing of paper presentations in the schedule. This is totally unprofessional. 3- Not enough "Beef" in the material. Only few papers were directly related to the "development of security Algorithms". This is workshop is becoming a circus, not a technical "Workshop"."
- "Always a great workshop because it's about applications and the "hard problems", less about the business and bureaucracy. Keep it outside the beltway to ensure the flavor stays this way. I liked the change in venue too."
- "Still too much animosity between government and industry."
- "It was not so Sensor OEM centric and the discussion was practical and applicable to solving operational challenges near-term and in the future. Extremely helpful to hear from Mall of America and other venues on Security applications."
- "I liked that we had more stakeholders present and participating. I appreciate that some speakers took on several talks and topics. It would be

great to see more people as engaged in the discussion."

- "Liked: broad perspectives on security; direct contact with airlines and other end-users Disliked: some talks were overly generic (no better than common sense)."

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

Respondents: 28

Skipped: 16

Individual responses:

- “Consider a briefing session for funding models for the industry, specifically from large leasing organisations. Why is a leasing model not adopted in the industry? How could a different funding model release additional funds to promote innovation?”
- “Realistic risk analysis.”
- “XRD continue Airlines invite Airport Authorities invite stadiums, transit authorities more about Air Cargo, and container/portal screening.”
- “Do not hold the event during graduation week.”
- “Define the challenges by TSA and collaborate with academia on resolving those challenges.”
- “High throughput CONOPS.”
- “To keep this format. Since threats and potential solutions are similar to open it to the E.U. Commission representatives and other stake holders.”
- “Some student talks.”
- “Carl and the NEU team did a great job. Thank you!”
- “Reduce attendance to one attendee per organization.”
- “Human factors around 3-D interfaces.”
- “In-depth sensor fusion discussions.”
- “More discussions regarding the interconnection of equipment and treating the checkpoint as more of a ecosystem than a bunch of stand-alone pieces of equipment.”
- “Software Libraries for Airport Security Screening (e.g. DICOS, OTAP).”
- “Perimeter security - integrated “system of systems” interfacingfor multi-sensor protection : https://www.gov.uk/government/news/autonomous-security-system-that-reduces-operator-workload One of the use cases (and demos) was protection of an airfield. PoC: PATHOMAS@mail.dstl.gov.uk (UK gov) or also T. Breckon can talk to this as partner project if he’s not able.”

- "Would be cool to get an inventory of all the technologies out there that could be applied to security -- from universities, from industry, from governments, best practices, etc."
- "Somehow we need new emerging technology discussions, always the same technologies."
- "Air cargo: the current state, the short term goals, long term goals, the challenges, overlap with passenger luggage security screening, who is in charge? Video analytics: solution is search of a problem or a real step towards better security?"
- "AIT algorithm grand challenge."
- "See 7."
- "Panel presentation of status of emerging screening technologies by industry (vendors), academia (COEs) and DHS components such as DNDO, TSA and CBP to meet common user screening requirements to reduce procurement cost to DHS."
- "Biometric innovations, the trace puffer machine ideas and which direction that should take."
- "Discuss new concepts which evolve operations and technologies which enable multi dimension detection."
- "Ensure the topics span (or integrate) the spectrum from intel to sensor. The detection of explosives-related threats can be informed by intel/people vetting, and vice-versa. Unless we have a perfect sensor (100% Pd, 0% Pfa), the operation will have to be a combination/integration of information and sensor based systems."
- "Continue the panel discussions....but shift them to be more panel discussions and not individuals presenting."
- "Hear from other agencies- CBP, SS, CG, Presentations on TSA's current data models and integration approach for all TSE and OEMs."
- "Not yet."
- "Crossing barriers between communities. E.g., involve more scientists from other disciplines (medical imaging, comp sci, gaming, google/microsoft/apple)."

Question 8: What would you like to see changed for future workshops?

Respondents: 21

Skipped: 23

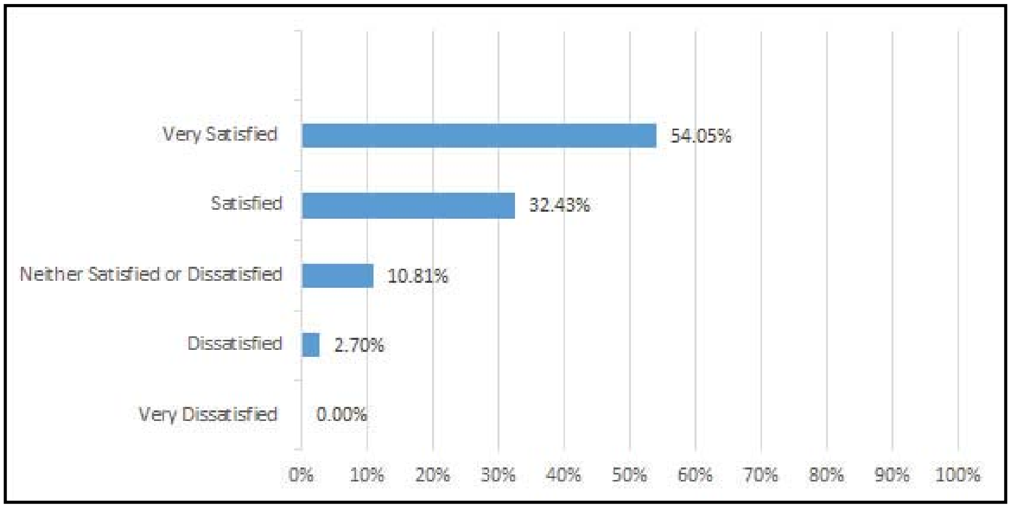
Individual responses:

- "Different room with better acoustics in which better communication between participants can be promoted."
- "More audience microphones for people asking questions."
- "Less rush, longer break times, more one-on-one networking discussion opportunities."
- "N/A."
- "More students and post docs attendees, technical talks to be presented all in one day and policy making and other issues to be discussed in a different day."
- "This was discussed at the end, but it would be great to figure out how to do a classified/SSI follow-on, since some critical topics just can't be discussed in this venue."
- "See my previous comment."
- "Location? (I know - not likely)."
- "1- L3 and Analogic were not present. It would be ideal to have them to contribute also. I know the culture, so, this statement is not a criticism! 2- Hotel accommodation should be expanded to more of the surrounding hotels. Rate was excessively high for a 3 star place at the best."
- "Address some sea and land container cargo applications."
- "New attendees and presenters."
- "Some more science."
- "More student presentations and more panel discussions."
- "Research posters?"
- "Less presentations or more days for longer discussions, some presentations had their briefs cut short."
- "See 7."
- "Brief overview by invited Academia SME on current status of screening

technologies to initiate discussions/dialog with the conference attendees. Framing of technical and programmatic issues should facilitate frank dialog between industry, academia and Govt. representatives addressing cost and performance of screening technologies."

- "I would like to see added something that would help on the networking aspect. This was my first time at an ADSA event and the networking which is crucial could include maybe an hour of "speed dating" style 5 minute intro's. Just have everyone rotate seats at tables every 5 minutes in order to make an initial intro or to catch up with what others are doing. I think something like this could really be great."
- "Add a slight portion for Trace detection."
- "See prior comment."
- "N/A."

Question 9: Please rate your overall satisfaction with the topics and focus of the ADSA16 presentations and discussion.



Respondents: 37

Skipped: 7

Very Satisfied – 54.05%

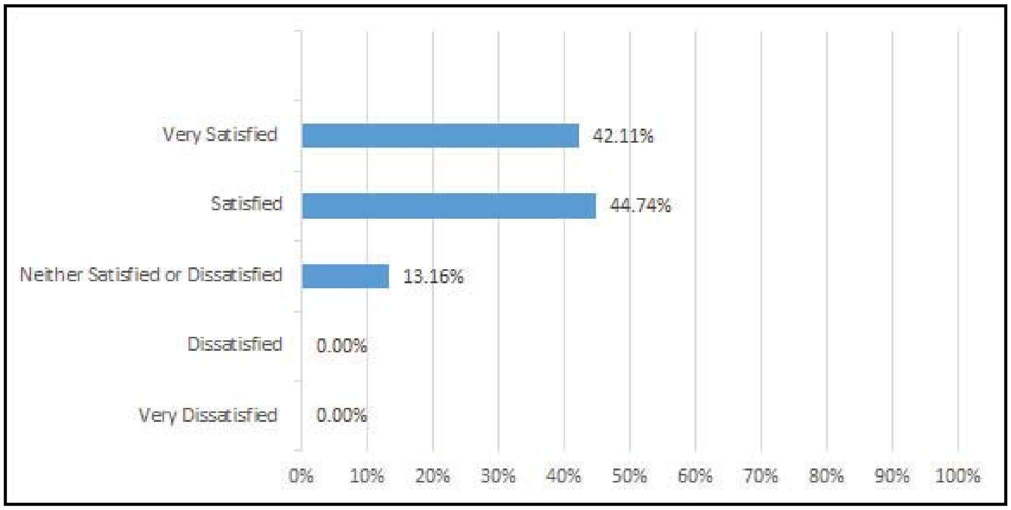
Satisfied – 32.43%

Neither Satisfied or Dissatisfied – 10.81%

Dissatisfied – 2.70%

Very Dissatisfied – 0%

Question 10: Please rate your overall satisfaction with the format of the ADSA workshops.



Respondents: 38

Skipped: 6

Very Satisfied – 42.11%

Satisfied – 44.74%

Neither Satisfied or Dissatisfied – 13.16%

Dissatisfied – 0.00%

Very Dissatisfied – 0.00%

Question 11: What other comments on the workshop do you have?

Respondents: 17

Skipped: 27

Individual responses:

- “Good Job. Well done. Thanks.”
- “Thanks to the sponsors and coordinators.”
- “Well done.”
- “Thanks goes to the hosts and the organizers from Northeastern. You do a great job.”
- “I’ll come again.”
- “Perhaps the registration fee for academics could be reduced slightly ($50).”
- “Thank you, great workshop!”
- “Just a few: With all the criticism, it is easy to overlook the enormous amount of work and preparation that went into this. Arranging the presenters and topics (who would have thought of inviting the Mall of America for what turned out to be a very interesting side-presentation), coordinating the venue, food, transportation. Remarkable job. There was an interesting comparison of US security needs and methods with those of Israel. Not sure, though, is the speaker was an expert or even very familiar with the subject matter. Perhaps revisiting this with other speakers -- perhaps one from the TSA and one from the Israeli counterpart going through the same list of points, each from his or her side.”
- “It was great, and I look forward to the next one!”
- “Not sure if this is the right place for misc comments. - I appreciated dairy free and vegan lunch options. - Putting wifi info on the back of the badge was very convenient.”
- “None.”
- “It would be beneficial to the conference attendees can stay (out of town attendees) and attend the conference at one venue like a hotel to simplify the logistics.”
- “Thank you.”
- “Thanks for having me, and great execution on your end. Looking forward

to future events."

- "I commend Carl, Laura, and the entire support team for organizing and facilitating this forum which brings together many different communities with a common goal of solving the security challenges."
- "N/A."
- "Would be good to adhere to published schedule (although I understand the needs to move things around)."

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 as MD-102 at TSA. http://www.dhs.gov/sites/default/files/publications/102-01_Acquisition_Management_Directive_Rev02.pdf
ADMM	Alternating direction method of multipliers
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

TERM	DEFINITION
ADSA13	Thirteenth ADSA workshop held in October 2015 on explosive detection at the checkpoint
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.
ADSA17	Seventeenth ADSA workshop to be held in October 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.
Al	Aluminum
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
APSS	Accessible property screening system
ARPA	Advanced Research Projects Agency
ASL	TSA Advanced Screening Lane
ASP	Airport security plan
ASTM	American Society for Testing and Materials
AS&E	American Science and Engineering
AT	Advanced Technology; a TSA term for X-ray equipment deployed at the checkpoint for screening cabin baggage and divested items
AT2	Advanced technology two. A TSA term for x-ray systems used for screening divested items at the checkpoint. May refer to multi-view projection x-ray screening systems.
ATD	Automated threat detection; a synonym of ATR
ATR	Automated threat recognition; a synonym of ATD
AUC	Area under the curve

TERM	DEFINITION
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
CBP	Customs and Border Protection, DHS. http://www.cbp.gov/
CBRA	Checked baggage resolution area. Level 3 screening: Open the bag
CCTV	Closed circuit television
CDG	Checkpoint design guide, TSA
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
COTS	Commercial off the shelf
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
DCNN	Deep convolution neural networks
DEA	Drug Enforcement Agency
DHS	Department of Homeland Security
DHS S&T	Science & Technology Directorate, DHS

TERM	DEFINITION
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
DoD	Department of Defense
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
EU	European Union
EXD	Explosive Division, DHS/S&T
FA	False alarm
FAA	Federal Airline Administration
FAMS	Federal Air Marshall Service
FAR	False alarm rate
FBI	Federal Bureau of Investigations
FOC	Full operational capability
FSD	Federal Security Director
FTE	Fulltime equivalent
GAO	Government Accountability Office
GEANT	An X-ray simulation tool
GPU	Graphical processor interface
GUI	Graphical user interface
HDPE	High-density PTFE
HME	Homemade explosive
HP	Hydrogen peroxide
HVAC	Heating, ventilation, and air conditioning
HW	Hardware

TERM	DEFINITION
IATA	International Air Transport Association
IED	Improvised explosive device
IG	Inspector General
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
MAD	Mission Analysis Division, TSA
MDI	Morpho Detection
Mg	Magnesium
MMW	Millimeter wave imaging
MOD SIM	Checkpoint models simulation set
MRI	Magnetic resonance imaging
MS	Mass spectroscopy
MSI	Minority service institutions
NEMA	National Electrical Manufacturers Association. http://www.nema.org/
NEU	Northeastern University
NGA	National Geospatial Intelligence Agency
NIH	National Institutes of Health
NMR	Nuclear magnetic resonance
NSF	National Science Foundation
NQR	Nuclear quadrupole resonance
OAPM	Office of Acquisition and Program Management, TSA
OCR	Optical character recognition
OCRA	Office of Risk and Capability Management
OEM	Original equipment manufacturer

TERM	DEFINITION
OGS	Office of Global Strategies, TSA
OIA	Office of Intelligence and Analysis, TSA
OMB	Office of Management and Budget
OPSL	Open platform software library, SNL
ORCA	Office of Requirements and Capability Analysis, TSA
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
PBOD	Passenger baggage object database, SNL
PC	Personal computer
PCB	Printed circuit board
PD	Probability of detection
PFA	Probability of false alarm
PGDS	Planning guidelines and design standards, TSA
PI	Principal investigator
PIV	Checkpoint models simulation set
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
PRISM	Particle/ray interaction simulation manager tool
PTFE	Polyethylene
QCL IR	Quantum cascade laser infrared
QDP	Qualified data packages
QPL	Qualified product list, TSA

TERM	DEFINITION
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
RAM	Risk assessment and mitigation
RAP	Resource allocation planning, TSA
RBS	Risk-based screening
RFI	Request for information
RFP	Request for proposal
RFST	Random finite sets trackers
ROC	Receiver operating characteristic. https://en.wikipedia.org/wiki/Receiver_operating_characteristic
ROI	Return on investment
S&T	Science and Technology Directorate, DHS
SAFETY Act	Support Anti-Terrorism by Fostering Effective Technologies Act. DHS Program to encourage rollout of Anti-Terrorism technologies by indemnifying solutions developers.
SaS	Screening at speed
SDK	Software development kit
SME	Subject matter expert
SBIR	Small Business Innovation Research. https://www.sbir.gov/
SNL	Sandia National Laboratory
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

TERM	DEFINITION
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
TSCAP	Transportation Security Capability Analysis Process, TSA
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
TSRA	Transportation security risk assessment, TSA
TSWG	Technical Support Working Group
UAV	Unmanned aerial vehicle
UI	User interface
UON	Urgent operational need
UK	United Kingdom
USB	Universal serial bus
WTMD	Walk-through metal detector
XBS	X-ray back scatter
XRD	X-ray diffraction
Zeff	Effect atomic number

15. Appendix: Minutes

The ADSA16 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: May 2, 2017

I. INTRODUCTION

Presentation: Welcoming Remarks (Part I)

Speakers: Carey Rappaport (ALERT, Northeastern University) and Laura Parker (DHS)

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

S: We really do need the community to attend and make comments and discuss. As the program manager for ALERT, I work with Michael Silevitch and the team to remain engaged with academia, industry, and the federal government. We really look forward to the discussions today.

Topic: Setting the Stage

Title: Workshop Objectives

Speaker: Carl Crawford (Csuptwo)

Discussion regarding the workshop format, the scope and challenges for aviation security and industry engagement, and of recent developments.

A: There are competing goals in aviation security. One stakeholder is the terrorist, who is still trying to disrupt aviation security, and that stakeholder is a smart and adaptive adversary. Vendors need to make money. Looking back to ADSA01, we were all looking for the next silver bullet. There is no magic part of the electromagnetic spectrum that we haven't explored.

A: The purpose of the ADSA format is to engage in conversation at all times. Expect to be interrupted.

ALERT: Carl's estimate is an understatement of the changes happening all around us. Yes, they are happening in our sphere, but they extend beyond.

C: An important point for me, and one that is disruptive to the airline business, is the laptop ban. If it grows, that's going to be a big problem. From my perspective, that's something that I'd like to discuss.

A: At the last ADSA, we had panel discussions. This time we have three panel discussions. You can ask the airlines directly.

ALERT: The problem that I see with the laptop issue is that there is a level of sophistication necessary to see that laptops are a problem. We need to understand the sophistication of the adversaries. That's what we should be thinking about. It has taken a long time for them to understand what confusers are.

C: Some of the problems are going to disappear when we move to materials characterization – i.e. figuring out what is in the bag.

C: There are not silver bullets, I think we can all agree. We are constraining innovation if we say incremental improvement only. We need to keep thinking outside of the box. We need to move to materials characterization.

TSA: I want to bring up the topic of cargo – displacement and no silver bullet.

C: This is shifting back and forth in reaction to processes and policies. We don't have a set long-term goal we can plan to. Take the shoe bomber, for example. Our response to the threat was expensive and reactive – developing and testing shoe scanners and requiring passengers to take their shoes off – mainly because that sort of thinking was not incorporated into the original plan. In Israel, the risk of this threat was calculated upfront. So how does Israel think about risk, the processes, and the technologies? That modus operandi was thought about and incorporated into the execution and security plans years before. We here in the US have the ability to do the same.

Q: Does Israel incorporate this or accept the risk?

C: Are we safer today than we were 20 years ago? Airlines have a difficult time telling us how things are working. I'd like to see a better connection between what intel is telling us and how we are performing.

C: I have a problem with the silver bullet line. The pipeline of emerging technologies is rich: CT is going to checkpoints, and additional sensors can be added. We are seeing smaller sizes, reduced cost of operation, and reduced divestiture needs. What hasn't moved yet is how effective these emerging technologies are against these points. In checked baggage, we haven't had any threats slip through. It's doing a good job. In checkpoint, it's a very weak system. We have to get past that. It's easy to spot the threat using CT, but you can't find that at checkpoints today.

A: These are some of my opinions, the speaker's prerogative. The reason for ADSA is to create these discussions. My job is to create a provocative forum to have these discussions.

C: We have been talking about checkpoint and checked baggage. We haven't been talking about the crowds before you get to the airport door – the so-called "soft targets." As we've seen in Europe, there is a threat there.

A: Agreed. Look at an NFL football stadium. You must screen 20,000 – 30,000 people. Look to the parking lot, where people have been partying and drinking. There is no perimeter control. All that someone needs to do is blow themselves up, and you disrupt this whole stadium. Displacement is happening.

C: At some point, we will have to start flying naked.

Presentation: Welcoming Remarks (Part II)

Speaker: Nadine Aubrey (College of Engineering, Northeastern University)

A: I'd like to welcome you on behalf of the School of Engineering and Northeastern. Welcome to TSA, vendors, airlines, academia, and all attendees. We all come to workshops such as this one where all stakeholders discuss technologies that we can come up with for the future.

Thanks to DHS for your support to the ALERT Center of Excellence and for encouraging the ALERT workshops. We wish Michael Silevitch a speedy recovery.

I will shorten my remarks as I see that the discussion has already started. I love the idea of breakthrough technologies, thinking outside the box. I can't encourage you enough to do so to make progress in this area, a crucial area for many stakeholders. This is extremely important, and I want to reiterate my support, the President's support, and the Provost's support for this workshop. Have a productive workshop.

II. TSA/DHS PERSPECTIVES

Panel Discussion: Perspectives, Advanced Topics, Cybersecurity

Speakers: Keith Goll, Mara Winn, Jeffrey Quinones, and Dominic Bianchini (Transportation Security Administration); John Fortune (DHS S&T)

Panel discussion of program pipelines that TSA is using to access innovation and move enabling solutions to the field. Topics addressed include:

- *Innovation Task Force (ITF)*
- *Transportation Security Capability Analysis Process (TSCAP) – A TSA-wide capability gap process.*
- *TSA international collaborations*
- *Office of Requirements and Capability Analysis (ORCA) requirements and system engineering technology development process and technology portfolio impact*

Panel Themes

A: Together, we've been doing aviation security for a long time. ADSA has morphed into one of the premier tech conferences that we have. It is good to get together and talk about emerging technology, but it seems that back in the FAA days, we had a tighter technical group. This conference gives us the opportunity to come together with airlines and stakeholders. It seems to keep getting better. A lot of TSA folks wanting to come is a testament to how important this conference has become.

We could go in any order. The Innovation Task Force (ITF) will go first. All four of us work very close together. I don't think these are silos. Anyone who likes to watch congressional testimony will have noticed that ITF had a front seat at the table. It's not about ITF, it's the mindset. We know we have a gap, and see that the threats keep changing. It is unsustainable with the growth in passengers. A lot of airports don't have a sustainable footprint or are just moving those passengers through. We work with all of our stakeholders to find solutions, be they processes or technology. Our focus is not just the TSA silo but what the solutions might be. What things will be assessed, and what can we bring to an operational environment with a focus on collecting data? We are tracing a path to understanding and making it better. We need to take that knowledge and take it back to TSA requirements, to help the vendors understand what works and what doesn't.

ITF

Summary of the ITF roots, current initiatives, and future outlook.

We are pulling solution concepts from internal initiatives in S&T and in the TSA ORCA's (Office of Requirements and Capability Analysis) Mission Analysis Division (MAD) that would work in an operational environment. We did a solicitation in the form of a Broad Agency Announcement (BAA). Unlike the others, we were not paying for developers. We asked them to bring their stuff to the field.

We have two types of demonstrations:

- ITF-led demonstrations: these are solutions specifically for the passenger checkpoint or checked baggage.
- ITF-enabled demonstrations: how do you replicate that demo mentality in other environments (e.g. Biometric bag drop)? We work with the TSA Office of Security Policy and Industry Engagement (OSPIE) to come up with a method to demonstrate and gain the knowledge. We get to see better security and tech come to the field and we all learn together.

C: What is the relationship of these efforts to the Advanced Screening Lane (ASL)? The ASL has moved through ITF.

A: The first demonstration was in Atlanta roughly one year ago. We now have three different baggage handling vendors approved for demonstration. This means that they have gone through functional test at TSIF, and that we believe that they are capable of being deployed to the field without causing issues.

Following a demonstration, the vendor takes that knowledge gained and makes updates, we take that knowledge back and review operational impacts.

The ASL implementation was approved by DHS for deployment under an Urgent Operational Need (UON). They can be deployed permanently at up to 21 airports.

Once the others are approved we will proceed with them as well.

We have a lot of studies around staffing models (e.g. FTE per mod set). You can't think about staffing per mod set. You need to think about it in terms of passengers per FTE. It's not enough to move the choke point, our goal is always to improve security. We look at different risk models and configurations. The checkpoint is a system, not just a bunch of technologies, and it has an overarching security profile.

Q: Is it applicable or is it simply constrained by space?

A: There are 440 federalized airports. If you look at a Category 4 airport, you don't need it, as you don't have so much throughput that presses demands on the operator.

We are in the first phase. The ASL is a program of record. Later this summer, there may be multiple approved configurations, perhaps there is an alternate. We think about access control events and different component that have different costs. The program office will help determine which make sense, in a matrix style. Some have large, 20-lane deployments, others 4-5, and others just 2. What works for one may not work for others.

Q: Can you talk about computed tomography (CT), passenger communications, and pre-check.

A: There was work on this previously but, in this earlier work, there were challenges with respect to size, weight, and throughput pertaining to attempts to deploy CT equipment to the checkpoint. There has been a lot of maturity since. There is a demo of checkpoint CT planned for two airports. This is truly an ITF demo. The system is not in a state that we would deploy at many airports. We don't want to wait.

What do officers really need? – prohibited item detection in a 3D environment. We are looking at the CONOPS, the flow, and the standard operating procedures (SOPs) in both the primary and secondary screening workflows, and how CT impacts secondary search rates. Vendors will continue to refine their solutions. When it is ready, it will be optimized and optimal. By late May/early June, we will have them in airports.

Regarding passenger communications, if you have a knowledgeable mature passenger, they sail through the checkpoint. They know what they need to divest and they are calm. On the other hand, my mother gets very nervous and doesn't remember all the rules. We want her to have the same comfort level. The person at the front is not focused on educating the passenger; they are just doing flow control. A better process is needed so that the passenger will divest properly, including items that they need to discard. We will try avatars in June. We are looking at flat screen and interactive displays. We just don't have the data of what works best for airport environments. We will customize what that language says based on what works for the passenger.

Regarding pre-check, the more people in it, the more we know more about the passenger, and it's better for TSA. Pre-check is enabled by the intelligence and legislation on how to do background checks. If a passenger doesn't travel enough, it's not worth the cost to them. We are still working through the legal factors.

We have a new BAA that we plan to release in the next two weeks.

TSCAP

Summary of the TSCAP approach, current initiatives, and future outlook.

A: Regarding TSCAP, when TSA budgets were starting to shrink, we needed to come up with a repeatable process to determine how TSA should spend its limited funding. We engaged E3 federal systems to support this endeavor. Initially, the focus was on the world of security technology at the passenger checkpoint and in checked baggage screening. TSA does not have a way to prioritize investments across the enterprise. We are expanding it to look at TSA enterprise challenges.

A quick overview of some of the thinking processes:

- What is TSA's mission by law or department mandate that we are required to do? There are some projects that someone thought was a good idea.
- What is TSA's true mission? What should TSA be doing? How is TSA executing against that mission? Will we be faced with or contribute to shutting down the checkpoint?
- What are our capability gaps and do we prioritize those gaps? Which are the most important to close? TSA will come up a list of prioritized capability gaps.

We socialized this five years ago in the Capability Investment Plan. There are SSI and Classified elements. We provided this list to DHS S&T Explosives Division (EXD) to prioritize their investments. It continues to mature. CFO is interested in using this as part of the PPBE as we develop future Resource Allocation Planning (RAP) sessions. We are getting legs with this process.

What needs to be done to close the gaps? What is the course of action? For example: do we conduct case studies? Demonstrate through ITF and collect data on CT at checkpoint? For something that needs more development, we turn to S&T.

A lot of times we focus on security effectiveness and efficiency. TSCAP looks at other factors too, such as industry vitality and passenger experience. We are also looking to exchange data with CBP. They have a lot of biometrics engagements. TSA is right in the middle of the passenger journey. CBP has different authorities than TSA. For legal authority, policies are in place. If we want biometrics, what are the courses of actions we need to take? TSCAP allows us to study that.

Q: Are you looking a different risk levels per threat vector? If you have high operational efficiency, you may not have good detection.

A: Yes. To determine the course, we do need to do an analysis of the tradeoffs. We might only be able to deploy at some sites, or incremental improvements might be sufficient.

Q: Does that include human performance?

A: Yes.

C: I see a tie-in in TSCAP and ITF. You identify capability gaps and the solutions to close, both material and non-material. The focus has been on material solutions, but ITF does both. A lot has to do with transferring information freely with industry, which is typically SSI. I wonder if you have been thinking about how to convey information more freely with industry.

The full value of creating a prioritized list is not achieved if you can't share with industry. It's more important to share the capability gap list. We do it with the detection standards.

TSA: We are trying to be more intentional in how we connect and quantify capability gaps and risk against the Transportation Security Risk Assessment (TSRA).

TSA: Those capability gaps are a direct criterion to select ITF solutions.

International Collaboration

Summary of TSA's international collaboration efforts, current initiatives, standards harmonization, efforts towards testing harmonization, and future outlook.

A: In the last five or so years, TSA has been engaged strongly in international coordination and collaboration. It is not just a U.S. market, an EU market, or an Asian market. It is a global aviation security community. It is the same type of threats, the same manufacturers, the same sorts of problems. We are all looking for throughput, effectiveness, and staying ahead of the terrorists.

First and foremost, the goal is increasing security effectiveness. The U.S. and the EU are in the process of updating their detection standards. We were highly dependent on single view in 2008. Now, it's 2017 and we are looking to what's next. We are looking at intel about where the adversaries are going next. We are working to mitigate throughput challenges, and how to allow the passenger to divest less. This is an international focus.

To the manufacturers: We know you are dealing with trying to address everyone's challenges. Where can we align and focus on common goals? We understand that on some elements, we will have to agree to disagree.

Innovation is key. Working with EXD and ITF, we want out-of-the-box ideas, new concepts, new ways to solve this problem. Advanced Imaging Technology (AIT) has been around since 2008/2009. We have 7-8 years of experience, and there are problems that still need to be addressed. We understand that it is a market and it has to be profitable. We will provide early awareness on recapitalization plans, with the caveat that this is highly dependent on budget.

We are working with our partners on test methodologies. The cost is high. We will work with you to reduce those costs and, amongst regulators, find ways to rely and leverage each other's test results. We are working to find agreement in how they test and how we test.

The following is a list of upcoming initiatives:

- Electronic Trace Detection (ETD) standards within the U.S., EU and Australia.
- Enhanced Metal Detector (EMD) standards are being updated this summer with significant changes.
- AIT: 850 systems in the fleet implement ATR. We are looking towards next gen systems.
- For Accessible Property Screening System (APSS) standards and next generation checkpoint X-ray requirements, the EU is pushing forward with EDS checkpoint with C-1 and C-2 standards.
- Checked Baggage standards 7.1 and 7.2 will be updated to 8.0.
- The Bottle Liquid Scanner (BLS) standard will be revised by this summer.

We want industry to move in the direction of smaller threats, expanded threat lists, and lower false alarm rates. Through the ECAC working groups, the EU is looking at explosives vapor detection and shoe detection. Draft standards are available.

Q: Are we looking to integrate technologies?

A: We want to look at different models to close our capability gaps. We might turn to industry and provide the operational requirements. If you want to integrate so be it, as long as it meets the desired performance. We need to try out different operating models at airports.

A: The last ITF BAA talked about open architecture. We need to have a discussion of a recasting the Checkpoint Design Guide (CDG) to be more like the Planning Guidelines and Design Standards (PGDS) and the Interface Requirements Document (IRD) for checked baggage inspection systems.

Q: Do you think we will see convergence of testing acceptance, so that vendors can submit results as evidence to in Qualified Data Packages (QDPs).

A: The threat lists are not drastically different, but how the test is designed and administered is different. We are attending study groups and walking through our standards. The UK implements outcome-based requirements.

Q: What does commensurate technologies mean?

ORCA requirements and system engineering technology development process and technology portfolio impact

Summary of how TSA requirements development process, stakeholder elicitation, and partnerships.

A: ORCA taps a diverse community of stakeholders to support requirements development. These include physicists, technical program managers, engineers, end-users and operators, and other specialists. We apply a systems engineering discipline. We work in ORCA, and work together and collaborate. Contributing inputs also include mission intelligence, risk, human factors, and initiatives that identify and close the gaps.

Our trade space is always growing, in both technical and operational requirements. We are constantly evaluating emerging technologies. We organize ourselves into different groups and work with a number of stakeholders.

When you look at the chart of "Technology Readiness Level" for rating solutions, systems, and subsystems, it appears to be sequential and linear. In reality it's not sequential, it's iterative. It's a dynamic and high-dimension problem. There is extensive planning and tech development with lots of research and development (R&D) coordination and transition.

Once the system or device is ready to be transitioned by the Office of Acquisition and Program Management (OAPM) for volume purchase, it is driven by the process directed by DHS, regulators, and various authorities within DHS.

As an example of the emerging threat trade space, look at Paris and Belgium. What can our equipment do, and what should we be doing?

The following elements are key parts of our process:

- We use intel to inform on what that threat is.
- We initiate the data collection process. What can the systems do and what should they be doing?
- We work with various manufactures.
- What could we tradeoff on probability of detection and probability of false alarm, e.g.:
  - o An approach yields an increase in detection, but may not be operationally feasible if it also double false alarm rates.
  - o If the approach yields the right set of classifiers, the probability of detection could be phenomenal without giving up too much probability of false alarm.
- We are applying a systems engineering approach, which will set the tone for how we develop the next set of detection standards.

We are investing in third party ATR, normalizing the data coming off the sensors, and challenging the community. We are seeing a lot of promise in this emerging space, but it is not an easy problem; some are just struggling to meet the current standards.

Q: Have you installed third party algorithms on any TSA equipment yet?

A: We are in the prototyping phase and have expanded to cargo. What can we do at 450kV, versus what we have traditionally seen at 180kV? We are seeing a broadening of the field of options, including using cases such as specialized ATRs stacked on top of existing ATRs.

Some algorithms deliver high PD but struggle to operationalize it, because of a couple points of PFA Those points break us. These airports work in peaks and valleys. Those are the types of challenges in getting to TRL 9, and moving the threshold up the ladder.

I’m here to give our perspective, and to challenge and inspire the community.

Q: It’s good to hear that you are working with the EU. How far do you take this? When you get to the operational environment, it takes forever. If I were to test something at TSA, can I deploy to an EU airport or vice versa?

A: Yes, if we get to the point of accepting EU results as entry criteria into the operational testing. As we've continued to work with the EU, we've made changes and they've made changes. They have multiple test centers while we have one. It's all about what we test, how we test, and where we test. We need to loop in DHS test directors with TSA/TSL test directors and EU test centers.

A: We might have equivalent standards, but we have another set of requirements, such as those pertaining to efficiency, suitability, and reliability. We see differences in X-ray tubes, etc.…

Q: There is a lot of innovation at the airports, so you can get into one airport. But there is no uniform standardization across all airports, which can limit growth.

C: It is not a linear process. This is an iterative process, not just within ORCA or OAPM or S&T, but across the enterprise. One of the things that can help is the business processes that support engagement across all stakeholders.

Topic: Cybersecurity

Title: Security Technology Integrated Program (STIP) Cybersecurity

Speaker: Tim Smith (Transportation Security Administration)

Discussion of the evolving cybersecurity environment. Topics addressed include:

- *Nine cybersecurity pillars*
- *Cyber threats and potential impact on transportation security screening systems*
- *Cybersecurity for standalone systems*
- *Networked TSE*
- *Red-teaming*

Q: Are you requiring PIV card log-ins on all deployed equipment? Are you offering waivers?

A: It will be on a case-by-case basis. There will be no PIV requirement for EMD, but we do want it for AT, etc.…

C: That's going to be a lot of equipment.

Q: If you upgrade the operating system (OS), do you have to go back and recertify?

A: If you upgrade, no; if you replace, yes. Even standalone equipment has cyber security needs. For example, if bad tech with a thumb drive upgrades a standalone scanner at JFK.

C: Do you have plans to stand-up a permanent red-team? The types of cyber-attacks will be very broad. The nine cybersecurity pillars are a good base, but they will not be sufficient over the long-term. What are the plans to stand up evolution?

A: There is a division responsible for penetration testing and red-teaming.

Q: Do they do it now?

A: They don't do it now for TSE, but will start in a few months. We view TSE as the "internet of things," whether or not they are networked. And denial of service is a concern. I discussed the USB port as being a vulnerability. It only takes one individual (unwittingly or intentionally) with a thumb drive to bring down TSE.

Q: What is the connection between S&T Cyber and TSA Cyber?

A: TSA gets its direction from DHS. It is translated into the policies and procedures of cyber security.

Q: There is no such thing as "bug free software." You might be able to protect against the vulnerabilities of today. Networking is sexy, but why would you want to expose your tech to the vulnerabilities of tomorrow?

A: Networking TSE brings efficiency of maintenance.

C: It's also a vector for spreading malware.

A: We live with that risk every day. There is a cost benefit.

C: I'm astonished that you can bring airports down.

A: There are policies and procedures for reporting non-compliance.

C: It's not just about push updates. The system adjusts to high-risk passengers, or prohibited item detection in the cloud, or five people are coming through with separate components. There are tons of security benefits. It's not completely baffling.

C: That's a vision of a distant future.

C: But you have to get started now.

C: We want to have situational awareness at an airport, including video and equipment feeds, when something is happening.

C: There have been studies that have shown that when TSE can communicate, you can support a 10x increase in throughput.

III. TERRORIST PERSPECTIVES

Topic/Title: Yes, We Can Now Predict Terrorist Targets

Speaker: Max Abrams (Northeastern University)

Discussion of how terrorist events are predictable to some extent. Topics addressed include:

- *Terrorist targeting choices (e.g. civilian, military, government)*
- *Types of terrorists and terrorist organizations*
- *Communication challenges or power vacuum results in increased civilian attacks*
- *Different motivations, religious and secularist*
- *Counter terrorism constraints.*
- *Western fear of lone wolves, not groups.*
- *Open-door policy reduces quality of fighters as there is limited vetting and, disproportionally, they suffer from mental illness.*

Q: If you hold everything equal, can you correlate between population density and attacks?

A: Yes. Look at how much territory is being targeted. They tend to be a particular kind. Liberal democracies are less likely to suffer terrorist attacks.

Q: A failure can lead to the next success of a similar type.

A: Almost no matter what the outcome, they will declare victory. We occupied after 9/11, and that's what the terrorists wanted. Spain withdrew, that's what the terrorists wanted. If you succeed, then they state that that's what they want, because you continue to be in fear of another attack. They celebrate as a recruitment tool.

Q: Regarding suicide bombers, we haven't seen that in the U.S.

A: There simply aren't that many terrorists in the U.S. Occupying events tend to result in suicide attacks.

Q: How do you deter terrorism?

A: Terrorists are strategic actors. That makes it hard to totally stop. In 1970, more X-ray machines were put into airports. Attacks went down at airports and up elsewhere, such as at embassies. They don't know how their violence will translate into their stated agenda, but they are procedurally driven. Certain targets are deferrable. If you harden targets, you reduce the likelihood of a successful direct attack on that target, but you end up with displacement. Terrorists pick targets for the symbolism. They are not grievance motivated. They are opportunity motivated. It's not in a place where they are being oppressed/have grievances. It's a power vacuum.

C: Is there any evidence that if you throw assets and resources at the problem, you end up with less attacks?

A: John Muller stated that you don't get a good rate of return when you spend. It's not how much you spend, but where you spend and how you spend. Counter terrorism has to be focused. Indiscriminant countermeasures target folks who were not previously terrorists, and is counterproductive. Terrorism is easy to perpetrate. There are countless soft targets. The goal is to not expand our enemies.

Once you reach a critical mass of terrorists, you are screwed. We need to appreciate how few terrorists we have in this country. We need to spend our resources in a way that is unlikely to exacerbate the Muslim-American population, and not do stupid things, that would turn a tolerable situation completely out of control.

C: Nationally, we have very few terrorists. This is measureable.

A: It's often said that insurgency and terrorism is a political problem. Accordingly, we need to deal with the political unrest. I believe, instead, in a smaller U.S. footprint. I am not a proponent of nation-building to overhaul the entire political system.

IV. THOMAS KUHN'S PARADIGM SHIFT PERSPECTIVES

Topic/Title: Macro Security

Speaker: Matthew Merzbacher (Smiths Detection)

Discussion of end-to-end architecture to capture the security process. Topics addressed include:

- *Browser-to-gate and beyond*

- *Limits of individual technology elements*
- *Segregating and classifying people based on capabilities*
- *Testing and validation, including the meta-data*
- *Proper meta-data that supports general and specific cases*
- *Flexible CONOPS*
- *Applying algorithms appropriately*
- *Appropriate cost per passenger at a Category 4 airport vs. at a Category X airport*
- *Preparing for a disruptive solution: Auto-industry comparison – trapped in an incrementally improvement world; it is now experiencing transformational change that was not predicted (self-driving vehicles)*
- *Hippocratic oath for security*

C: It's not the incumbent manufacturers that have pushed self-driving cars. It is not the old guys doing it. We are the old guys.

A: The current manufactures, including GM, are embracing self-driving technologies; maybe they are seeing the train leaving the station.

C: You skipped over the whole political issue without indicating how difficult it is. At the end of the day, we end up with the same difficult process. Put in a "clear all" button because there are too many alarms. It has to happen operationally because people have to get on a plane.

A; There are number of politicians who follow the public rather than lead the public. Technologists are single minded.

C: TSA has an asset that looks at the whole checkpoint, i.e. tradeoffs at the machine level, the macro level, the operation efficiency, the touch rate, and number of divested items. TSA should release the MOD SIM set to cleared vendors so they can experiment with different arrangements.

In 2011, when TSA was designing the pre-check process, they came up with a completely different process using trace, rather than lanes. It would have been as efficient on paper and possibly better detection. You can scale it up and down on a 1-for-1 basis, making it more efficient for TSA. The senior decision makers said it was interesting but too challenging for the public to accept, so they killed it. The ITF can offer the opportunity to explore these things.

C: The problem is choice, in the immortal words of Neo – choice in the checkpoint for passengers. We need to embed that risk into our thinking.

Additionally:

- Are ATRs better than screeners?
- Best screener on best day?
- Worst screener on worst day?
- It's a risk we have to accept.

A: I would not advocate "one size fits all." One size fits some.

V. VENDOR PERSPECTIVES (PART I)

Topic/Title: Requirement-Based Design

Speaker: Bernard M. Gordon (Photo Diagnostic Systems, Inc.)

Discussion of requirement-based design. Topics addressed include:

- *In 1898, they thought that everything that could be invented has been invented.*
- *Market requirements vs. specifications*
- *Solutions development is a complicated and iterative process of getting it into a product and to market it.*
- *Only 1 in 100 inventors are able to get their arms around the whole product.*
- *TSA may lack the sufficient technical breadth found in industry that is needed to prepare a suitable specification.*
- *Placing engineers at the helm*
- *Broken processes can defeat the incentives that would bring about new solutions.*

Q: You are talking about a leadership gap. What can be done? TSA has political-based turnover. How do you fix that gap?

A: This is a very big problem. There is a leadership development program for engineers. The technical people, in general, don't love to be leaders. It's too much trouble.

At the age of 18, I was a naval officer, and I have a different view of what engineers should be doing. The Harvard Business School types have taken over and believe that it's a substitute for the engineers being leaders in their companies. The engineers have to be at the helm. Many organizations have moved in the opposite direction. If the engineers aren't the leaders, I don't know who is going to be.

Topic: Former Insider Looking Back from the Outside

Title: A Look from the Outside

Speaker: Pierfrancesco Landolfi (Tesla)

Discussion of the pace of innovation at TSA. Topics addressed include:

- *New equipment is incrementally better, but is it 2-3 years better? Right now, OEMs can stick with the same product for several years because they know nothing else is coming out.*
- *Test everywhere and streamline testing. Run beta in parallel to main work-flow to gather data and evaluate what-ifs. Some equipment has been trapped in qualification for years.*
- *Massive investments in automation do pay off. Being able to connect to the system is a huge advantage. You can get access to information and remote diagnostics; you know what has happened. You can develop prognostics and intervene earlier.*
- *Innovation needs to be a higher priority because:*
  - o *There is limited collaboration and everything is very segmented.*
  - o *If faster deployment can be managed, vendors would be incentivized to spend more on R&D. This would have rollover effects with universities and others; to stay competitive requires partnerships.*
  - o *It would lower the barrier of entry for other companies. As it becomes too difficult to qualify, fewer companies participate. With more competition and the right incentives, you get more innovation, and can focus resources on what really pays dividends.*

C: I agree that until you get to an airport, you don't really understand what needs to be fixed. We had to make a deal with American Airlines to put EDS into an airport, and then we found out what we needed to fix. We were able to learn from the deployment, not from the lab tests. We are spending a lot of time in the labs and not enough time in the field.

A: After September 11, we had to deploy, and we learned in the field. You have an incentive to take a little bit of risk. I need to know how to fix it very quickly. People love that. They are happy that they can experience something new quickly.

Q: How do you deal with the fact that there is only one customer?

A: There is not one customer. TSA is the largest one, but not the only one. The problem is in the tradeoff between risk and benefit. The balance is very much on one side. We are not in favor of taking risk. Innovation comes with failures. It is seen as a black spot on one's record.

C: We used to get a lot of things done much faster when there were only 50 people in TSA. Now that there are 500 people, it isn't just one TSA.

A: We need to get back into startup mode.

VI. VENDOR PERSPECTIVES (PART II)

Panel Discussion: Vendor Perspectives and Challenges in Deploying Security Technologies

Speakers: Matthew Merzbacher (Smiths Detection), Shiva Kumar (Rapiscan), Steve Urchuk (Analogic), Kristofer Roe (Smiths Detection Americas), Andrew Fullen (L-3 Communications), and Joseph Paresi (Integrated Defense and Security Solutions)

Discussion of how industry can work with TSA to deliver solutions. Topics addressed include:

- *What can be done to decrease the time to deploy new technologies.*
- *What barriers have to be reduced for vendors to increase their own investment in new technologies*
- *What can be done to cause vendors to work on long-term, high-risk detection systems?*
- *How should third parties (e.g. academia, national labs, and industry other than the extant security vendors) be involved in the development of new technologies?*

Decrease the Time to Deploy New Technologies

Summary of how TSA proceeds with technology development oversight and acquisitions.

A: The ITF is a great start with the ASL, integration, AT, and CT. Biometrics and other passive ID systems are headed in the right direction. If you look at what is happening in the EU and other places, there is more innovation at the airports since the airports are responsible for purchasing these systems. But where is the balance between the two? We need to get systems deployed faster. That is a model to look at – the time it takes to get through the OT&E phase. You can then run into the false alarm issues that make it unfeasible and undeployable. Harmonization between the U.S. and EU is needed, i.e. “certification” across the pond. We need to see how we can get through faster. It is time for TSA to leverage best practices and bring it into our world here.

A: ITF is a step in that direction, but there's much more to go. Europe allows a replay test, that is when they have a new algorithm they replay on that same data and see if you detect or not.

A: Perfection is the enemy of good, i.e. all or nothing. TSA needs to focus on the core mission for that first generation to go out, perhaps apply a weighting system. Is the color of the font as important as another feature with respect to detection? Go back later or in a second generation to fill in the lower impact gaps.

A: The checkpoint problem is getting worse and worse, and unless we do something quickly, we will be limited on what can be done. We need to fail fast. Don't be worried about a little bit of chaos if it improves. There are 5% more passengers every year. It is hard to introduce an innovation for fear of impacting and already impacted process.

A: Focusing on consensus standards rather than arbitrary requirements would allow for third party participation, which would expedite delivery of enhanced capabilities. Timelines are measured in years, which is too slow for innovation. TSA needs to adopt agile methods. The ITF is a great step, but doesn't measure up to what we see in European airports or in Canada; their abilities are much more agile.

A: It takes 36 months for a new device, half of which is taken up by testing at TSA. How do we solve that? New technology requires capital investment, and time is part of the return on investment calculus. Investment will flow only if it's going to take 2 years to get sales. The QPL should be under 100 requirements. Safety has to be in place, but after that, get the device into the field and start gathering real-world data. The longer it takes, the longer it takes to achieve improved security. Let's go and do operational evaluation while we go through the qualification process.

Barriers to Vendor Investments

Summary of funding and planning roadmaps, IP licensing, resourcing challenges, and testing approaches.

A: DoD spells out money for each phase of their program, so their vendors are fine with R&D cost share. On the other hand, TSA's approach is "if we like it, we'll buy it." It's hard to plan. We only had tier 2 requirements rather than what we would need in the future. That's not a well-defined goal. Another example is that 400 bags per hour (bph) is the target now, but what will it be next?

A: The service business is small compared to the cost of developing products. We need to add value to the equipment and reduce the overall cost of delivering security.

A: Every university has a different IP license. Lawyers have to work through it every single time. If the government could lead and create templates for the different sorts of rights, such as general purpose, explicit licensing, etc., and encourage partners to choose one of these off the shelf, it would help engagement with academia. When we are doing academic partnerships, we spend 6 months to a year just negotiating terms. If the barrier is technical, there is an approach that has yielded dividends; the grand challenge. If it's straight money, then provide funding.

There is a resourcing risk, We try to hire a pipeline of people. How to then choose the appropriate approach? Do you use push for next generation platforms or sustain existing platforms? Bringing in more talent is a good way to go about it. The strategic discussion of long term goals is important. When you start off, you have to make very gross assumptions. Please do continue to share with us your long-term goals. They help inform.

Q: You've asked to shorten the certification process. What can be shortened?

A: There are three steps to become the system of record:

1. Pass the certification test, which is just PD and PFA. This is the easiest step. If your CT can't pass that, it doesn't belong there.
2. Then there are hosts of suitability requirements to achieve, for example safety, TIP, controls, etc. There are 500+ requirements that also have to be met. The way this goes is that TSA says it takes 8 weeks for this testing, but it's now in the 10th week and it's going to be another 8 weeks. Some people at TSA agree that this process is broken.
3. Make it work in an airport. This could take a year. Then you are in a position that you can sell something. Qualification on a non-priority system can take years. That's non-viable, and you end up abandoning it.

A: The cost of the long certification process is not just long calendar time. You have to hold a team together for a long period of time, and it take a lot of people to push through this certification. I want to comment on the DoD roadmaps. There is a lot of skepticism about how realistic the roadmap is.

A: If you look at alignment of roadmaps, that's indicative. Government invests in high-risk initiatives. Industry wants to get a return on investment. A better dialog is warranted.

TSA: There are a lot of complaints about TSA. We see a lot of the issues on your side too, such as a lot of cycle times, the same failures, different failures. I want to know what you are doing on your side to address the issues on your side.

A: We are doing a better job of presenting our test plans and what we were doing for integrated testing that is harder to do in the laboratory.

A: What about tapping into third-party testing? Another is to make people pay for the service which will sharpen their focus. We build platforms which are more stable.

A: We are being more reactive. TSA is asking for more detail, for some feature as an example. Make sure you are ready before you go forward.

A: Alignment of detection standards becomes much more important. Look at differences in stream of commerce.

A: There is a lot of use, and we trying to do the best we can. We try to meet all requirements. Budgets are stable at best and declining. Keeping the team together is hard to maintain.

A: We are trying to set up mirror testing environments and test loops to be as close to what we know we are going to face from the different entities. Requirements can be up to interpretation. We are asking a lot of questions up front, such as:

- I think this requirement meets this, you think it means that, I think I passed, you think I failed, etc.…
- It means this in 2012, it means that in 2015, etc.

We are getting third parties involved. They are expensive. If we can get a reasonable test plan, so that we can agree that when we are done we can deploy, that would help.

Long-Term, High-Risk Development

Summary of the development roadmap strategy.

C: The government was going to be shut down last year. Vendors ask for 5 year plans. TSA cannot really promise you that. Every few years, it's a new congress. There is nothing you can do about it. We need to learn to live with it.

A: That has been true for a long time, but military does not have those same problems.

TSA: You are in business and want to survive. It is not our responsibility to prop you up. This is part of you being in business. We are looking for new innovation, new improvement. You are in business to take risk. Don't expect the government to be your sugar daddy. You are selling to Europe and to the rest of the world. You are shooting yourself in the foot if you won't innovate unless you are paid for it. This is a new reality. This is not your fault and not our fault. This is the new reality.

Q: How do you make it a business that people want to be in? Nobody asked the government to pay them to have an idea. I don't know how much money the government spent in academia. The government has to make it possible for the people to want to have the ideas, for the 1 in 100 to have the ideas. No one is saying we guarantee your business, but if society needs the inventions, society needs to make it possible for people to want to create the investments.

C: Millimeter wave (MMW) technology did not come from industry. MMW is licensed to L-3 and used in their AIT scanners. Licensing technology is a very painful process. Industry wants them extremely mature. Licensing fees are not horribly large, but vendors still struggle to pay. It is unclear why $10-20K is a barrier when they will pay that much to send one person to a conference.

S: Do you feel that there is a need for government sponsored R&D?

A: Yes. I went to graduate school on government R&D, it was an apprenticeship if you view it that way. I'd like to see industry involved in the assessment of that R&D. The national labs and academia do a lot of the early work and industry takes it to product. It would be better if industry could get on early and invested in the intellectual part of the R&D to progress it further. I think it would work better than the current model. I don't know how to make it happen through.

Q: How does the DHS S&T industry relationship work and how could it improve?

A: It can improve. What S&T is funding is what TSA wants to get out there. Get industry involved in that discussion. S&T wants to fund high-risk instead of applied R&D. TSA wants to get something out pronto.

A: If we knew we had to make some milestones, and knew we would get orders, we would be willing to make the investment. That structure does not exist. It is very much go on your own risk. I spent a lot of money developing a

CT scanner for the checkpoint, but I haven't sold any yet. I can make a version of that for checked baggage. We get asked "when are you going to add this feature?" We understand we are taking the risk and that there are no guarantees.

S: Having worked in DoD, I can attest that there is a significant difference between DoD acquisition and TSA acquisition. Are we developing the right things?

Third Party Involvement

Summary of how to engage third parties.

A: We may be smart but we are glad that S&T came out with a BAA to ask that third parties be integrated in with the suppliers at the end of the day, so that the solutions work in an integrated environment.

A: In the medical field, there is lots of growth in MRI and CT. The community was much larger. There are 1500 MRI physicists. All had laboratories, delivering substantial contributions used today. The work was funded by NIH. It's a larger market, and the same can be said for DoD. Working in an FDA market does have some advantages, such as:

- Yes, to science;
- Yes, to applied science; and
- Links to industry.

We should not accept a compromise or limitation that we can't afford it. We have to be creating.

A: If you gave every one of these companies $25M, you would have good stuff.

A: This industry is unique. We are symbiotic, in that we need TSA, we need DHS, and we need information. You need stuff that works. There's good research done. The sooner we get together the better. The challenge in partnerships is that a partner discovers one of your trade secrets.

A: Let's look at what S&T is putting money behind. There is money going into deep learning. It is a joint effort between TSA and S&T. It's not going to be easy. You look at X-ray diffraction, OTAP, and other initiatives; we have also invested in some of these efforts. Ultimately, it's about industry, TSA, and others, including labs, and how to take these technologies. We need to align the roadmaps.

A: NIH funded $23B in research last year. DoD funded $500B in research. TSA has $44.1M in discretionary funding. At that level, a comparison to the National Endowment for Humanities is more realistic.

C: Even those of us working in the state of the art don't know what can really be detected in current machines. And we don't know it for legitimate reasons, because TSA won't share that information. We don't know where to push the algorithms. That's why some of those other examples don't apply to this domain. There is a lot of critical information that is missing.

A: There is a lot of other items that are out there that you can bring into this space to leverage a lot of other capabilities. We just have to figure out how to implement it.

A: For the record, I love TSA and DHS very much. They are my favorite customer.

A: If you solve your problems, our investments will pay off. That is the healthiest outcome. As long as everyone believe that those will pay off, people will continue to take risks.

A: You are struggling with rules that have been set by someone else. Instead of industry using this forum as an opportunity to vent, we need to work together.

Topic: Stratovan's Perspective as Being a Third-Party Vendor and Recent Stratovan Involvement

Title: Stratovan's Perspective and Recent Involvement as a 3rd Party

Speaker: David Wiley (Stratovan)

Discussion of a third party's experience of getting engaged in security screening solution development. Topics addressed include:

- *Third parties can be small and ambitious. Initial hires are critical for delivery and experience with delivering on government contracts is key (i.e. milestones, payments, etc.).*
- *TSA bent over backwards to help us succeed.*
- *The barriers to entry are challenges. We did not have a vertically integrated software and hardware stack. We wanted to get our software into airports.*
- *Getting involved through sponsors, including national laboratories and grant challenges through the Center of Excellence, which led to more interest and more opportunities. Funding for each was extremely critical, enough to keep us interested, and showed that there was a light at the end of the tunnel for this work.*

- *We were a guinea pig for TSA to work with a tiny company, which provided validation of this process.*
- *A lot of information is difficult to access. We got lucky making guesses about what the industry needs and wants.*
- *TSA wants to work with third parties. There is a lot of pressure from all sorts of directions. Industry is going through change. Interoperability, automation, and other capabilities are extremely painful. A flourishing industry with better products is better for vendors and customers alike.*
- *The need for an airport security Software Development Kit (SDK).*

Q: Why would TSA work with you directly and not through vendors?

A: We thought our pathway was through vendors. It turned out to be easier to work with the government than vendors at that time. The government was willing to take the risk.

One of our initial efforts was the DICOS SDK. DICOS had momentum but was just a paper format. To get adoption, you need to be able to go and download it and use it. Getting everyone to meet a paper standard is a nightmare. Let's relieve the pain to get people to standardize. That was the point of the SDK: to encourage adoption, provide it for free, and provide examples. That's really a way to get it in. Today, there are 89 current users from 44 different companies.

Q: How do you make money from the SDK?

A: We don't. If we can help change the environment, we can make money on other products.

For our work on the ATR project, the goal was to improve PD and PFA, and tackle other threats the terrorists are coming up with. We had an idea when we started. We ran into other challenges. It's a complex problem. We are meeting our goals and exceeding by an order of magnitude.

Q: Do you know what the performance was?

A: We didn't know how many threats there were. We took educated guesses, of which 85% right and 15% were way off. We were authorized access to Sensitive Security Information at the start of the project, but we didn't get our security clearance until 1.5 years into the project.

We didn't have knowledge of what that bar was until 1.5 years into the project. It took a long time to get sufficient training data for the system. We are very easily meeting the bar. Now we can start tweaking different parts of the process.

Q: What dataset are we getting?

A: Volumetric CT scans that were captured at TSL on a vendor EDS unit owned by TSA.

Q: What were your lessons learned from this experience?

A: I severely underestimated what it takes to work with the government. We are having daily phone calls. Before it was only every 6 months. I can't even begin to understand what the government has to deal with and I don't want to. They were really trying to help us. It was really confusing.

David Hinojosa left General Dynamics and took a chance to join our startup. These contracts end in a year. What are we going to do after that? How do we sell into the industry? How do we press on? There is no one you can talk to. We're in software. This industry should in investing in SDKs so that you can adopt new technology. Not everyone understands software.

A clear example of why this work is the iPhone SDK. That SDK handles credit card processing, integration into an Appstore, even marketing. We need the airport security software development kit. How do we get there? We are listening to everyone's perspectives and synthesizing it.

TSA's OTAP that Sandia is delivering includes a data collection project called the Passenger Baggage Object Database (PBOD). We are sharing experiences and how it should be done. We are exploring new hardware sensors and ATR algorithms, and how we combine all of those things together through the project's Open Platform Software Library (OPSL). That's what we are trying to turn into the airport SDK, if you want a heterogeneous environment at the checkpoint. The trace detector doesn't need to know about the walkthrough metal detectors. You can dynamically configure screening workflow based on risk. Can we change the devices at the airports?

Two examples from the computing and mobile industries:

- The PC revolutionized that entire industry.
- Apple can deliver the best of breed even with standards.

The OPSL strategy is to have well defined purposes and roles in the overall ecosystem, such as:

- OTAP provides a framework for certification.

- I can make assumptions about other devices in my ecosystems.
- I can deliver risk information to a particular device.

VII. AIRLINE AND AIRPORT PERSPECTIVES

Panel Discussion: Airline and Airport Perspectives

Speakers: Dan Weber (Alaska Airlines), Stephanie Vargas and John Niebling (JetBlue Airlines), Peter Boynton (Northeastern University, formerly FSD at Bradley International Airport)

Panel discussion of the airlines' perspectives. Topics addressed include:

- *Innovation*
- *Airline-run checkpoints*
- *Airport ecosystem*
- *International aspects*
- *Laptops*
- *Risk assessments and behavior*
- *Employee screening and insider threat*

A: This is a very interesting workshop. You have to have smooth checkpoint operations or you get backups or breaches.

A: We are very much into innovation and technology. We provide service to our customers in 101 cities; not as large as legacy carriers but slowly growing. TSA operates the screening at the checkpoints in most of our locations. However, we do operate checkpoints in the Caribbean, South America, and for a secondary checkpoint in Haiti. We do work hand-in-hand controlling the queues.

A: I am responsible for 12 cities. In 2003, we had 3,000 crewmembers. Over the past few years, we have seen lots of innovation, and grew from 20 cities to 101. We have a good relationship with TSA and the airports.

TSA: The reason we wanted you today is for you to share your experience talking about aviation security as a whole. The market segment is not just TSA. The future vision, after we deal with the security policy issue, is the integrated passenger experience and interconnectedness.

A: We like to give the passengers the seamless experience. Passengers often want to get through security and to the gate without having to speak to anyone. Capabilities in this space include bag drop and biometrics.

A: We want to make flying easy, to give people choice and the ability to control as many of the interactions as possible. We've rolled out kiosks, web check-in, and web bag check so you can tag your own bag. We are empowering passengers to do things for yourselves. It seems that it would all be a manpower savings but we find people like it better because it's at their own pace. We want to deliver the best customer experience and the best flying experience possible. The checkpoint is a big part of this. It is hugely impactful. All of your technology and how TSA is managing things comes back to us. We spend a lot of time dealing with pre-check questions like "Why did I get it on this trip?" We want the experience to be fast, smooth, and as much in the passengers' hands as possible. We want the lines to be short, be we want it to be secure. Our view is security first and then fast and convenient next.

Q: What are the top three things that you want from the security solution developers and vendors?

A: We have a whole group called Jet Blue Technology Ventures that focuses on innovation. It involves the following:

- Uber came to us 5-6 years ago.
- How many of you thought commercial vehicles would be self-driving?
- What about battery powered airplanes?
- How to best to utilize hotel space when you have a long layover.

TSA: Delta opened up their own checkpoint for their own employees.

A: Airports have implemented 100% employee screening.

A: We are working with the airports and supporting the processes.

C: There is an intersection between TSA and the airline. For example, at Boston's Terminal C, if you are a JetBlue Mosaic, it is nice. Then you walk into the large checkpoint. TSA owns the checkpoint and the airlines own the terminal.

A: We lease the terminal. We try to implement our Blue Juice into everything we do.

A: We have a great relationship with the FSD in Seattle, and have had input into the architecture around the checkpoints and around the lines. We have had visits from TSA and are actively engaging with our airport partners.

TSA: We aren't the only federal entity at airports. What about CBP? What are things that they do well that we could learn from them?

A: Every department of alphabet soup does something well. At large airports, such as Cat-X, it's imperative that airlines have a close relationship with TSA. When we don't have that partnership, when we don't have a collaborative engagement, the passenger experience suffers. TSA is great at listening to airlines. If we bring suggestions, we can see that that's implemented during that week. It's all about partnerships.

A: We have a different department that deals with international and CBP, and who have a direct line into TSA stakeholder liaison managers. We have a stakeholder role, and connect with the local TSA coordination centers and help coordinate incident response.

A: With TSA, you get the same standards everywhere, at every airport. We have written guidance we can go from there. With CBP, it's tougher.

C: You are putting in employee screening?

A: TSA is not involved with that. Screening employees separately removes 10,000 people from the passenger checkpoint.

Q: How many passengers will go through Orlando this year and next year? As you run out of space, you have to pray that someone finds a way to speed up checkpoints.

A: We are working with the innovation team and the space flow team on how to make our lines work better. People from Disney visited to advise. With precheck, we saw a number of people automatically being enrolled. Congress didn't like that so many people were going through expedited screening, which involves 2 lanes and 800 people an hour. Now, more people have to go through standard screening which causes the bottleneck; some as much as 40-minute delays. Use of canines to expedite customers through is a positive step. In 2020, the South Terminal will open. We will own that and it will have its own checkpoint.

C: 20 years ago, Pan Am went out of business. TSA is doing a pretty good job here in America but one plane blows up and you are out of business. How do Alaska and JetBlue weigh in considering that other countries provide the right security for your passengers?

A: We are engaging with the local governments, their aviation security and the TSA Office of Global Strategies (OGS), the State Department, FBI, and other stakeholders. We are focused on what threats might be in those countries, the security measures, and how effective they are. We have our own QA people looking at every aspect that we can. Cuba is particularly challenging but we have had remarkably good cooperation. We are partnering on an ongoing basis with TSA inspection folks to make sure we are doing everything that we are supposed to be doing. We are continually learning to assess risks.

A: The same goes for JetBlue. We do intense due diligence. There are many countries on the list that we are scoping out. We have meetings at the embassy, and we know all of the DEA representatives and regional security officers. It doesn't matter if its international or domestic.

A: We do threat assessments. Training programs are looked over on a regular basis. We partner with TSA and CBP.

ALERT: Thank you for coming. We have tried to get the airlines involved for a long time, and everyone has been engaged. Airports are under a myriad of ownership. Some spaces are leased from the local authority. TSA sits in the middle of that with a responsibility for a specific area and are responsible for the safety component. Multiple agencies are engaged. In Cleveland, TSA got the funding to put in cameras. I had to get approval from the city.

A: The approach is "collaborate, demonstrate, assess." There is an airport ecosystem. When I took over as FSD at Bradley International Airport in Connecticut, I experienced it first hand and heard on Day 1 "You should be ashamed of your incompetence."

The lines were such that you could not tell where the end of the line began. Piles of bags waiting to be checked were 10 feet high. My eyes focused on one of the airline employees who was engaged in a conversation with an irate passenger, and who was then directed to the TSA manager to my right. The passenger asked: "What is going on in this terminal on this morning?" and "Who is your boss?" He pointed at me. I am responsible for what is happening and this is my first day on the job.

Two weeks later, I went to my first meeting of FSDs from various airports. The briefing charts went up on the view screen showing rankings of some impressive lean six sigma rankings on who is improving and not improving. The person giving the briefing hired me but had not told me that my airport was ranked dead last. After the briefing, he took to speed walking. I had to jam the elevator doors open to catch up to him. He told me "Peter that's why we hired you. We didn't want to scare you away."

18 months later, on December 20, 2008, TSA Connecticut was rated amongst the top 10. We moved from dead last to the top 10. All of the metrics were green, such personnel efficiency and attrition, and we had hired, trained, and certified 100 officers that we had been short. We reduced wait times to 1/3.

I was used to hierarchy. There was none. It is an ecosystem that involves:

- Needing to understand the stakeholders and what their needs are.
- Taking advantage of the data feedback loop.
- Driving staffing to approved levels.
- Training.
- Technology.
- Airport operators and the airlines.
- There have to be leaders.
- Talk to the people doing the work.
- Turn around in the checkpoint and look.
- They don't stop coming.
- 3TSOs may be high school graduates, former marines, or PhD chemists.

You need to separating the truly relevant feedback from the noise.

Q: What happens if laptops are banned?

A: Pilferage goes up. We discourage electronics in checked baggage.

A: There are unintended consequences. We would kick-start a massive communication pushout and direct communication with social media to avoid surprise when people show up and can't take their electronics in to the cabin. Nevertheless, it will have a massive impact.

A: We saw it with the phones. Samsung was there helping to make it as smooth as possible. Hopefully, our partners at Airlines for America would intervene there.

A: The government has a responsibility to explain why this action is needed.

TSA: In your experience as FSD, what is your opinion of the Behavior Detection Officer program (BDO) and profiling?

A: I am a big fan, but I don't think they are perfect. It uses medical research as the underpinning. I would not want to be in charge of security with BDOs as the only layer of security. How many precious seconds do we have? Some people had more affinity and ability for that role, for standing back and watching. It is a terrific addition as one of the layers. We would find people with the BDOs doing things that were illegal.

A: The airlines do not profile. We work closely with the BDO team to be situationally aware. Walk through the checkpoint and look over your shoulder and just be aware. You'll see things that make your hair stand up.

A: "See something, say something" comes in. We encourage that they report.

C: TSA considered relaxing the list of threats; for example, sharps. How do the airlines navigate the different constituencies? If we could relax the restrictions on sharps, the checkpoint would be faster.

A: Would it be safer for passengers? We would support our crew members. Safety and security are paramount. The government has a responsibility. How do we balance risk? It is a difficult message to communicate publicly. When we held a town hall, there were 8 live TV cameras and half dozen print outlets, but there were only three people from the town. This is a tough public message. People get involve only if it happens to them.

C: If he came from my town.

A: Do you have no responsibility or no control?

It was a T-shirt vendor who noticed something odd. You don't leave that car with the door open, that is unusual. You know what's normal in your local environment better than anybody else.

A: Accepting risk is something that we all have to do, but we are reluctant to do. We have a motto: "Ready, Safe, Go." Every vendor has the right to say stop. Are you going to search your aircraft constantly? At some point, you say no. Regarding "See something, say something," one of the screeners came and found me. That guy had 5 bullet proof vests and $10K on him.

C: That's two incidents. What about what comes before the terrorist incident on the tarmac? There was a flight attendant with 20 pounds of cocaine exploiting relaxed screening protocols for flight crews. Next time that might not be cocaine. Vetting your people for insider threats is critical.

A: All of our employees go through background checks. They have airport media badges. We monitor their travel. They are subject to employee screening for any time of travel. She went to known crewmember lanes which is an approved screening method.

C: A year ago, a Delta employee was transporting weapons from Atlanta to New York.

A: We work closely with airports and law enforcement. We work hard to educate our employees, that it's our families on their flight.

A: We've looked into the background of national security leaks. There have been university-based studies looking at common characteristics for people who stole classified information. There were always people in the organization who knew enough that if they had raised it, the theft would have been prevented. It's not just training and mitigation. There are common things that you can observe.

Topic: Collection and Dissemination of Security-Related Information

Title: BlueWatch Operation

Speaker: Lisa Asaro (JetBlue Airlines)

Discussion of how an airline views security in practice. Topics addressed include:

- *Proactive*
  - *Watchstanding, "concierge" real time reporting centers and triage.*
  - *Active shooter training.*
  - *Human trafficking – "see something, say something."*
- *Internal watchlists and case management system*
  - *Yellow List – track and trend customers, crewmembers, individuals who have caused an incident, denied boarding, indicators, refused medical attention, and investigations team.*
  - *Direct interaction with customers when they fly after the first incident.*
  - *706 matches in 2016.*
  - *JetBlue proprietary and not shared.*
  - *Physical injury warrants "uninvited to fly."*
- *Social media threats and communications – spike in 2014 and 2015*
  - *Threats social media playbook*
- *Law enforcement interaction*
- *Remote surveillance, including CCTV, which allowed coordination with other airlines during lockdown incidents.*

Q: How does JetBlue partner with TSA with data sharing for an integrated passenger experience?

A: We do not release customer information under any circumstances.

VIII. OTHER USERS PERSPECTIVES

Topic: Cargo Update

Title: TSA Air Cargo Screening Update

Speaker: Allan Collier (Transportation Security Administration)

Discussion of how TSA manages the Cargo Screening Program. Topics addressed include:

- *100% screening mandate and challenges:*
    - *Ecommerce is increasing volume.*
    - *Water content of commodities.*
    - *Alarm resolution and secondary inspection.*
- *Air cargo supply chain:*
    - *Secure facility, secure supply chain, monitoring of tampering.*
- *Multiple approved screening methods:*
    - *For stowaway detection: CO2 monitors.*
    - *For contraband and threat detection: physical search, X-ray, ETD, EMD, EDS, TSA-certified canines.*
    - *No more proprietary canine teams.*
- *Compliance inspections and audits:*
    - *All cargo is still subject to random inspections.*
- *Phased expedited qualification process for new screening equipment models:*
    - *In 2020, single-view X-ray systems will be deprecated. ETD is dropping off in 2021.*
- *Interest in EDS screening for cargo:*
    - *Screening of heterogeneous commodities that is cheap and fast (20 skids per hour).*
    - *Accommodate 48”x48”x65” skid or pallet.*
    - *Pallet-level or piece-level screening of heterogeneous cargo.*

Q: Why is TSA not using canines?

Q: Can a shipper just do trace for cargo?

A: Yes, but it is very complex. You submit a security plan for review. You can pick any way you want. When we certify the facilities, we briefed them. The cost is up to them to decide. We share the ramifications and give recommendations and best practices. The facility submits a business plan for screening. The supply chain has security regulations. Anyone can initiate a rescreen in the chain.

Q: Can things be shipped without it being independently screened?

A: A certified shipper does not need to adopt screening methods as they are considered to be a secure source. They have brick and mortar, they have fencing, and they perform background checks and other processes delineated in the security plan. There is no technology requirement. There are 500-600 certified cargo inspectors hitting these facilities all the time.

Topic/Title: Aviation Security in Israel Compared to the United States

Speaker: Avi Cagan

Discussion of how aviation security compares between Israel and the U.S. Topics addressed include:

- *Comparing and contrasting each country's respective airport experiences at arrivals and departures, including:*
    - *Defense through architectural design and directing flow.*
    - *Screening from the perimeter inwards.*
    - *Both countries are using similar concepts of detection equipment.*
    - *Waiting times in airports – "You may miss your flight."*
    - *Undercover agents – Israel staffs security with ex-military service, who are well-trained to interact with suspects in a crowd. There are hourly vigilance checks. Uniforms do not necessarily act as a deterrence.*
- *Human factors and profiling are still stronger than detection equipment:*
    - *Probing questions and interviews (a minimum of 15 minutes but could be longer).*
- *Difference in number of airports. Most flights in the U.S. are domestic while most flights in Israel are international. The number of passengers is rising every year.*
- *Two populations – 70% are Israelis, 30% are foreigners.*
- *Unwitting couriers – someone gets a bag from someone else that he trusts, so there were no indicators, but they found drugs hidden in dolls. All passengers related to his flight were rechecked. They found other dolls. This resulted in a 3-hour delay.*

Q: Is there a difference between cargo screening in the U.S. and Israel? For checked baggage, you as a passenger, you don't see anything.

Q: Can you apply the Israel system here?

A: I don't know.

Q: Could you apply the interviewing process here?

A: Yes. If you see something, and the answers are not right… You don't have a technology that can replace this interview.

IX. EMERGING HARDWARE PERSPECTIVES (PART I)

Topic: Future X-ray System Concepts: Approaches and Issues

Title: Emerging Explosives Detection Technologies for Luggage

Speaker: David Castañón (Boston University)

Discussion of emerging explosives detection technologies for screening checked baggage. Topics addressed include:

- *Challenges with existing approaches:*
  - *Dual energy is effective for low Z materials but not for items with high k-edges.*
  - *Only two degrees of freedom – Compton and photoelectric*
- *Signatures and limitations of several new approaches*
  - *Limited field of view tomography:*
    - *Computation times are 3-5 seconds now due to increased computational complexity of iterative algorithms.*
    - *Lower resolution than existing scanners.*
  - *Multi-energy tomography:*
    - *Even if you can measure 128 bins, how many are useful?*
  - *X-ray diffraction imaging and tomography:*
    - *Potentially a different dimension; absorption properties and spectral properties.*
    - *Not as a primary but as an adjunct; confirmatory.*
  - *Compton scatter tomography:*
    - *A lot of the scatter is not isotropic. Collecting from a lot of directions and aggregate photons can lead to interesting behavior.*
    - *There are many materials of interest that have some crystal structure.*

        - *Need to remove collimators.*
        - *Investigated at Tufts with AS&E.*
    - o *Other X-ray signatures: phase-contracts imaging and dark-field imaging.*
        - *Have not looked at the depth of absorption; could be very good for a liquid scanner.*
        - *Works in the absence of clutter and materials that have low attenuation.*

Q: How long do you have to stay on target?

A: It depends on your system design.

Q: What are you figuring on throughput?

A: It depends on if you need to use this as primary or secondary. We are imaging a smaller area.

Q: X-ray diffraction imaging doesn't look cheap.

C: It has poor spatial resolution, but it does the job. When it comes to checkpoint, there are several models that are going for certification right now. The speed is approaching today's systems. It is 1 minute per bag for older systems, but we are seeing improvements that speed up these systems significantly. The CONOPS is usually different; e.g. an inline secondary system with a transmission system. The time on beam/slice is 1 second.

Q: How severe is this angular issue, and how often does that occur?

A: We have tried to start a task order with LLNL based on the types of materials that they care about and investigating the spectrum of variability. There are plenty of questions remaining as to which of these will be effective. Each of these are looking at weaker signatures. You have to look at signal strength and noise. How are they affected by nuisance materials and from the environment? Do these extra signatures help separate explosives from non-explosives? Is there mission value from the additional signatures that you can collect?

Q: How do you establish the value of signatures?

A: You do a study. You build a few experiments and show the signatures you are collecting, and separate the confusers from the classes you are interested in detecting (hopefully at a lower TRL level before you go and build a system).

Q: Why can't you do it on paper?

A: It's hard to predict. There are phenomena that we don't yet understand.

Q: What about the improvised explosives with non-explosives mixed in?

A: Improvised explosives may contain uncertain mixtures. We aren't clear on the extent of the range. You can easily introduce a bit of high Z and introduce a k-edge that you didn't expect to see. This is why multispectral might be interesting. Academics are not best suited to determine this.

X. SELF-REFLECTIVE PERSPECTIVES

Topic: ADSA + Related Projects - Past, Present, and Future

Title: Advanced Development for Security Applications (ADSA) Workshops: Past, Present, and Future

Speaker: Laura Parker (DHS S&T)

Discussion of DHS S&T's objectives for and outcomes from the ADSA workshops. Topics addressed include:

- *Purpose of Centers of Excellence.*
- *Minority Service Institutions (MSI) Programs.*
- *ALERT Task Orders.*
- *Lessons learned since ADSA01, growth and pains.*
- *Results.*

15.3 Day 2 Minutes: May 3, 2017

I. DEPLOYMENT PERSPECTIVES

Topic/Title: Specifying a Jell-O™ Detector

Speaker: Matthew Merzbacher (Smiths Detection)

Discussion of Jell-O as an exemplar for detection targets. Topics addressed include:

- *Challenges in describing needs, in specifying requirements, and the risks inherent in over specification.*
- *Government procurement specifications as well as competing and conflicting requirements.*
- *Evolution of needs, and variability in targets.*
    - o *Feasibility of full factorial empirical data collection.*
    - o *Variability, physical phenomenology, and viable presentations of real-world specimens.*
    - o *Approaches for reducing the number and spread of the variables to consider in detection.*
    - o *Platfor- specific data collection, measurement, exploitation, and terminology.*
    - o *Test articles selection, representation, application, and management.*
- *Proposal for adopting a heat map as a specification, rather than absolute thresholds.*
    - o *Responsibility of regulators to manage tradeoffs.*
    - o *Managing detection cliffs.*

Q: The vendors who build equipment want to have specs. The trouble with emerging threats is if you over specify the regions you want to see, you open up vulnerabilities.

A: I agree and I disagree. Specifications enable white-box and black-box testing.

Q: What are they currently testing?

A: Informed black boxes.

Q: Grey boxes?

A: Pink boxes. We have to be really careful. Can we know what isn't in the specification, such as color? There is a whole bunch of properties that aren't in the specification. You care if it goes boom. How do you ensure you have robustness, that you aren't right by a cliff where you go from perfect detection to zero detection?

There's some great tools from data science where you can detect you are near a detection cliff. Ideally, mix analytical and empirical data. It's tough to do detection if you have no scans. What if I give you three scans? What if you have different acquisition devices? The detection device is a lens. If I build one, and David Shafer builds one, and Shiva builds one, the data are going to look different feeding into the algorithm. Depending on what you scanned it with, you get different results.

Q: Do you have to use physics and chemistry only? Do the recipes get sensitive enough?

A: You can cover all of that in the heat map. It doesn't have to be the jell-o-ness, but it can be the jell-o-ness that you care about. In two dimensions, it's hard. Now we are talking about fifteen dimensions, so it's very hard. We can have an honest conversation about we can and can't do, what the limitations are, or the cost to overcome the limitations of false-alarm rate, throughput, and secondary screening.

C: There are other technologies that do materials characterization.

C: We talked about mix ratios and impurities and those sorts of things. There is a lot of work to be done to determine which formulations are detonable. Do you see a way around someone making and detonating them?

A: We don't know the range of a particular material. That's one of the nice things about using specs for detection. If there is intel that adversaries are using Folgers crystals, that can be a challenge because if you add Folgers crystals to the mix, the properties change. In the empirical world, someone needs to mix it up and scan it. Under a specification approach, the regulators would ask "We just found a new window in our detection space, tell us how you think you would do." It's not going to be perfect, but you can get to "we can probably change our algorithm in this way and get detection."

A: The thing I like about specifications is you can have a non-technical discussion. If it's on the list, do I get 100% detection? No. With a heat map, where do you want to focus your attention?

C: There has been discussion that vendors consider many, many features in their detection algorithms. Vendors have sometimes > 100.

A: It's a function of the acquisition device and hopefully of the material and not the specification. It is easy to create a feature capturing something you are not supposed to.

Q: Is this a mathematical model vs. a physical model?

A: This is more of a mathematical model. If you are not careful, you will marry yourself to your detection device.

Topic/Title: Regions of Responsibilities, Transfer Functions, and the Role of Simulants

Speaker: Harry Martz (Lawrence Livermore National Laboratory)

Discussion of how to specify the detection requirements to vendors and the responsible use of simulants. Topics addressed include:

- *Current approach is to specify a uniform distribution as a bounding box region of responsibility, rather than a heat map.*
- *Detonable non-stoichiometric and range of densities in mixtures.*
- *Variable range of features that vendors use for detection.*
- *Test article management, sourcing, and aging effects.*
- *Variability and evolution in manufacturing.*
- *Clutter and electronic clutter effects.*
- *Cost and viability of scanning specimens.*
- *Viability of transfer functions for mapping scan data between scanner instruments.*
- *Exploration of the use of simulants, for training and testing.*

A: And they change as a function of time; they emit gasses and create space. Depending on when you do the scan, you may get different scan data. When you do CT, you do not get good recovery if it is evolving during the CT scan.

Q: How long does it take to go from specification to full samples? And how much does it cost?

Q: We are talking about the limits of performance of detection systems. What's next?

A: A lot of people are looking at dark field, scatter, phase contrast. If 100 features in a CT machine are not enough then what else should we be pursuing? One of the hard things we haven't been doing is "Here's the things we can't sort with CT, can you do so with other technologies?" But this is sensitive or classified. Come to the dark side. Here's the real problem. Help us solve the real problem. How do I know if I can get better if I don't know what I'm supposed to find?

Q: Can you talk about the limitations of transfer functions? MicroCT to other CT could be aligned, but what about diffraction?

A: It's controversial enough now to go from one CT to another. We are still trying to figure out how all this will work. We need to test it.

C: If you transfer from A to B and A to D, do we need a standard to make sure it works? There is an unfair advantage if A to B works well, but not so well A to D. It goes the same for simulants. Does it work better for one machine or another? A lot of OEMs rely upon the government purchasing equipment from them. If scans are sourced only on a single platform and transfer functions are used, a protest may arise from other vendors who may feel disadvantaged.

A: Why does the government not tell the manufacturers that these are the mixtures that we are concerned about? Here is the item at 80/20. Here is the bounding box for Feature 1 and Feature 2. Here is the chemical make-up -- Al and C, or photoelectric and Compton, or etc. The more features you capture and deliver, the better you can sort threats from non-threats. If we have to measure 16 different machines and 30 different features, we have to measure 16 different machines and 30 different features. It gets complex. When we do get instructions, or get intel about how they make it and do try and make it that way, most of them do fall in the window. That's good.

C: The list of explosives that TSA wants to detect is classified, but aren't there publications that describe all this stuff in the open?

C: It seems there's a lot of challenges in doing this outside of a classified environment. There's going to be a time where you have to get into the classified regime.

A: Yes. Prioritization is important. We can't afford to do 100%, or lower the priority. With intel, the focus shifts to "this is an important material and we will live with the false alarm rates," and we will have to find ways to balance the impact.

II. VENUE PROTECTION PERSPECTIVES

Topic/Title: Mall of America Security

Speaker: Ashly Helser (Mall of America)

Discussion of security at the 6M square foot Mall of America, equipped with 3 police substations and co-located with a transit hub. Topics addressed include:

- *Shoppers want to feel safe, and the mall needs to be inviting to visitors:*
  - o *Impact of threats from social media resulted in an increase in security teams from 5 to 15 canine teams, and adoption of additional measures including checks into garbage cans by Risk Assessment and Mitigation (RAM) officers.*
- *Protection of soft targets:*
  - o *400+ large event activities annually (public appearances, etc.).*
- *Protection of large venues:*
  - o *Layered security.*
    - *Trained security force, uniformed and non-uniformed; includes explosives detection K9 teams.*
    - *Staffed with in-house intel analyst.*
    - *Use of red-teaming.*
    - *Deployment of explosives trace detection equipment.*
  - o *Close partnerships with local agencies.*
    - *Co-located police provide armed presence.*
    - *Authorized by ATF to have explosives on site.*
    - *FBI brings peroxides.*
  - o *Transition away from babysitting: parental escort program decreased juvenile crime by 1/3.*
  - o *Challenges due to the co-located transit hub.*
- *Detection of harmful intentions:*
  - o *Apply lessons learned from looking at the pre-incident cycle (6 months – 9 years prior to attack).*
  - o *Adopt behavior detection: RAM program is focused on oddities, not crime.*
  - o *Focus on intention vs. means.*

C: You said people want to feel safe, but they want to be safe.

A: People want to be safe. There are things we can do behind the scenes, but visible efforts are important too. Everyone is aware of layering security. Training is a large part of what we do. Each officer spends 100 hours before taking any call alone. We do apply behavior detection. It's that human element that allows us to be proactive.

How do you detect someone who has harmful intentions? In 2005, we took a look at this. We had to look at what type of activity happens. After 9/11, bigger guns and trucks were purchased by other venues. We looked at the pre-incident cycle. We aren't DHS, police, or the FBI, but what we can do is be first responders and defense. We are close partners with our local agencies. What can we do to be proactive? People get scared by the work profiling. What makes someone standout is that they are not there to shop or to work.

We apply RAM, which is not focused on criminal nature (i.e. not medicals, shoplifting, visible deterrent, patrolling). We are looking for the fish that is swimming in the opposite direction. You can tell who is there to shop, bring their kids to entertainment, and everyone else. We focus on intention vs. means. Someone carrying a large gun through the mall would be odd. A person standing in Igloo Universe that doesn't have kids is odd.

We deploy plainclothes assets as well. Clandestine would be best for us by watching their reaction to other security features. We call it elicitation. Using that plainclothes method, we can take their next step, which we call interview. We ask "What brings you to the mall today?", identifying the suspicious indicator and asking very friendly questions. If you see someone at the entrance pacing back and forth, looking nervous, that's an opportunity.

Q: Is there any persistence. Is this temporal? Do you correlate this when they come back 3 days later?

A: There is a difference between suspicious and weird. We have a lot of weird people. We have to articulate and define why it is suspicious to us. For example, a person pacing by the east entrance, it may be because they were meeting someone.

Q: How many visitors?

A: 42M visitors annually; changes from day to day. Most are fine but a small number show criminal behavior. We pass that along. They usually say "Ok, ok, I stole the watch."

Q: Of the 1,400 annual interviews, is 8-9% the actual criminal rate or is this the referral rate?

C: You might consider doing a validation study with some third party. It would be useful.

C: 1,400 interactions seems very low.

A: There are more people detected. After watching for a few minutes, we refer them to our patrol division if we think they are doing something criminal.

Q: Are you using any facial recognition.

A: No. We have a wide array of entrance points, and they are designed to have an open feel. It is something we continue to review.

Q: Are you doing some type of training for behavior?

A: We've studied micro expression, based on Israel. It was a new thing in Minnesota.

Q: Do you red-team?

A: Yes, a few times a month. We have actors with a script. We tell them "You are here to surveil the rotunda to determine the best place to place an IED." We check through open sources (does your flight actually exist, what time did you get there).

Q: You have your own facility, but you have a mix of police officers. What about 4th amendment concerns?

A: It is private property. We are able to say here are the codes and rules and we can ask you to leave. Only the police officers have firearms. We have OC spray and Tasers.

Q: What are you doing differently for events? There are lots of people standing around.

A: We will have armed police officer presence. We may do bag checks for concerts, when entering queue lines. RAM are looking at every person's face.

Q: Are you using any technology?

A: Mostly because we want to create that family-friendly feel, we rely upon security presence and dogs.

Q: You have 15,000 workers making minimum wage. Do you do background checks?

A: Any Mall of American employee, or contractors getting to secure areas, have a background check and are accompanied by security officer. We can't specify that for tenants.

Q: I am a behavioral scientist. You are talking about something akin to TSA's SPOT program. The numbers you are getting are similar to what we were seeing. It was a quasi-experimental design. Some of the behaviors are involuntary. How do you get your red-team to react? People in the lab react differently. If you look at the published literature, what happens if there are no incentives, no punishments, and no rewards for getting caught?

A: We do try and give them an incentive. They are interested in the field, but that makes them nervous. Just don't act too nervous when the people get there. It is difficult to create.

Q: What is the success rate of your red-team?

A: It is comparable. 85% are detecting what we want them to. We learn what our vulnerabilities are, and where we need to do more training.

Q: Can you speak a bit more about intent vs. means? Sometimes you can't find means, so you have to look for intent. It's comparable to SPOT. There is a low frequency, but it's hard to show effectiveness. Do you see similarities in justifying it?

A: It's not the end all be all; it's justifying what we are doing and how we are doing it. Newer officers ask "We don't have a crime committed. What do you want me to do about it?" It is about establishing a security presence, a security impression.

Q: You flew here yesterday. Do you have advice for TSA?

A: I loved flying here. You can see the BDOs and why they are asking questions.

Q: What is the annual budget?

A: $5M

Q: How many layers, and what haven't you told us?

A: Multiple layers.

Topic: Screening/Security at Large Venues

Title: Venue Public Security & Stadium Access Security

Speaker: Fred Roberts (Rutgers University)

Discussion of facility planning for emergency situations and how to approach responsive redesign for large venues. Topics addressed include:

- *Value of data science, modeling, and simulations to justify and adjust placement of security elements, response planning, and venue architecture and structural elements.*
- *Agent-based crowd simulation modeling that considers origin and destination, behavior, and motivation including individualized preferences, effect of crowding on behavior, population demographics, parameterized, logistics, and bottlenecks.*
- *Evaluate the changes to parameters and the dynamic preferences of individual behavior in response to different architecture designs and signage.*
- *Adjusting the models to real-world conditions (e.g. heavy wind, intoxicated patrons) and randomness.*
- *Certify venues through the SAFETY act to attain incentives and reduced liability against terrorist activities.*
- *Soft targets:*
    - o *Minimize queue length.*
    - o *Manage screening impact.*
    - o *Develop incentives to get people in early.*
- *Security measures are viewed as a cost to management, but valued by the security department:*
    - o *Alarm resolution and nuisance alarms.*
    - o *Sufficient staffing to manage screening.*
- *Technologies don't work as well in the real world as they do in the lab.*

C: Very impressive model. It takes into account, children, baggage, and disabilities.

A: That's why we do agent-based simulation, so that we can inject characters of families or friends that want to stick together, and include lots of luggage that might obstructs others.

C: Different stimuli have different reactions. If there is a gunshot, people turn and look, rather than run away. If people start running, people start to instinctively run in the same direction.

A: What will actually happen if there is an active shooter? Will they turn or just run? Can we direct their reactions? Would you listen to the hot dog vendor? A lot of this has to do with behavior in emergency situations. You need to do a lot of experiments.

C: What is the motivation from sports arenas? Walk through metal detectors can support detection, but also act as a deterrence.

A: It depends on who the customer is. Is the customer in management or in the security department? Professional sports are a multi-billion-dollar business. If any event happens, it would affect everyone's business. In Oakland, the Raiders were the first ones to deploy walk through metal detectors. These things don't work when there's wind. Management have to invest in a large cover area, which meant they gave up valuable parking spaces. Not every management would do so.

C: There is detection, and the audience knows what they can and can't detect.

A: Just roll out someone with a canine, if it looks like they know what they are doing.

Q: Has anyone from TSA asked you to apply this to a specific category of problem? For example, if you have a 10% increase in passengers because it's July?

A: No.

Q: Does the NFL mandate that they do some security?

A: Yes.

Q: How much money is available for security?

A: Each stadium will have their own budget and features. Leagues/teams will do their own red-teaming. The NFL and MLB are trying to get SAFETY act approval.

III. ALGORITHM PERSPECTIVES (PART II)

Topic: Weapons Detection

Title: Weapons ATR for Checkpoint CT

Speaker: Rohit Patnaik (Capture)

Discussion of weapons detection algorithms for firearms, knives, and others, to enable bags to be automatically cleared. Topics addressed include:

- *Goal of the project is that 75% of bags are cleared automatically, leaving*

25% for image review.

- *Leverage machine learning to extract features, rather than extracting features manually.*
    - o *Requires a lot of data. The request is for 6,000 images.*
    - o *Training is typically in the order of hundreds of thousands of images. Stream of commerce can be plugged back into the system to train against false alarms.*
    - o *Potential to apply deep convolution neural networks (DCNN) depending on funding.*
- *DICOS is a key enabler, otherwise we would be locked out as a third party, and we are a partner on the TSA's OTAP project through Sandia National Laboratories.*

Q: You are training on chips around the objects of interest?

A: Yes. You don't have to work on low density things; you can move onto denser things.

Q: What about parts?

A: Eventually.

Q: Regrading the timescale, does that include annotation of images? 3D volume annotation is a significant time sync.

A: Yes, it takes time.

Q: The published state of the art is to detect knives, firearms, and parts in CT. Can you speak a bit more about the number of images that you needed?

A: We need to have hundreds of thousands to train the initial network. The plan is to use the 6,000 to train. You don't have time to annotate 100,000 volumes.

Topic/Title: Visual Analytics for Security Applications

Speaker: David Ebert (Purdue University)

Discussion of the value and use of visual analytics for security applications. Topics addressed include:

- *The importance of visual analytics in feature extraction.*
    - o *Visual analytics help people understand this data, so that they aren't*

  flooded, and so they don't perform automated detection without context.
  - o *Apply information theory anomaly detection.*
- *The "Human-Computer Collaborative Decision-Making Environment" steps away from black boxes with large dimensionality that lacks context; supports data-driven policy and decision making.*
  - o *Fuse and analyze information correctly, discover and report correlation and causation, share synchronized situational awareness, and actionable information, applied to a real-time operational environment.*
  - o *Supports more effective decision-making with increased certainty, with tools for better communication to stakeholders.*
- *Engagements include TSA FSDs, flight delay data, and police agencies.*
  - o *Predictive analysis, crowd sourcing social media, planning for asset deployment and response.*
  - o *Optimizations for most effective patrol routes, community policing, subjective and quantitative measures together, and avoid duplicative coverage.*

Q: What happens if you get misinformation in your crown sourcing of social media?

A: That's something we've always been worried about. We have worked with social scientists to understand the impact of influencers, and modeled patterns about how false information is spread vs. accurate information.

Q: Are you trying to collect information the reverse way, such as using cellphones?

A: We try to see what is on social media and news. Cellphone data is a great source, but it's very expensive. Everything that we do is based on the data we collect, and we try and do it with the minimal amount of data. We are looking for new sources to see data coming from multiple providers. We work with FSDs at airports to access the compliments and complaints data, and the majority was complaint data.

Topic/Title: Dual Energy Decomposition Methods for Accurate Material Discrimination

Speaker: Harry Martz (Lawrence Livermore National Laboratory)

Discussion of the dual energy decomposition methods to assist in identifying materials. Topics addressed include:

- *Using multiple basis materials or Compton/photoelectric.*
- *Focusing on physical properties provides a system independent feature space.*
- *Decomposition helps mitigate the impact of imaging artifacts.*
- *Adaptive method for transfer of region of responsibilities between scanner platforms.*
- *Accuracy, noise, and error rates.*

Q: Is this simulated data, post processing or before reconstruction?

A: This is before reconstruction. Our approach is to measure the spectral response of the system. In simulation space, you model the 100kV-160kV, do the forward projection, convert to whatever basis you want, and you can then do the reconstruction. We would run some reference materials which will reveal the detector response to the source energy. Jeff Kallman came up with a method to automatically establish the spectral determination, which is different when looking at the basis of material.

Topic: Basis Material Decomposition

Title: Basis Material Decomposition for CT Analysis

Speakers: Rob Kleug and Ron Krauss (DHS S&T), Joseph Palma (Battelle), and Alex Demasi (Signature Science)

Discussion of alternate approaches for specifying targets of interest. Topics addressed include:

- *Explore alternatives to physical scan data collection of baggage.*
- *Characterize target materials in terms of the equivalent mass density of two or more known and well-characterized basis materials.*
  - o *Allows for describing the system independent space for region of responsibility*
  - o *Reduces the need to compensate for artifacts.*
  - o *Use of a MicroCT instrument and a basis material decomposition test fixture at each laboratory will reduce system dependent factors and provide consistent effective measurements across different platforms at various labs.*
- *Evaluation of technique with CT and photo-counting approaches.*

Q: How accurate can we get with this method?

A: Results to date are inaccuracy in density of less than 1.1%, and in Z-effective of less than 2%, with a standard deviation of less than 1%. These results were collected using Aluminum (Al) and Polyethylene (PTFE) with the phantom, over a range of beam path lengths and dual energy power levels.

For decomposition, you get an Al sonogram and a PTFE sonogram. You get reconstructions based on Al and PTFE equivalent reconstructions. With the high-density PTFE (HDPE) basis, it is 1.0 and the Al disappears. We then normalize, similar for the opposite Al base.

As you change these acquisition parameters, you get tight groupings, even the Magnesium (Mg), which has a higher Z-effective.

A: Have you had any feedback from the vendor or academic communities with respect to feature space that would allow you to turn around upgrades more quickly?

C: What about streaking, metal artifacts, and noise issues? You have to tradeoff integration times with throughput. These are things that the academic community would be good at attacking. Noise is an issue for sure. The industry has tight throughput requirements. How do you manage this in an operational environment? Use our scanner. It's at TSL. What we need to do now is port this technique over to a full-scale system. Let me know how I can help.

Q: Have you used it to predict the performance of another system?

A: We have done this with two MicroCT scanners so far; different acquisition, different source. We will port it down to Tyndall to see if this process is portable from system to system.

Topic: Iterative Low-dose CT Reconstruction with Deep Neural Networks

Title: Low-dose CT Image Processing & Reconstruction with Deep Learning

Speaker: Quanzheng Li (Massachusetts General Hospital)

Discussion of applying deep learning techniques to improve image quality in CT. Topics addressed include:

- *Prize competitions for improving image quality for low dose CT.*
- *Deep learning methodology includes high dimensional CNN, the missing data problem, learning annotation, transfer learning, novel network structures, and optimization/compression networks.*
- *Deep neural networks can separate two different categories in feature space; shallow neural networks (less than five layers) will struggle.*

  - o *Image de-noising and restoration of missing data is more effective with more than 8 cascades of CNN and larger numbers of layers.*
- *Correlation to security – for medical imaging, there is no ground truth; you can't scan the patient 10 times.*

C: Historically, people don't give back data.

A: We talked to a manufacturer who volunteered the data.

Q: And who owns the IP?

A: I don't think you can own the IP for this method. You don't need to open your source code but you have to describe your method.

Q: And what was the prize?

A: There was no prize for this competition.

C: This is a very fertile area of research. Have you looked at sparse view data? For a lot of security applications, the systems have sparse views.

A: We have looked at limited view data. Preliminary results show that you can get rid of some artifacts, but not too many. Intrinsically, there is a huge space of missing data that you can't compensate for.

C: Do you have advice for the speaker for getting involved in security?

C: The challenge here in the security application is getting a lot of training data. But that's also a challenge in the medical field.

A: If you look at a lot of CT challenges, they don't provide a lot of data. Instead of using the image as input, use the image features as input. The neural network is not as large and you can use less data. There are methods to learn to automatically label an image for annotation.

C: Here, there is a lot of metal in this industry.

A: Yes. We can remove metal artifacts.

Q: Is there a heavy computational expense?

A: Training takes a lot of time. Our system uses eight NVidia Tesla P100 GPUs. It is a challenge.

Q: What data do you put into the CNN? The sinogram? The reconstructed image?

A: The reconstructed data, at each iteration.

Q: In research, we hear that you don't want the data to be lossy. So, can you try sinogram?

A: For this work, that would be difficult, but look to Alternating Direction Method of Multipliers (ADMM) approaches. The computational burden is even higher, and there are other challenges you have to address.

Topic/Title: Realistic Simulations of Baggage

Speaker: Taly Gilat-Schmidt (Marquette University)

Discussion of simulations of baggage for predicting performance of scanning technology. Topics addressed include:

- *Potential to explore designs in simulation space prior to committing significant investments.*
- *Use of COTS computer animation tools to model numerous complex suitcase configurations, threats, clutter, concealments, and to perform automated packing.*
- *Dynamics of real-world baggage packing and contents shifting.*
- *Suitable use of simulations in qualification testing.*

Q: What are the variables that you put in to model the system?

A: System geometry, detector policy, lag, focal spot, spectrum, glare, and long list. You can model the system as you like, it's just the complexity of getting the code to do it.

Q: How do you get ground truth for the simulations, and how do you label the data?

A: We need 6,000–100,000 images.Manually modeling 5,000 suitcases is very labor intensive. Deterministic packing is a really difficult problem. It looks like it has been solved for boxes, but for regular objects it is very challenging.

Q: What about how items compress in a bag, such as shoes with upper soles, and bodies that are grouped together?

Q: What about surfaces and shape? Don't you need material properties?

A: Yes. You do need to define a material inside the surface of that material.

C: Ultimately, with any simulation, you have to compare it to experiments to see that it is giving you realistic results. You take some of your bags with the simulated threat, pack a real bag against your simulated images and the experimental images, and see if you get similar results.

A: We have done some work to validate the simulations of X-ray physics with simpler objects. We see similar streaks and other artifacts in the Particle/Ray Interaction Simulation Manager (PRISM) tool. We see noise that's realistic and artifacts. We are using established tools such as GEANT4. We do review the data and ask "does our suitcase look like a real suitcase?"

C: You should work with a regulator and define the parameters for clothes, laptops, shoes, and the rest of baggage contents. Get your real parameters. You will need a few hundred thousand bags.

C: Don't forget to move the bags or rotate them. You need to capture what happens when the bag tumbles over.

C: Study a specific object rather than stream of commerce. Not everything really matters.

Q: How realistic is your capture of scatter? Speed is the issue for realistic results.

A: For PRISM, it's wrapped around GEANT4 and is very slow. You need to increase the compute power.

C: You may want to do calibration. Emulate the ALERT Task Order 1 (TO1) database.

C: You should move away from dropping items into the bag. That will be important for the artful concealment.

Topic: DICOS 2A and the TSL/DHS Database

Title: DICOS Status Update

Speaker: Doug Bauer (Global Systems Technologies)

Discussion of DICOS 2A and future steps for DICOS. Topics addressed include:

- *DICOS is linked to key TSA objectives.*
- *Reasons for vendors to participate in DICOS standard development.*
- *DICOS Version 3.0 will address additional screening technology modalities and functionalities, and may potentially be including biometrics.*

Q: What incentives should be given to vendors to participate in DICOS 3?

C: It lets us vendors understand the standard as early as possible. We gain expertise so that we are able to ensure that silly things don't end up in it. If you put everything in, it will sink under the weight. Participation lets us influence the usability of it so that it becomes something that is useful. Even if you don't participate, it will occur anyway, and you will have to use it.

C: There is no reason not to participate, other than that it does require an investment of time.

C: Rapiscan is on the committee, if not one of the chairs. As it becomes a standard, it opens up a market and interoperability and is getting equipment out there. You can still have proprietary information and pass it along in an open format.

TSA: It's a vital piece of our system architecture roadmap. We've taken TSA definitions as far as we can. Most recently, we are working on user interfaces, i.e. where we want buttons and panels, and how images need to be displayed to best support operations. While important, that was just a facelift. Interoperability is where we want to go. As vendors start using DICOS, the more money we will put into maintenance of DICOS itself. There are so many applications that will build upon DICOS, including image archiving and retrieval, replay, and objective capabilities such as data rich images to third party ATR and specialized ATRs.

Q: When is TSA going to mandate it?

TSA: TSA can do it an any time. We are evaluating and looking at progress with 2A and 3.

C: It's never going to be mature enough for the field.

A: It is a not a long stretch for adoption in air cargo. There's already a DX standard. It's just a format for representing data. The threat detection is already pretty generic. There are just a handful of additional attributes; it is just a handful. We discuss and call out the nomenclature.

IV. EMERGING HARDWARE PERSPECTIVES

Topic/Title: Explosives Trace Detection – Emerging Technologies

Speaker: David Atkinson (Pacific Northwest National Laboratory)

Discussion of emerging technologies in trace detection. Topics addressed include:

- *Inexpensive and complementary to existing inspection methods.*
- *Trace is a secondary indication, and can result in nuisance alarms.*
- *Existing implementations can be slow to adapt and cumbersome.*
- *Investigation of new ion-sources.*
- *Emerging techniques are designed to mitigate these challenges through non-contact sampling, non-contact detection, enhancements in sampling, adapting to emerging threats, and integration with physics-based bulk methods.*
- *Suitability for cargo screening.*
- *Upcoming Concealed Explosives Detection Workshop in Charlottesville, VA, in November. Info is at Concealedexplosivesdetection.org.*

Q: Have any trace instruments with non-radioactive sources been deployed in airports?

A: Most deployments in European airports were non-radioactive last year. Implant Science is deployed at DCA (Reagan Airport).

Q: Is trace the silver bullet?

A: No.

Q: Why not?

A: Certainly not right now. It relies heavily upon sampling. It does not cover all of the emerging threats. It's a secondary signature. It does not look at mass, so there would be a concern about using it as a primary screening method. It does work in a fused system, but you have to use the data appropriately.

Q: What about trace for cargo?

A: Vapor-based methods would work well. You can build up the volume for sampling and move it to the detector fairly easily. Detection limit and dilution doesn't hurt you too much.

Q: What about denial of service issues?

A: That has always been there. You can contaminate a checkpoint, but I haven't seen that happen. In DoD venues, it does happen; munitions going off would leave residue everywhere.

C: Mobility of ETD equipment allows for changes in CONOPS that you can't achieve with larger boxes.

V. NEXT STEPS

Topic/Title: Summary and Next Steps

Speakers: Harry Martz (Lawrence Livermore National Laboratories), Suri-yun Whitehead (Booz Allen Hamilton), and Carl Crawford (Csuptwo, LLC)

Discussion of ADSA16 and next steps. Topics addressed include:

- *ADSA16 criteria for success and opportunities.*
- *Recap on what we heard.*
- *Topics conspicuous by their absence.*

Topic: AIT Prize Competition

Speaker: Laura Parker (DHS S&T)

Discussion of an upcoming AIT prize competition. Topics addressed include:

- *The goal is to develop an improved ATR.*
- *Prize competition will be released in six weeks, with an accompanying dataset.*
- *Secondary dataset will be reserved for scoring.*

VI. CLOSING REMARKS

Speakers: Laura Parker (DHS S&T) and Carl Crawford (Csuptwo, LLC)

Discussion of ADSA. Topics addressed include:

- *ALERT is successful in meeting challenges head on, including:*
  - *How to set up a forum and make an impact in the community. ADSA has grown into a forum for discussion and interchange.*
  - *How to use assets and the group of ALERT to augment the capabilities and capacities of the vendors.*
  - *How to engage third parties.*
  - *How to perform outreach to academia and across the country.*
- *Presenting problems that you can't openly talk about, and translate it for use in the public domain.*
- *Funding of third parties has gained traction and could continue through DHS S&T directly.*
- *Growing the community includes:*

- *Trying to get new groups to come, and continue to broaden beyond the medical imaging community roots.*
- *Subject matter experts to help new groups who really don't know the problems; the learning curve can be so great.*
- *Explaining government funding vehicles, opportunities, and industry days.*
- *Conveying real-world problems in the field to academia.*

- *Maintaining the community includes:*
  - *Always needing to retain X-ray as one of the thrusts. Otherwise, some of the key community members won't attend.*
  - *Relevance is critical as a measure of ROI (return on investment); ALERT relies upon community support to justify to DHS the sustaining of their investment.*

C: I really enjoy ADSA. You can just get up to interrupt. It really is great. Some of the issues would benefit from more information. If the meeting became invite only, we could discuss SSI. We skate around them. It would be good to deep dive. Knowing how many TSOs work at the checkpoint is SSI. That's key to understanding how to improve.

A: Every ADSA we talk about how to get more information out. In this forum, the government has more restrictions on what they can say than many of you. I cannot confirm or deny that sort of information. The issue is when you start saying so-and-so is SSI. The government people just don't engage in that discussion. I released a BAA on the trace side to shake the trees for the art of the possible. You propose what you can do to me, rather than I tell you what I need.

Q: There are 2-3 very important things going on in the current topic. There are topics we didn't even touch.

A: That's why we keep having ADSAs. Sometimes we have had speakers who have discussed specific challenges. Sometimes we have a global view and sometimes we get more focused.

Q: ITF is spending attention on long lines, but it wasn't discussed here. What happens with the security checkpoint? The electronics ban is a big thing. Should hot topics be part of our agenda because we have all of the stakeholders here?

A: We try to balance the longer term against the immediate. Sometimes its timely and sometimes it's better to not be in the immediate.

TSA: TSA already has a model about how many lanes, how many officers, and when we need the lanes. We don't manage lines or queues; these are driven by airlines and airports. Perhaps that's something that they should fund. We don't have any data about what it does to improve throughput. Data pertaining to first class passengers doesn't really translate to general population.

We don't own the queue, so we can't even touch the queue. In Orlando, we can't put in stanchions. We need the model. We know how many officers. We have the staffing model. It's a mathematical model, and it's easy to do. We have lines because people print boarding passes at home. They are going straight to the checkpoint, which changes the arrival curve.

S&T: Thank you for the invitation today. This is a great forum. We don't have this on the customs side. You have universities and operational people. I understand your SSI issue. I'll give you a great story. I asked Stanford "Can you handle SSI?" Their answer was "We don't want to touch SSI of any kind."

A: We have some partners that are comfortable with SSI, and we exercise the right to review before publication.

Q: What happens if one month from now or two months from now, the equipment is not detecting the threats? Say, if we are only detecting at 80%. Do we tell people to fly at your own risk?

A: I asked the airline panel. No way will this ever happen, but it could happen.

Q: From a cost point of view, perfect security would require an infinite amount of money. How do we talk about what we miss, or how do we lock it up?

A: We take for granted a certain amount of risk every time we cross the street. Looking at the history of the last 20 years, what is the risk of a terrorist on an airplane vs. the risk of me dying driving across the country? We are running out of capability. How do we feed into the system when the system is not perfect? How do we design suboptimal systems but still optimize the system?

C: You can have two kinds of airline flights. There is screening like today and then another that has no screening at all. Presumably that would be cheaper. Pay more and come to the airport an hour earlier. See how much of the public would choose the cheaper flight.

C: It's not a poorly understanding that detection is less than unity. DHS is comfortable with that fact because I published it. A real struggle is getting information about PD across different subsystems to the different players.

If you go to Level 2 screening after being prompted at Level 1 screening, it becomes difficult to quantify PD at Level 2. The Inspector General's (IG) report described poor performance in AIT screening during the test events. What if that was really the PD at all times? The number of people who died on 9/11 is far less that the road every year. It's a national trauma, a nation's horror.

C: Trying to quantify risk is impossible. Looking at the 9/11 total, its $580B in actuarial and buildings. You can divide it by the number of casualties and establish a cost per passenger. You can perform a cost benefit analysis as it relates to security, identify the cost of the baseline, of avoidance, a % decrease in risk (as described by likelihood of an attack).

A: I hope we can challenge that assumption. We have to do it.

Q: How do you do this when the airports continually undermine security?

C: There are some great successes at ADSA, such as networking, different viewpoints, and different problems. Mall of America presenting is a great example of this.

C: This could also serve as informal TSA market research and inform strategic planning.

C: People don't do sales pitches. There is good information exchange.

C: It would useful to hear from other components such as the Secret Service and CBP. It would be beneficial to hear from those stakeholders.

ALERT: People are more willing to participate in a panel rather than a talk. There is a give and take with the audience, vs. the individual. You do lose something. It took until ADSA03 for us to understand how to talk to each other. Maybe bring in one or two new parties and introduce them slowly.

C: We look forward to chatting with you from the Coast Guard's perspective, and presenting some of our challenges. We can discuss maritime security concerns. We look forward to the opportunity.

C: We appreciate hearing about the process that TSA goes through, especially tied to the fiscal cycle. More information would be helpful.

C: Invite a TSO to the next ADSA?

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://my-files.neu.edu/groups/ALERT/strategic_studies/ADSA16_Presentations.

16.1 Carl Crawford: Workshop Objectives

Sixteenth Advanced Development for Security Applications
Workshop (ADSA16):

Addressing the Requirement for
Different Stakeholders in Transportation Security

Workshop Objectives

Carl R. Crawford
Csuptwo, LLC

1

So What? Who Cares?

- Competing goals for aviation security
  - Terrorist
    - Still trying to disrupt aviation security, smart adapting adversary
  - Strengthen security
    - More threats, lower mass
  - Increase operational efficiency
    - Reduce costs, labor, footprint, deployment time/effort
  - Improve passenger experience
    - Reduce divesture, wait time
- Still no silver bullets
  - No emerging technologies can satisfy all competing objectives – just incremental improvements
- More problems
  - Long wait times predicted for this summer
  - Possible TSA budget cuts
  - Laptops banned on some international flights
  - Displacement – bomb threats at Jewish community centers and schools, London Parliament
- ADSA16 objectives – finding solutions to problems – examples:
  - Allocate funding differently – scan some people less, some more, spend more on baggage claim
  - Get more performance from existing equipment
    - Marco-security – use additional information – “Google Security,” deterrence ….
  - Balance the competing goals
    - Predict and accept more risk – is terrorism just crime? Accept false negatives?

2

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
- No speaker introductions; read handouts

3

Does solving one problem lead to another?

4

BACKUP SLIDES

5

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

6

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

7

Questionnaire

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

https://www.surveymonkey.com/s/ADSA16

SurveyMonkey.com
because knowledge is everything

8

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

9

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/

10

Acknowledgements

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

11

Logistics

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

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

12

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

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VENDOR PANEL DISCUSSION

14

Vendor Panel Discussion

- What could be done to decrease the time to deploy new technologies?
- What barriers have to be reduced for vendors to increase their own investment in new technologies?
- What can be done to cause vendors to work on long-term, high risk detection systems?
- How should third-parties (e.g., academia, national labs and industry other than the security vendors) be involved in the development of new technologies?

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AIRLINE/AIRPORT PANEL DISCUSSION

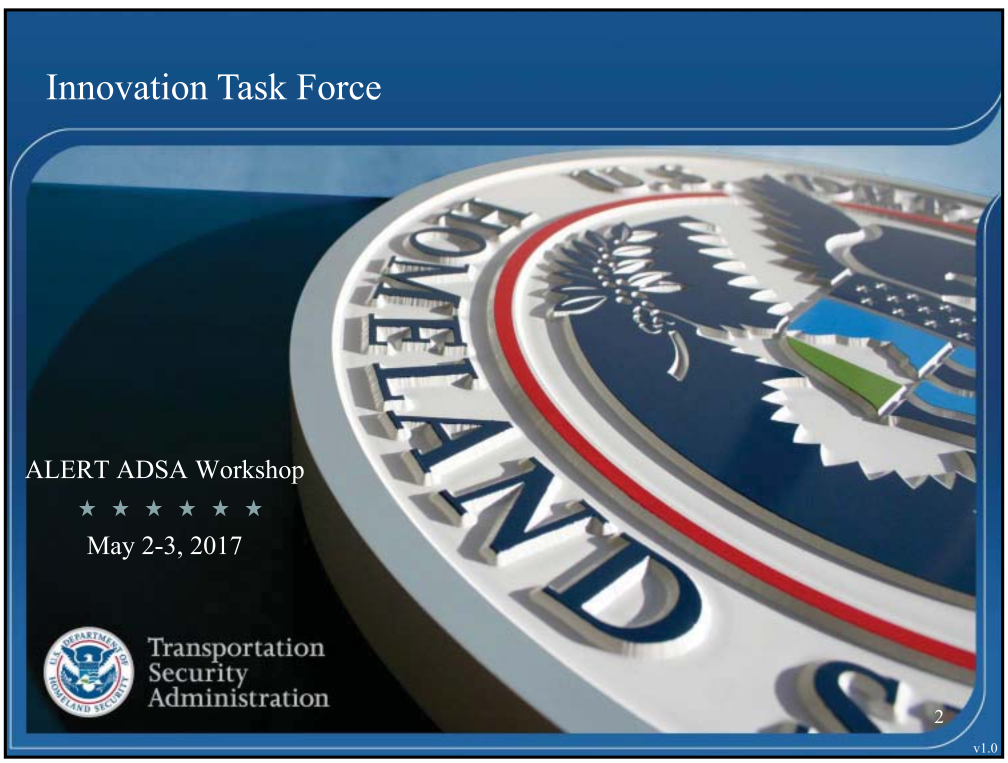
16

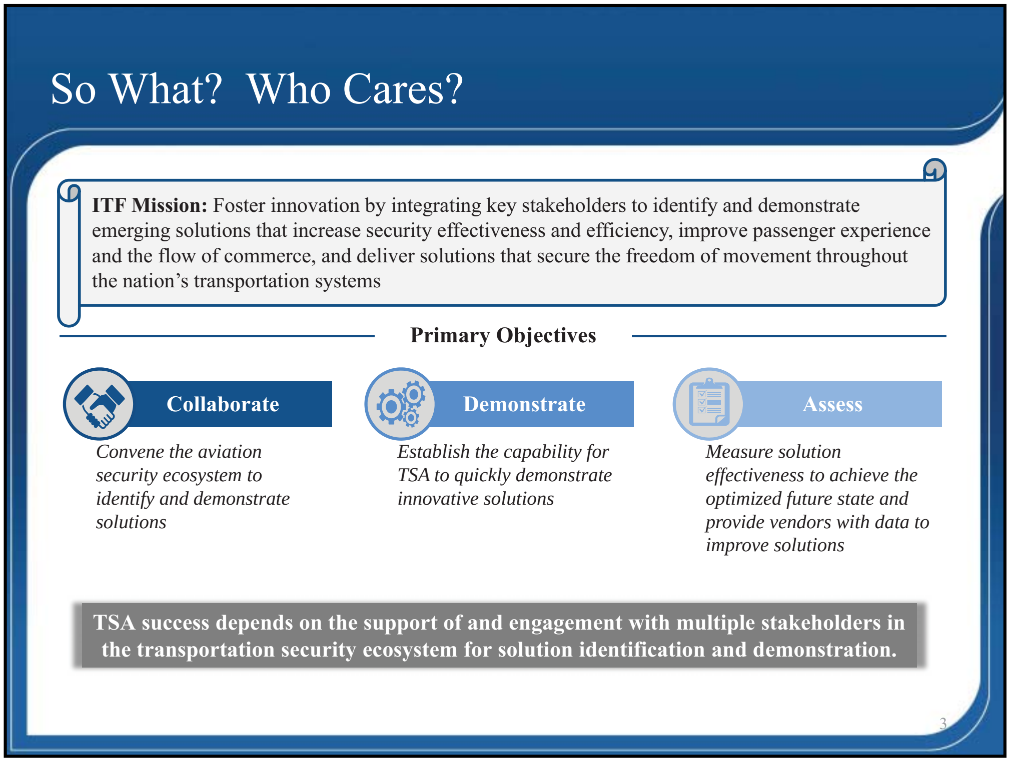
Airline/Airport Panel Discussion

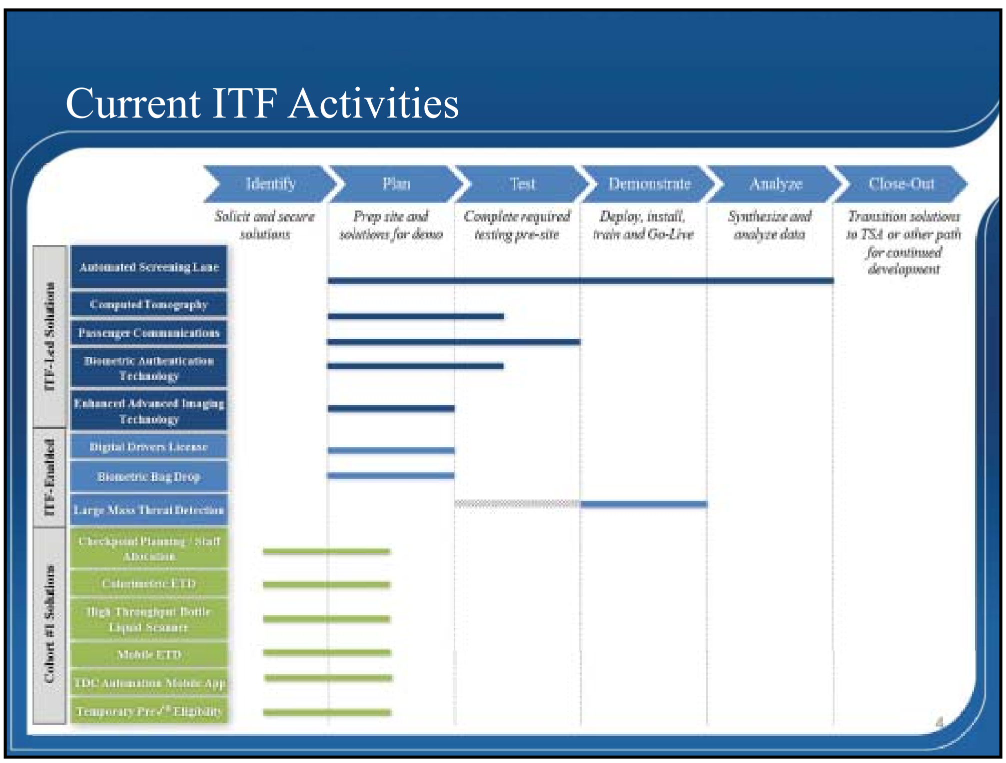
- How to balance competing goals
- Strengthen security
  - More threats, lower mass, smart adapting adversary
- Increase operational efficiency
  - Reduce costs, labor, footprint, deployment time/effort
- Improve passenger experience
  - Reduce divesture, wait times

17

16.2 Mara Winn, Keith Goll, Nick Bianchini, Jeff Quinones, & John Fortune: DHS/TSA Panel




So What? Who Cares?
ITF Mission: Foster innovation by integrating key stakeholders to identify and demonstrate emerging solutions that increase security effectiveness and efficiency, improve passenger experience and the flow of commerce, and deliver solutions that secure the freedom of movement throughout the nation's transportation systems
Primary Objectives
Collaborate
Convene the aviation security ecosystem to identify and demonstrate 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
TSA success depends on the support of and engagement with multiple stakeholders in the transportation security ecosystem for solution identification and demonstration.
3


Current ITF Activities
Identify
Plan
Test
Demonstrate
Analyze
Close-Out
Solicit and secure solutions
Prep site and solutions for demo
Complete required testing pre-site
Deploy, install, train and Go-Live
Synthesize and analyze data
Transition solutions to TSA or other path for continued development
ITF-Led Solutions
Automated Screening Lane
Computed Tomography
Passenger Communications
Biometric Authentication Technology
Enhanced Advanced Imaging Technology
ITF-Enabled
Digital Drivers License
Biometric Bag Drop
Large Mass Threat Detection
Cohort #1 Solutions
Checkpoint Planning / Staff Allocation
Colorimetric ETD
High Throughput Bottle Liquid Scanner
Mobile ETD
TDC Automation Mobile App
Temporary Pre✓® Eligibility
4

Future Solution Identification

As a continuation of innovative solution solicitation, ITF plans to launch its Innovative Demonstrations for Enterprise Advancement (IDEA) Broad Agency Announcement in Spring 2017.

IDEA Purpose

ITF is working with airports and airlines across the nation to identify innovation sites to demonstrate and assess solutions that address the following goals:

- Align to TSA Mission
- Address Capability Gaps
- Enhance Passenger Experience
- Improve Screening Efficiency
- Improve Security Effectiveness

Solution Categories

ITF has identified six submission categories for solutions under IDEA. These categories highlight specific areas of interest for TSA and will be used for the purposes of organization and evaluation. Vendors will be asked to submit a solution to a single category.

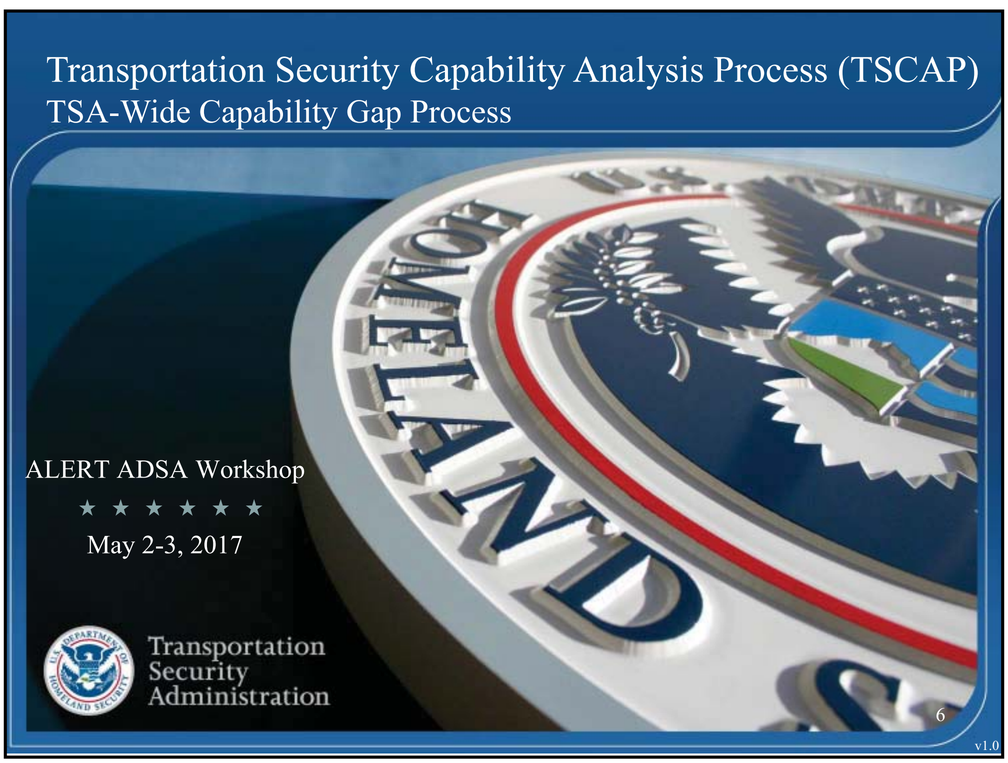
- Mobile Screening
- Security Design
- Queueing and Passenger Flow
- Training, Development, and Performance
- New Detection Capabilities
- General Submissions

Solution Selection

Solutions will be reviewed by various TSA stakeholders against the following criteria:

- **Vendor Capabilities**: Vendor's capabilities and related experience
- **Feasibility**: Feasibility of demonstrating the proposed solution in a live airport/operational environment within six months of submission
- **Funding**: Reasonableness of any funding requested and/or feasibility of lifecycle costs required for solution implementation
- **Mission Alignment**: Importance, relevance, and timeliness of technical approach to TSA's mission
- **Solution Impact**: Ability to address capability gaps, improve efficiency, or improve the passenger experience

5



So What, Who Cares?

The Transportation Security Capability Analysis Process (TSCAP) is used by the TSA Office of Requirements and Capabilities Analysis (ORCA) to identify TSA's needs, support better decision making, and recommend security solutions.

Process

1 Capability Gap Process — Establish TSCAP Baseline → Identify & Prioritize Cap Gaps

2 Case Study Process — Develop Baseline → Mitigation Options → Analysis → Handoff to Program Office

1 Capability Gap Process

Examine measurable performance factors (e.g., throughput rates, system detection) against Department and Agency legislative authorities and strategic plans.

2 Case Study Process

Complete a deep dive analysis into a capability gap(s) and identify alternatives to close the gap. Select appropriate alternatives to pursue R&D investments / new acquisition programs.

Evaluation Criteria

Industry and Academia Applicability

TSCAP allows TSA to document the applicability of new and emerging solutions to different capability gaps to justify investment from DHS. Initial TSCAP capability gaps have been made public in an un-prioritized list in the TSA Strategic Five Year Plan and can be used to guide research and development.

Impact of TSCAP

In the past, TSCAP has been used to justify investment decisions in checkpoint and checked baggage programs. TSCAP is expanding to include mission essential capability identification across the enterprise as TSA moves to inform investment decisions aligned to JRIMS, a DHS-wide process focused in mitigation of capability gaps.

Purpose

TSCAP provides a **structured, repeatable** and **transparent** process that strengthens TSA's ability to establish enterprise level capability gaps. Key elements of TSCAP include:

1. **What is the problem:** Establish the capability gap
2. **Why we need to solve it:** Establish the risk of the gap
3. **How we can solve it:** Document Courses of Action

Traceability

The TSCAP process identifies TSA capability gaps in meeting the TSA desired state. These gaps should identify:

1. Differences between current state and desired state;
2. Identify all of the current efforts underway to address the gap(s);
3. Relationship of gaps/current efforts;
4. The risk(s) associated with each gap.

Benefits

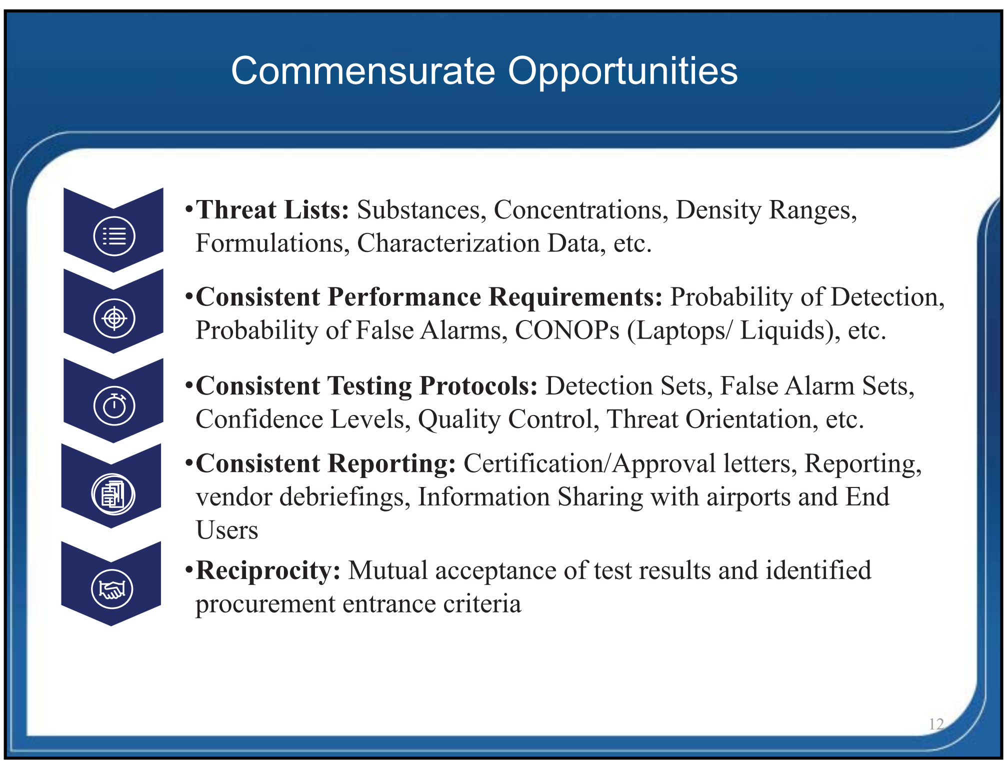
- A comprehensive view of essential capabilities needed to perform TSA's mission
- An understanding of capability gaps that impact multiple offices
- The ability to make prioritized decisions
- A rationale for potential GAO/OIG audits
- Well-documented justification for establishing and funding programs

Aviation Security Commensurate Levels of Security Screening Capabilities

1. **Increases Security Effectiveness**: Improvements to the global aviation security baseline by raising minimum system performance levels to more effectively and efficiently mitigate threats to transportation in the US and abroad
2. **Original Equipment Manufacturers (OEM) Efficiencies**: Reduces industry development timelines and costs by focusing limited resources on a common set of global market requirements
3. **Drives Innovation**: Incentivizes OEMs to become more innovative to distinguish product lines from competition (i.e. larger threat libraries, increase sensitivity, lower operating costs and increase reliability)
4. **Manage Unknowns:** Reduces the number of unknowns to foster better risk picture while eliminating questions surrounding the difference between US/EU security measures
5. **Increases Industry Vitality**: Enables Industry to deliver products to an expanded international global aviation market
6. **Reduces Test Burden**: Commensurate detection standards and testing methodologies to potentially reduce demands on US/EU test centers through reciprocity and limiting assessments to unique requirements

10


Technology Work Streams
Current Technologies
Explosive Trace Detection
Enhanced Metal Detectors
Advanced Imaging Technology/ Security Scanners
Advanced Technology/ Explosive Detection Scanners for Cabin Baggage (EDSCB)
Explosive Detection Systems
Bottled Liquid Scanners/ Liquid Explosive Detection Systems (LEDS)
Future Technologies
?
Explosive Vapor Detection
?
Shoe Detection
11


Commensurate Opportunities
•Threat Lists: Substances, Concentrations, Density Ranges, Formulations, Characterization Data, etc.
•Consistent Performance Requirements: Probability of Detection, Probability of False Alarms, CONOPs (Laptops/ Liquids), etc.
•Consistent Testing Protocols: Detection Sets, False Alarm Sets, Confidence Levels, Quality Control, Threat Orientation, etc.
•Consistent Reporting: Certification/Approval letters, Reporting, vendor debriefings, Information Sharing with airports and End Users
•Reciprocity: Mutual acceptance of test results and identified procurement entrance criteria
12

Next Steps

- Collaboration with key EU Member States on new aviation screening technology capabilities in the US and abroad
- Collaboration with ECAC through the Technical Taskforce and Technology Study Groups on threat lists, threat masses, and common testing methodologies
- Work with EC, ECAC and EU Member States to expand TSA/EU databases of international classified detection standards, common testing methodologies, and test data (level 1, 2, 3 reports)
- Strengthen collaboration with EU industry representatives (ACI Europe/ EOS) to drive innovative screening solutions and help predict market and revenue streams
- Expanded focus on leveraging information sharing agreements with ASIA, Middle East, and Western Hemisphere partners to continue supporting next generation solutions
- Host and participate in US/EU test center exchanges to instill great consistency in testing methodologies and common evaluation process

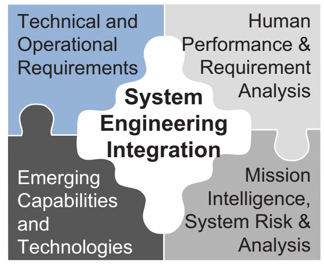
13

So What, Who Cares?

ORCA System Engineers are responsible for executing system level engineering at all technology readiness levels, integrating mission intelligence, risk, and human factors analysis, ORCA System Engineers are responsible generating robust requirements and capability analysis that close capability gaps and advance the overall security capabilities for the Transportation Security Administration

Technology Portfolios
- Translates user needs into technical requirements
- Evaluates current and emerging technologies and associated security capabilities

System Architecture
- Proactively define targeted screening capabilities at a system level and ultimately enable an integrated, interoperable, and modularized security screening system



Human Factors
- Provides user input to translate into technical requirements and performance improvements
- Reduce operational complexity of security technology and processes and gathers end-user input and feedback

System Risk and Analysis
- Improve understanding of adversary characteristics and preferences; conduct risk analysis of various populations to inform leadership decisions and operations; model adversary assumptions and development

ORCA Requirements and System Engineering Partners & Resources

- Office of Acquisitions and Program Management (**OAPM**)
- Office of Contracting and Procurement (**OCP**)
- Office of Global Strategy (**OGS**)
- Office of Intelligence & Analyses (**OIA**)
- Office of Information Technology (**OIT**)
- Office of Training & Development (**OTD**)
- Office of Inspection (**OOI**)
- Office of Security Operations (**OSO**)
- **ORCA Divisions:** to include Intermodal, Innovation Task Force, System Architecture, System Risk and Analysis, Operations and Improvement
- Office of Chief Risk Officer (**OCRO**)
- OAPM Test & Evaluation
- **External Partners:** DHS S&T, TSL, TSIF, TRMG, National Labs, CBP. USSS, DHS Centers of Excellences, Foreign Delegations & Government regulators, and DOE Labs

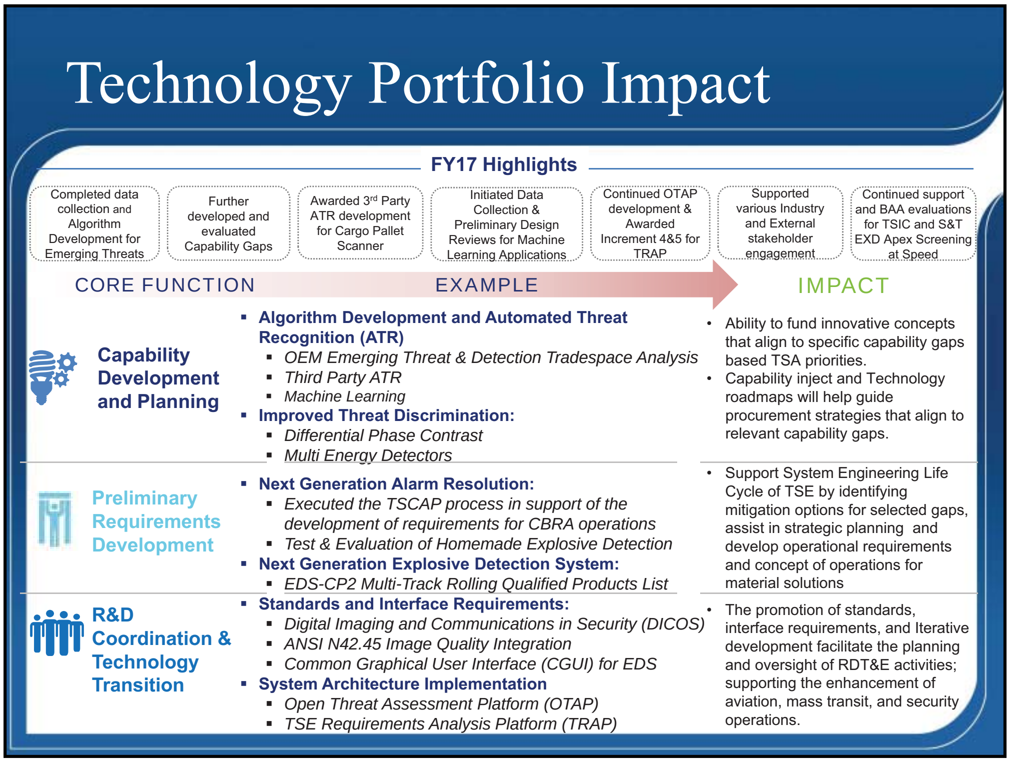
Technology Development Process

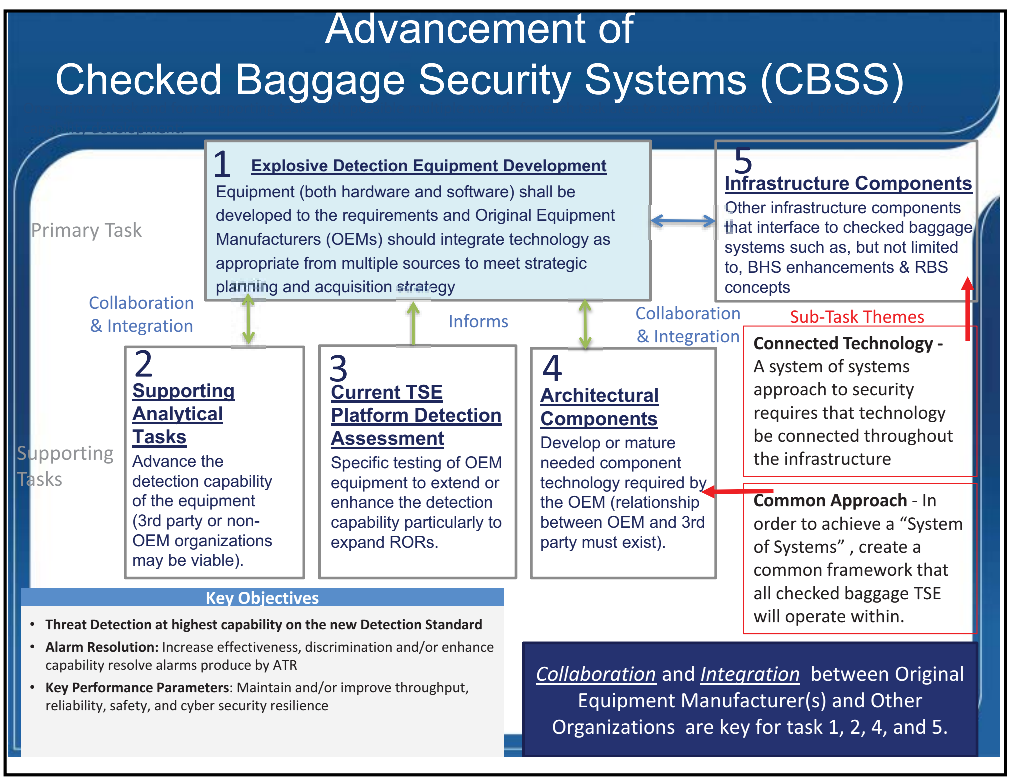
TSA's approach to achieving transformational improvements in passenger and checked baggage screening is centered on collaboration with S&T, academic and commercial R&D partners, and the existing vendor community.

	Scientific Research TRL 1 - 3			Technology Development TRL 4 - 6			Product Development TRL 7 - 9		
Technology Readiness Level (TRL)	TRL1	TRL2	TRL3	TRL4	TRL5	TRL6	TRL7	TRL8	TRL9
Key Objectives / Deliverables	Basic principles observed and reported	Technology concept and/or application formulated	Analytical and experimental critical function and/or characteristic proof of concept	Component and/or breadboard validation in a laboratory environment	Component and/or breadboard validation in a relevant environment	System/subsystem model or prototype demonstration in a relevant environment	System prototype demonstration in an operational environment	Actual system completed and qualified through test and demonstration	Actual system proven through successful mission operations
Managing Entity		DHS S&T				TSA ORCA		TSA OAPM	

Focus Areas

- **Capability Development & Planning:** *Provides system level engineering analysis, establishes holistic system architecture definition, and identifies innovative security concepts through the various acquisition strategies, Broad Agency Announcements, and Interagency Partners that can that can be applied to support TSA's mission.*
- **Preliminary Requirements Development:** *Conducts capability gap analysis and modeling and simulation to develop data-backed preliminary reports in support of the AD 102 process to include Detection Standards, p-MNS, high-level CONOPS, system-level analysis of alternatives, and unconstrained Operational Requirements Documents (ORD).*
- **R&D Coordination & Technology Transition:** *Works with Interagency & Foreign Partners, DHS S&T, OEMs, and ORCA Divisions and OAPM Programs to align user needs to technical requirements development. Also, engages industry and attends industry conferences (ALERT, ACC, ADSA, etc.).*


Technology Portfolio Impact
FY17 Highlights
Completed data collection and Algorithm Development for Emerging Threats
Further developed and evaluated Capability Gaps
Awarded 3rd Party ATR development for Cargo Pallet Scanner
Initiated Data Collection & Preliminary Design Reviews for Machine Learning Applications
Continued OTAP development & Awarded Increment 4&5 for TRAP
Supported various Industry and External stakeholder engagement
Continued support and BAA evaluations for TSIC and S&T EXD Apex Screening at Speed
CORE FUNCTION
EXAMPLE
IMPACT
Capability Development and Planning
Algorithm Development and Automated Threat Recognition (ATR)
OEM Emerging Threat & Detection Tradespace Analysis
Third Party ATR
Machine Learning
Improved Threat Discrimination:
Differential Phase Contrast
Multi Energy Detectors
Ability to fund innovative concepts that align to specific capability gaps based TSA priorities.
Capability inject and Technology roadmaps will help guide procurement strategies that align to relevant capability gaps.
Preliminary Requirements Development
Next Generation Alarm Resolution:
Executed the TSCAP process in support of the development of requirements for CBRA operations
Test & Evaluation of Homemade Explosive Detection
Next Generation Explosive Detection System:
EDS-CP2 Multi-Track Rolling Qualified Products List
Support System Engineering Life Cycle of TSE by identifying mitigation options for selected gaps, assist in strategic planning and develop operational requirements and concept of operations for material solutions
R&D Coordination & Technology Transition
Standards and Interface Requirements:
Digital Imaging and Communications in Security (DICOS)
ANSI N42.45 Image Quality Integration
Common Graphical User Interface (CGUI) for EDS
System Architecture Implementation
Open Threat Assessment Platform (OTAP)
TSE Requirements Analysis Platform (TRAP)
The promotion of standards, interface requirements, and Iterative development facilitate the planning and oversight of RDT&E activities; supporting the enhancement of aviation, mass transit, and security operations.


Advancement of
Checked Baggage Security Systems (CBSS)
Primary Task
1 Explosive Detection Equipment Development
Equipment (both hardware and software) shall be developed to the requirements and Original Equipment Manufacturers (OEMs) should integrate technology as appropriate from multiple sources to meet strategic planning and acquisition strategy
5 Infrastructure Components
Other infrastructure components that interface to checked baggage systems such as, but not limited to, BHS enhancements & RBS concepts
Collaboration & Integration
Informs
Collaboration & Integration
Sub-Task Themes
Supporting Tasks
2 Supporting Analytical Tasks
Advance the detection capability of the equipment (3rd party or non-OEM organizations may be viable).
3 Current TSE Platform Detection Assessment
Specific testing of OEM equipment to extend or enhance the detection capability particularly to expand RORs.
4 Architectural Components
Develop or mature needed component technology required by the OEM (relationship between OEM and 3rd party must exist).
Connected Technology - A system of systems approach to security requires that technology be connected throughout the infrastructure
Common Approach - In order to achieve a "System of Systems", create a common framework that all checked baggage TSE will operate within.
Key Objectives
Threat Detection at highest capability on the new Detection Standard
Alarm Resolution: Increase effectiveness, discrimination and/or enhance capability resolve alarms produce by ATR
Key Performance Parameters: Maintain and/or improve throughput, reliability, safety, and cyber security resilience
Collaboration and Integration between Original Equipment Manufacturer(s) and Other Organizations are key for task 1, 2, 4, and 5.

16.3 Tim Smith: Security Technology Integrated Program (STIP) Cybersecurity

Security Technology Integrated Program (STIP) Cybersecurity

May 2017

Transportation Security Administration

Office of ACQUISITION Program Management

Disclaimer

This is not a Q&A for DOMAIN

Search HSTS04-17-I-STAD01 on the FBO website

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Transportation Security Administration

Office of ACQUISITION Program Management

2

TSE Cybersecurity Requirements
(End-points)

TSA identified nine (9) IT security requirements to enforce cybersecurity compliance of legacy TSE. Future TSE must comply with all apporiate requirements prior to reconnecting to STIP. Monitoring/scanning will be automated in the future.

OS Currency/Security Patching	• All TSE operating systems (OS) shall be patched to current OS vendor-supported versions when first delivered. Patches will be updated every 30 days. For critical vulnerabilities, the Original Equipment Manufacturer (OEM) will patch per the prescribed time window as determined on a case by case basis.
OS Hardening	• All TSE shall be compliant with the approved DHS Hardening Guidelines for the platform on which they are being developed.
AV Updates	• TSE shall include TSA-approved anti-virus (AV) software configured to receive digitally signed automatic AV virus definition file updates remotely.
PIV Compatibility	• All privileged TSE users shall be vetted by TSA's Personnel Security Division and audited by IAD annually. Privileged users shall use Personal Identity Verification (PIV) cards issued by TSA to access the TSE. Vendors will be required to make their TSE compatible with TSA-issued PIV.
Security Scanning Support	• In support of OAPM's efforts to ensure devices are compliant with all IT Security requirements, TSE will be assessed and scanned by the OIT IAD. OEM technicians to be on-site as necessary to provide access to the TSE.
Technical Obsolescence	• All TSE contracts shall include technical obsolescence clauses that mandate the upgrade and/or replacement of any software or hardware components that are considered to be Configuration Items that are no longer actively supported by the manufacturer.
SOC Monitoring	• All TSE endpoints shall be monitored by the TSA Security Operations Center (SOC). TSE shall include TSA-approved Continuous Diagnostics and Mitigation (CDM) software configured enable SOC monitoring.
POA&M Support	• Upon completion of security scans, findings will be documented and categorized as high, medium, or low based on their potential impact to the TSE IT Security posture. OEMs will support the remediation of open Plan of Action and Milestones (POA&M) items in a timely manner.
Vendor ISSO Designation	• If TSA has procured Full-Rate Production (FRP) TSE from an OEM, then the OEM will be required to have a designated Information Systems Security Officer (ISSO) to coordinate with OAPM ISSOs on IT Security issues.

Transportation Security Administration

OAPM has stood up a Cybersecurity Integrated Project Team (IPT) with OIT and OAPM to address cybersecurity concerns and challenges

Office of ACQUISITION Program Management

3

Path Forward

Enhance Network Security

Provide secure TSE communication across the network.

Enhance Endpoint Security

Provide additional security at the endpoint.

Cyber IPT

Translation of NIST Standards to Acquisition Language

Process/Procedures for tracking and reporting on compliance

Transportation Security Administration

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4

Questions

1. **How real are cyber threats?**

Response: Cyber threats are very real! Especially if TSEs are considered as another class of Internet of Things (IoTs). Attacks against IoTs are now more pervasive and sometimes, massively successful, that can turn these devices into bots used to launch other types of attacks such as DDOS (Mirai botnets come to mind). If TSEs are ever put on a network that have little to no security controls in place, there is a high likelihood that these devices will get compromised. Also remember that even in its unconnected state, infection from USB thumb drives plugged into it is a risk and a viable attack vector as well. Remember STUXNet? The other factor that contributes to the realism of cyber threats is the amount of open source malicious information available on the internet. Any person can conduct a Google search to find entire libraries of malicious code as well as "how to" guides all free for download to exploit IoTs and unsecured networks.

2. **What is the impact of a cyber attack?**

Response The impact of a cyber-attack on TSE's could range from frustrating to catastrophic. We have spent some time considering various "nightmare scenarios" that could arise from a successful attack on TSE's. These scenarios include

- Injection of "clean" scan results on a bag containing dangerous weapons/explosive materials
- Injection of "dirty" scan results on a "clean" bag/item to slow a checkpoint.
- Injection of "dirty" scan results on all "clean" bags/items to shut down entire checkpoints/airports.
- Theft of scanning parameters to reverse engineering current capabilities and create mechanisms to escape detection.

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Questions

3. **What can be done to protect TSE, but not by hardening the TSE itself? E.g., removing TSE from networks or using private networks?**

Response A few suggestions:

- TSEs should be on a dedicated purpose built network with device access controls and highly secured, locked down and tightly controlled gateways connecting back to TSA
- Block unneeded ports and monitor ALL traffic to and from the TSEs
- Have a patching plan in place and regularly patch all TSEs
- Create strong authentication for all TSEs that need to communicate to other TSA systems and devices outside of its dedicated network

4. **Can TSE be safe if it is connected to a TSA or public networks?**

Response No. Not in our opinion.

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6

16.4 Max Abrahms: Yes, We Can Now Predict Terrorist Targets

Northeastern University

Max Abrahms

YES, WE CAN NOW PREDICT TERRORIST TARGETS

Northeastern University

Takeaways

1. There's wide variation in which targets terrorists attack.
2. But terrorist targeting choices are not random.
3. Only certain terrorist groups threaten civilian targets.
4. Terrorist groups with weaker leaders are most likely to attack civilian targets.
5. Knowing which kinds of terrorists are inclined to attack which targets can help us focus on relevant threats.

16.5 Matthew Merzbacher: Macro Security

Macro Security

Overview

- Big advances in detection are increasingly rare
  - Perhaps no longer possible
  - Even if possible, take a long time to enable
- Current situation is not sustainable
  - Passenger volumes continue to rise
  - Passenger expectations continue to rise
  - Terrorists haven't given up and change tactics
  - Budgets are under scrutiny
- What can we do?
  - Look at the bigger (macro) picture!

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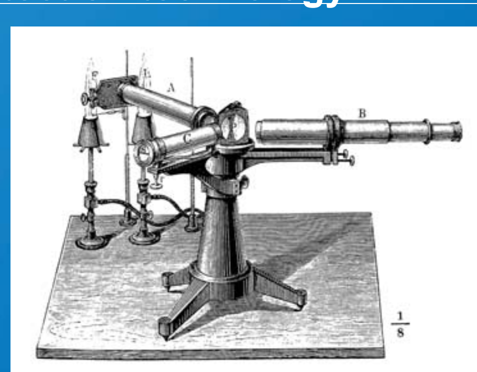
Macro Security

Hypothetical Premise:
<u>No more big leaps in detection technology</u>

- Why?
  - None available
  - No need
  - Cost
  - Bad timing
- Does this matter?
  - To security industry
  - To aviation industry
  - To academia
  - To public
  - To regulators
  - To politicians



- Can we draw general conclusions about whether it matters to each of these groups?
- **What big security improvements can be achieved if there are no technological silver bullets (or even lead bullets) left, and how do we achieve them?**
  - Oh, and what if the premise is wrong?

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Macro Security

Macro Security

- <u>End-to-end</u> architecture to capture the security process from ticket purchase to arrival at final destination
  - Passenger info (Meta-Data)
  - Threat info
    - Rapid change & deployment
  - ConOps (including screener)
  - Updated hardware and, more importantly, software
    - Support both transformational and incremental changes
  - Performance Model for decision making
    - Connects policy and implementation
  - Assessment & Reporting
  - Testing
  - Validation of all components
    - Including Data and Meta-Data
  - Enable and practice regular gap analysis

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Macro Security

Some examples

- Manage threat envelope upward, downward, sideways
  - Remove / Replace / Add material
  - Increase / Decrease mass thresholds
  - Change detection expectations
  - Allow holes, argue about the size and location of the holes
- Increase use of meta-data to clear more passengers
  - How many times do I need to fly before I'm accepted as "safe"?
  - How many times do I need to be cleared?
  - How about my Mom?
  - Is screening me (or my Mom) effective use of funds?

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Macro Security

More examples

- Replace screener with algorithm
- Less rigid ConOps
- Deterrence
  - Randomized tactics (Algorithms / Devices / ConOps)
- Passenger green teams
- Predict (through meta-data) what a passenger is carrying, so that the problem becomes quick look validation instead of generalized detection
- Identify "creative" ways to extend existing tools (possibly locally sub-optimally)
- Revise testing methodologies
- Ban luggage (or send through alternate means)

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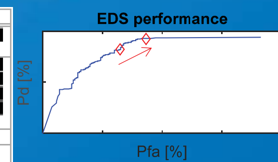
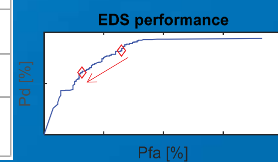
Macro Security

One more example

- Use Risk to manage decision

Sensor/Action	Characteristics
Passenger Classification (Low/High)	P(High Threat Class Assigned|Threat Passenger) = [redacted] P(High Threat Class Assigned|No Threat Passenger) = [redacted]
Passenger Classification (Low/Mid/High)	P(High Threat Class Assigned|Threat Passenger) = [redacted] P(High Threat Class Assigned|No Threat Passenger) = [redacted] P(Med Threat Class Assigned|Threat Passenger) = [redacted] P(Med Threat Class Assigned|No Threat Passenger) = [redacted]
Attack Prior	P_0(Threat) = [redacted]
Level 2 (OSR)	PD = [redacted] PF = [redacted] $/bag = [redacted]
Level 3 (ETD)	PD = [redacted] PF = [redacted] $/bag = [redacted]
Post-Level 3 Inspection	PD = [redacted] PF = [redacted] $/bag = [redacted]
Clearing a Bag	PD = [redacted] PF = [redacted] $/bag (Stream of Commerce) = [redacted] $/bag (Threat) = [redacted]





Risk-Based Screening Architecture with Partially Observable Markov Decision Process (POMPD)

DHS, S&T Directorate, Explosives Division, Contract HSHQDC-14-C-B0042 (BAA 1305)

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Macro Security

Where can we focus?

- Everyone wants sufficient detection
- If we have sufficient detection, why bother improving?
  - Gaps will surface
  - Things change
  - The status quo may not be sustainable
  - “Sufficient” could vary by situation
- What else is needed, beyond detection?
  - Passengers: Quicker and more seamless experience, Understanding of the tactical process
  - Regulator/Operator: Lower cost (overall and per PAX), Understanding of the strategic process
  - Industry: Continued opportunities, Low-overhead processes
  - Academia: Problems to be solved, Transition partners
- Macro Security: Extend the solution domain to enable transformational change

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Macro Security

Requirements

- Acceptance that security is not perfect
    - Public
    - Politicians
- Model to sustain makers of boxes and/or brains
- Language to describe problems and support collaboration
- Get it right
    - Or at least, don't get it wrong
- **Need a Hippocratic Oath for Security**

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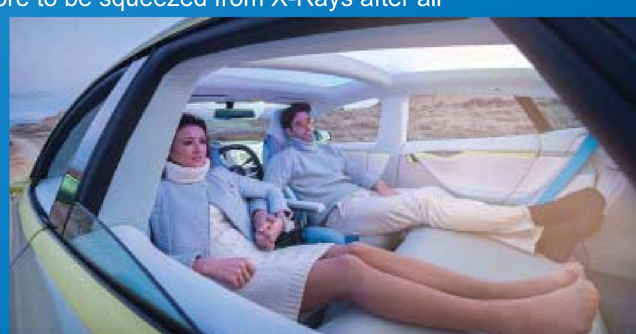
Macro Security

A thought that had no better place

- Can we learn from self-driving cars?
    - Question: Will we see self-driving cars during our lifetime?
    - Meta-Question: Has your answer to that changed in the past five years?
    - How will Google make money?
    - Maybe there's more to be squeezed from X-Rays after all



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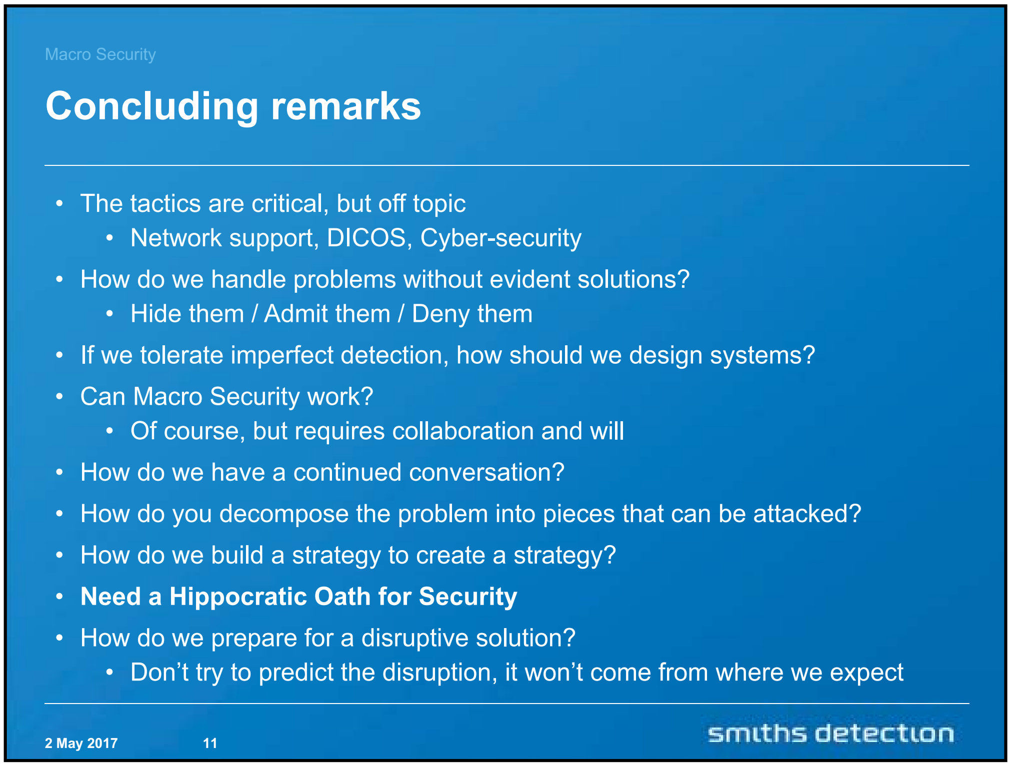
Macro Security
Concluding remarks
• The tactics are critical, but off topic
• Network support, DICOS, Cyber-security
• How do we handle problems without evident solutions?
• Hide them / Admit them / Deny them
• If we tolerate imperfect detection, how should we design systems?
• Can Macro Security work?
• Of course, but requires collaboration and will
• How do we have a continued conversation?
• How do you decompose the problem into pieces that can be attacked?
• How do we build a strategy to create a strategy?
• Need a Hippocratic Oath for Security
• How do we prepare for a disruptive solution?
• Don’t try to predict the disruption, it won’t come from where we expect
2 May 2017
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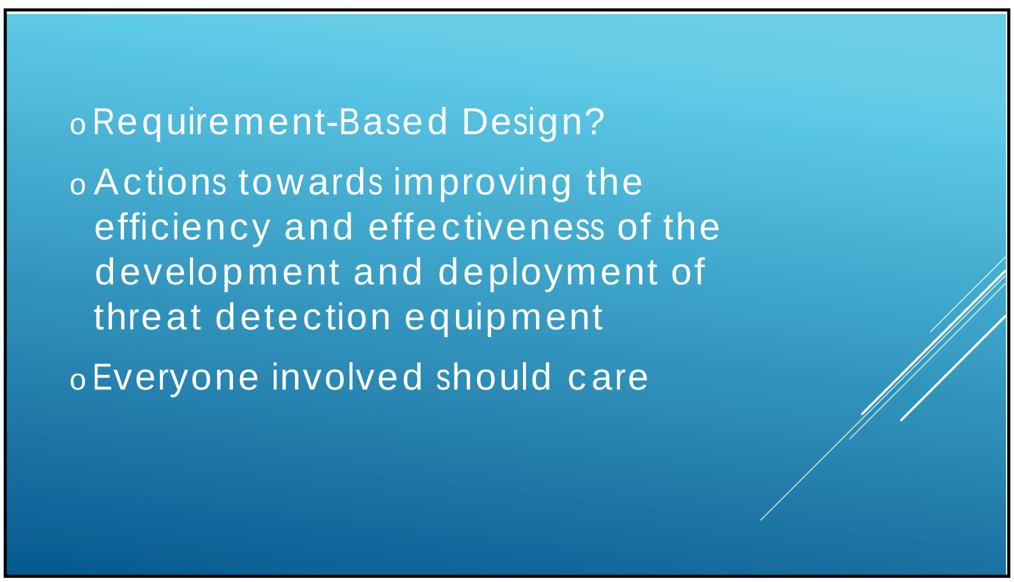
16.6 Bernard M. Gordon: Requirement-Based Design?

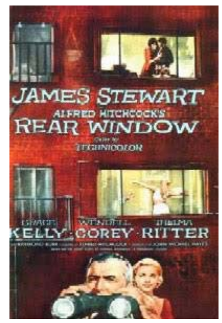


16.7 Pierfancesco Landolfi: A Look From The Outside

A Look From The Outside

ADSA16, Northeastern University

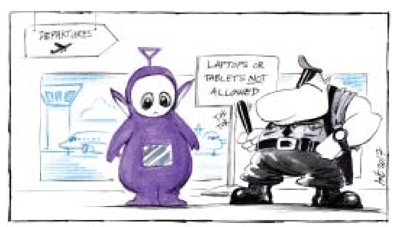
05/02/2017



Pierfancesco Landolfi
Director Technical Operations, Tesla Inc.
plandolfi@tesla.com

The Inside Looks Still The Same

- In the seven long months since I left the industry the problems have not changed
  - The adversary is motivated capable and adaptable
  - "…we know that would be the Super Bowl for the terrorists, to knock down an airplane in flight, particularly if it was full of Americans" (John Kelly at Face the Nation)
  - Resources for the good guys keep being limited (2018 TSA budget likely less than 2017)
- We must be able to qualify and deploy new technologies faster



Some Reflections From The Outside

- We have lost track of the mission: the OEMs are not the enemy
  - Most of them want to do a great job
  - It is not fun to get a call from an airport at 4 AM in California!
- There is a diminishing return by spending more time on lab testing

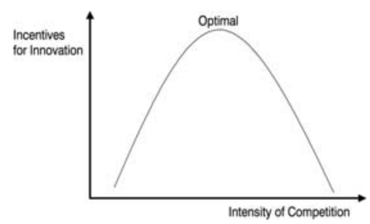
Can we accelerate the rate of innovation by learning to be faster to deploy and fix issues when they appear?

Some Ideas From The Outside

- OEMs: Massively invest on automation to reduce test time and to test edge conditions: it really pays off
- TSA: allow remote connections to deployed systems
  - Quick deployment of SW updates
  - Data gathered can drive significant increase in reliability and availability and speed up algorithm development
- Both: develop a software architecture to mitigate operational risks
  - SW to run in “Shadow” mode
  - Capability to seamlessly revert to older SW version if needed (common IT practice).

And Then …

- Once testing of new technologies is streamlined many good things will happen:
  - Lower barrier to entry for other players, which means somewhat more competition
  - More resources spent on value added efforts…by everybody!
  - OEMs enabled and incentivized to invest in R&D and long term projects
  - Partnerships with third parties becomes a need to stay competitive
    - Government role should be to fund these smaller players and then let the market play out



P. Aghion et. Al., Oxford Journals, 2005

16.8 Matthew Merzbacher: Vendor Perspectives – II Panel

Vendor Panel -- Merzbacher

Some Ideas

- Reducing Deployment Time
  - Fail faster
- Eliminating Barriers
  - General IP License (or set of licenses)
- Encouraging Long-Term High-Risk Development
  - Create a long-term funding pipeline
  - Involve industry in assessment of early academic research
- Third Parties
  - Use as augment, not replacement

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16.9 Shiva Kumar: Vendor Perspectives – II Panel

- What could be done to decrease the time to deploy new technologies?
  - In the USA, with ITF (Innovation Task Force) it is a great start
  - In EU and ROW, Innovation leading to faster adoption operationally is happening at the airports
  - Reduce the certification process timeline/window and Operational Test & Evaluation
  - Is there an opportunity to look at model similar to EU, where you have multiple facilities?
  - Another area that requires additional attention is the process between cert and Operational Test and Evaluation due to gaps between what gets certified and what happens in the real world primarily as it relates to false alarms.
- What barriers have to be reduced for vendors to increase their own investment in new technologies?
  - Better alignment of R&D road maps between government and industry
  - It would be good to get up front commitment from the government to procure prototype for further evaluation and testing upon vendor successfully meeting certain requirements
  - Giving individual US airports greater say in procurement would allow industry to develop better solutions on a global scale.
  - It is difficult to have innovation in the deployment side in the US because of the need to standardize across all the airports.
- What can be done to cause vendors to work on long-term, high risk detection systems?
  - Government encouragement, interest and commitment through funding is always great
  - There are partnerships already in place with National Labs and Universities to explore newer technologies and techniques like OTAP and Deep Learning
  - Continue to foster and grow these partnership with labs, academia and industry
  - Create incentives for companies to meet specific detection standards beyond procurement of systems.
- How should third-parties (e.g., academia, national labs and industry other than the security vendors) be involved in the development of new technologies?
  - Look at 3rd party entities doing pre-TSL work prior to going to TSL
  - Getting labs and academia involved in technology evaluation long before a system gets that far would be useful.
  - As industry we are always interested in licensing technologies from national labs and academia as well as looking at promising products/technologies from industry to incorporate into our product portfolio

16.10 Kristofer Roe: Vendor Perspectives – II Panel

Vendor Perspectives
Dr. Kristofer Roe
Smiths Detection

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Question Topics

What could be done to decrease the time to deploy new technologies?

Focus first generation requirements on key mission critical functionality with weighted specifications

Greater acceptance of third party data including other testing organizations

What barriers have to be reduced for vendors to increase their own investment in new technologies?

Longer term strategic discussions; Need to strike a balance of support of current and next-generation

What can be done to cause vendors to work on long-term, high risk detection systems?

We do. Mitigation depends on the risk (monetary, resource limit, not clear requirements)

How should third-parties (e.g., academia, national labs and industry other than the security vendors) be involved in the development of new technologies?

Defined problems that provide benefit to both parties

Simplified contracting models? Eliminate delays due to contract terms and SSI/IP issues

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16.11 Joseph Paresi: Response to Questions on Challenges in Deploying Security Technologies

IDSS
Integrated Defense & Security Solutions

Response to Questions on Challenges in Deploying Security Technologies

Joseph Paresi

2 May 2017

TSA Qualification Process – Simple Version

IDSS
Integrated Defense & Security Solutions

1. What could be done to decrease the time to deploy new technologies? ***Look at ways to perform more of the validation and testing efforts in parallel. Early system fieldlings will identify the problems that cannot be uncovered in lab testing and should be expanded as feasible. The ITF is a big step towards expediting the process.***

2. What barriers have to be reduced for vendors to increase their own investment in new technologies? ***Defined Plan for Orders if Certain Milestones are Achieved. (i.e., Concept – Development – Test – LRIP at a minimum). Implement a DoD-type model for requirements and system developments with a Production Plan.***

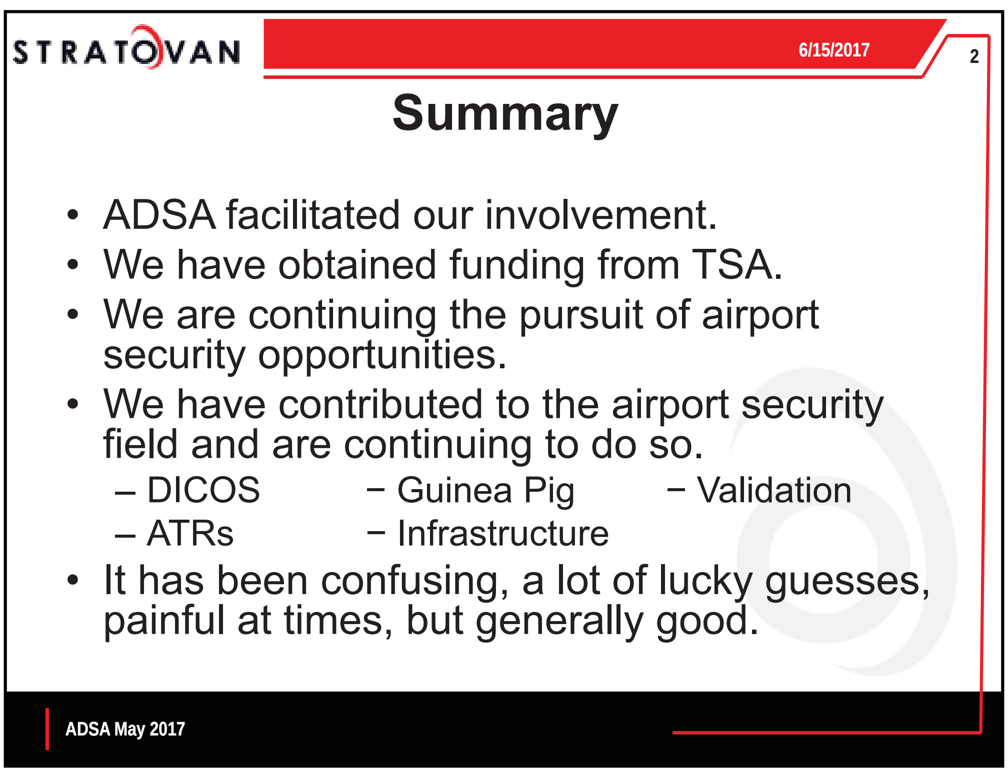
Obtain Certification against Threats within FAR Limit → *Obtain Compliance Approval with Operational Requirements* → *Perform Operational Testing at Airports* → TSA Orders!

Other Areas of Consideration

3. What can be done to cause vendors to work on long-term, high risk detection systems?
Joint DHS Funding and Defined Plan for Orders. Businesses will invest if they have a path to sales and development programs are only a path to sales orders

4. How should third-parties (e.g., academia, national labs and industry other than the security vendors) be involved in the development of new technologies?
For new Solutions, this is easier, such as a University or Lab solution to address Body Scanning which then needs to be productionized by a supplier (e.g., PNNL/ProVision). DHS Funding of Third Parties and Integration into systems can a positive benefits. Third Parties offer new ideas and approaches. But a clear definition of technical roles and objectives should be established up front. Third Party efforts fall into Software and hardware categories. Third Party Algorithms are a Good Starting Point, as new ways to detect threats and reduce fall alarms can be implemented as software updates. Funding for recertification should also be considered.
Integration of New Add-on Hardware Technology is more complicated. DHS has to work with suppliers to understand the hardware benefits and cost impact to integrate and operate. For instance, an add on capability (e.g., Coherent Scatter or Multi-Energy Detectors) can reduce false alarms but may also add $100-200K in TSA acquisition cost. Is this acceptable because the FAR reduction related savings supports a Return on Investment?

16.12 David F. Wiley: Stratovan's Perspective and Recent Involvement as a 3rd Party



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TSA to Work With Stratovan

- Act(s) of Congress needed (not kidding).
- We didn't already have clearance.
- We had never worked with the gov. before.
- Tiny business ("small" is < 500 people).
- Initial hires were critical.
- Timeline, delays, cash flow, payment mechanism - all challenges.
- Fail early and fail fast.

-- TSA has been incredibly supportive --

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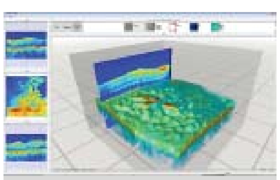
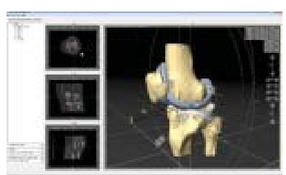
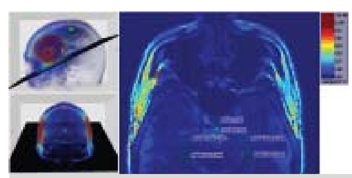
Stratovan Pre-Airport Security


Retinal Imaging


Total Knee Replacement


Transcranial Current Simulation

- Stratovan Encircle™ integrates a high-performance 3D imaging toolkit with a user interface widget library. *(Similar to combining Kitware's VTK and QT.)*
- This saves time, money, and makes our software developers more efficient at solving difficult real-world problems.

- Stratovan Maxillo™ segments the orbital volume from CT scans.
- Used for planning orbital fracture repairs.
- Originated our Tumbler segmentation technology.

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How We Transitioned

- ALERT ADSA meetings acted as introduction to industry. Facilitated networking.
- ADSA Task Order 2: CT Segmentation Initiative (as a researcher).
- ADSA Task Order 3: CT Reconstruction Initiative (as a reviewer).
- **Funding for these Task Orders was critical to keep us involved – since we're a small business.**
- 2013 Obtained two TSA contracts through BAA process:
  - DICOS SDK
  - ATR for CT

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6

Why would TSA work with Stratovan?

- TSA is under significant pressure from multiple directions.
- Airport security industry is going through a transition towards interoperability to alleviate pressure.
- This has happened for many industries:
  - Personal computers
  - Operating systems
  - Satellite broadcasting
  - Factory floor automation
  - Networking equipment
  - Etc.
- This has resulted every time in increased growth, profitability, and a flourishing industry for customers *and* vendors.
- This change also allows best-of-breed to percolate upwards providing the customer with higher value.

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DICOS SDK

Goal	Rationale
Provide an SDK to the Industry	A step in the direction of interoperability
Provide SDK for free via download	Encourage adoption
Provide tools for compatibility, compliance, and testing.	Improve multi-vendor compatibility
DICOS Viewer	Debugging of spatial data
Support multiple operating systems	Meet your development needs
Help the software developer in your org: documentation, examples, and support.	Don't have to become a DICOS expert
High-performance	Can be included in production
Target one or two week dev investment	To reduce the burden of becoming DICOS compliant

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DICOS SDK - Current Status

- No cost and unrestricted access and use once approved.

As of last week:

- **89** users have signed up and downloaded our SDK.
- From **44** different airport security companies around the world.

https://www.stratovan.com/products/dicos-toolkit

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ATR Effort

- Goal is to improve PD and reduce PFA.
- Cover more material classes and smaller sizes.
- Build upon technologies developed for our medical imaging applications and also CT Segmentation Initiative success.
- Project challenges are numerous:
  - Obtaining training data
  - Large data
  - Borderline research
  - Data dependent problem
  - Limited time budget
  - Complex algorithms
- Involves complex computer science technologies:
  - GPGPU
  - Image processing
  - Large data
  - High-performance computing
  - 3D data
  - Image segmentation
  - Machine learning

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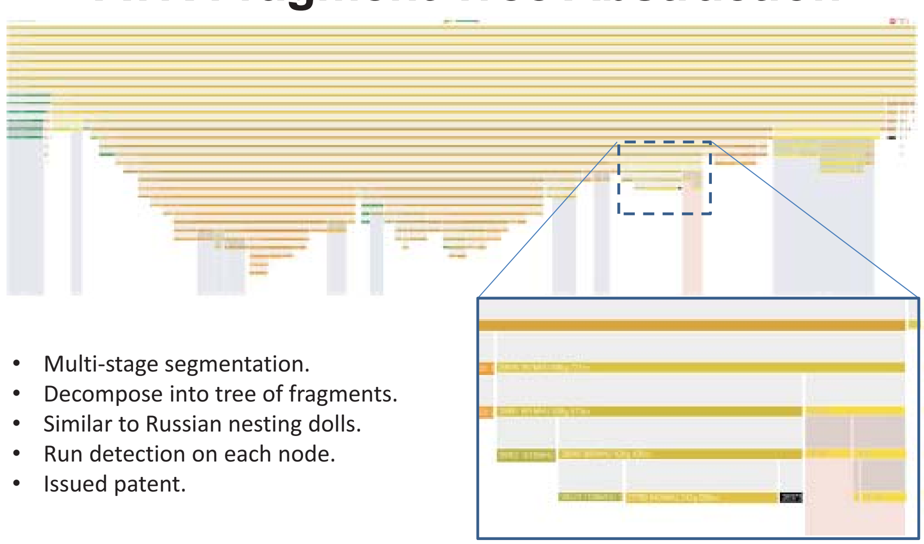
ATR Fragment Tree Abstraction



- Multi-stage segmentation.
- Decompose into tree of fragments.
- Similar to Russian nesting dolls.
- Run detection on each node.
- Issued patent.

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3rd Party Deployment Barriers

Third party looking into marketplace:

- How do we get our “stuff” into airports?
- What opportunities are there for innovation?
- What performance requirements must we meet?
- How can we add value?
- What is the certification process?
- How do we know our “stuff” will work with others?
- **How is passenger risk determined?**

These questions can be answered with software!
-- Interoperability is a software problem --

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Invest in SDKs

(Software Development Kits)

- Software problems are solved with SDKs.
- Provides a common ground for everyone.
- Clearly defines (in software) what is possible and what is not.
- Reduces barrier for becoming compliant.

Apple iPhone SDK example:

- Provides clear interfaces/standards for developing cell phone applications.
- Handles credit card processing, interaction with App Store, user interfaces, access to hardware resources, etc.
- Apple has a process for “approving” apps prior to inclusion in App Store – akin to certification.
- Ecosystem supports millions of vendors and billions of users.

Challenge is that not everyone understands software…

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13

Sandia OTAP Collaboration

- Data collection effort (PBOD)
- Hardware sensor exploration
- Reconstruction exploration
- ATR exploration
- OPSL (Open Platform Software Library)
  - An SDK for screening workflow operation.
  - Supports Risk Based Screening (RBS).
  - Works with: DICOS, STIP, Secure Flight, BHS, etc.
  - Meant to interconnect *all* security devices via Ethernet.
  - Orchestrates data flow by facilitating communication between devices.

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Questions?

Thank you!

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OPSL

- Why not use existing platforms?
  - No other environment has the same requirements.
  - 1,000 times the data volume than in hospitals.
  - Scalability, automation, cyber security, reliability, and management are key.
- Use IBM PC model to decompose security components into **OPSL Roles** and define interfaces between them.
  - PC Roles: Mouse, Keyboard, Monitor, Printer, CPU, RAM, Hard drive, etc.
  - PC Interfaces: PCIe, USB, Bluetooth, Ethernet, TCP/IP, etc.
  - Roles compartmentalize requirements and provide foundation for certification.
- An OPSL Role plays a part in the passenger screening process.
- Provides mechanism for transporting passenger risk score to OPSL Roles to enable RBS.
- Allows dynamic and heterogeneous configuration of Roles within airports. No longer need the same everywhere.

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OPSL

- Define architecture around OPSL Roles:
  - What does it do?
  - What are the input/output formats? Data, passengers, baggage, cargo, etc.?
  - How fast does it need to process?
- Treats each Role as black box.
- Supports innovation within Roles.
- Provides foundation for Automated testing via Role interfaces:
  - Compatibility testing against a gold standard.
  - What happens when…?
  - How is the Role tested and certified?
  - Self testing prior to certification testing.

ADSA May 2017

16.13 Allan Collier: TSA Air Cargo Screening Update

TSA Air Cargo Screening Update

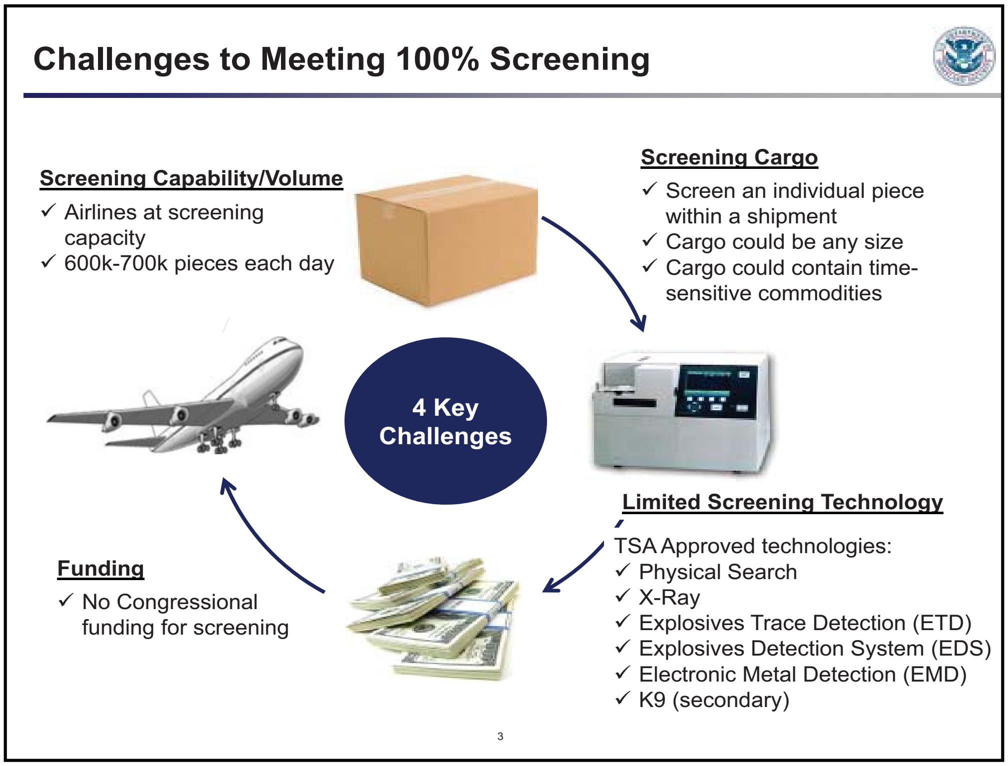
ALERT ADSA16
Cargo Inspection Workshop
2 May 2017

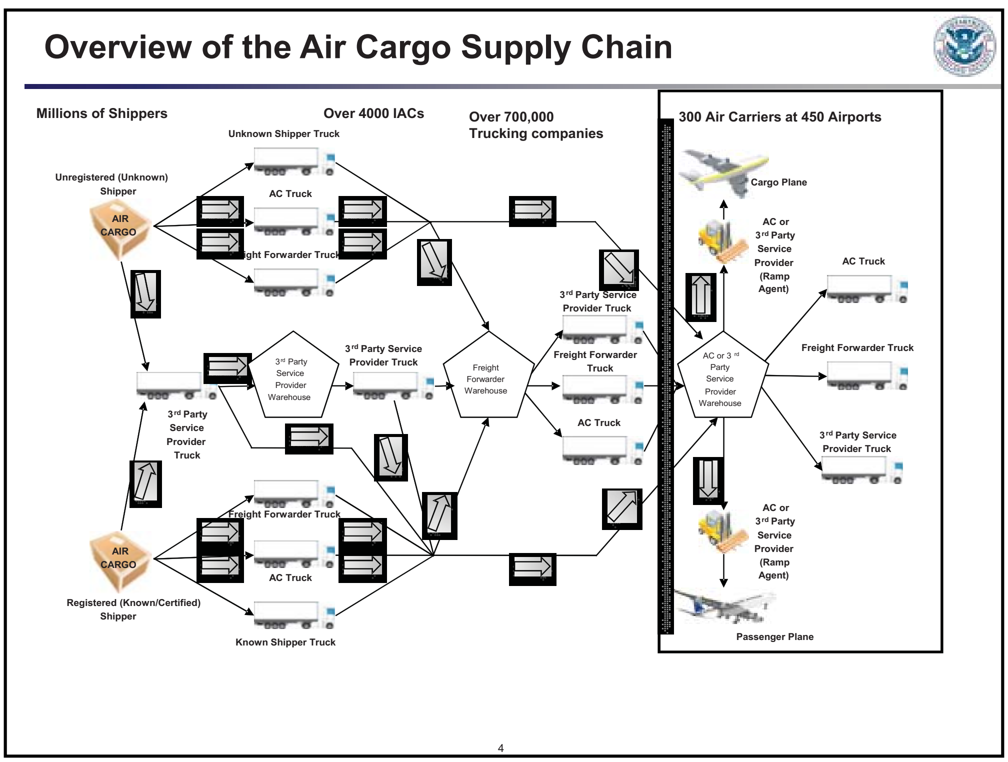
1

Law – 100% Screening Legislation

- The Implementing Recommendations of the 9/11 Commission Act of 2007 were signed into law on August 3, 2007
- The law required 100% screened for domestic flights by August 3, 2010 at the piece level
- Further guidance required 100% screened for international inbound flights to the United States by December 3, 2012
- Prevent or deter the carriage of any unauthorized persons, and any unauthorized explosives, incendiaries, and other destructive substances or items in cargo onboard an aircraft.
- Commensurate with baggage (piece level)
- No Congressional funding
- TSA required to establish program to accomplish mandate

2


Challenges to Meeting 100% Screening
Screening Capability/Volume
✓ Airlines at screening capacity
✓ 600k-700k pieces each day
Screening Cargo
✓ Screen an individual piece within a shipment
✓ Cargo could be any size
✓ Cargo could contain time-sensitive commodities
4 Key Challenges
Limited Screening Technology
TSA Approved technologies:
✓ Physical Search
✓ X-Ray
✓ Explosives Trace Detection (ETD)
✓ Explosives Detection System (EDS)
✓ Electronic Metal Detection (EMD)
✓ K9 (secondary)
Funding
✓ No Congressional funding for screening
3


Overview of the Air Cargo Supply Chain
Millions of Shippers
Over 4000 IACs
Over 700,000 Trucking companies
300 Air Carriers at 450 Airports
Unknown Shipper Truck
Unregistered (Unknown) Shipper
AIR CARGO
AC Truck
Freight Forwarder Truck
3rd Party Service Provider Truck
3rd Party Service Provider Warehouse
Freight Forwarder Warehouse
Freight Forwarder Truck
AC Truck
Cargo Plane
AC or 3rd Party Service Provider (Ramp Agent)
AC Truck
AC or 3rd Party Service Provider Warehouse
Freight Forwarder Truck
3rd Party Service Provider Truck
Freight Forwarder Truck
AC Truck
Registered (Known/Certified) Shipper
Known Shipper Truck
Passenger Plane
4

TSA Domestic Approach for 100% Screening

- TSA established the Certified Cargo Screening Program (CCSP)

CCSP

- Enables all entities in the supply chain who meet stringent security standards to screen cargo
- Businesses may choose the best and most effective screening model for their needs
- Supported and implemented by industry
- Leverages best practices from global supply chain security programs

Approach Includes:
- Standard Security Program updates
- Compliance Inspections/Audits
- TSA Proprietary Canine Teams
- Risk-Based Strategies

5

Facility Types

Over 2300 Cargo Screening Facilities Across Supply Chain
About Half are under the CCSP

Air Carriers

~1200 sites

IACs

~520 CCSF sites

Shippers

~500 CCSF sites

Independents (ICSFs)

~80 CCSF sites

6

Current Approved Methods of Screening

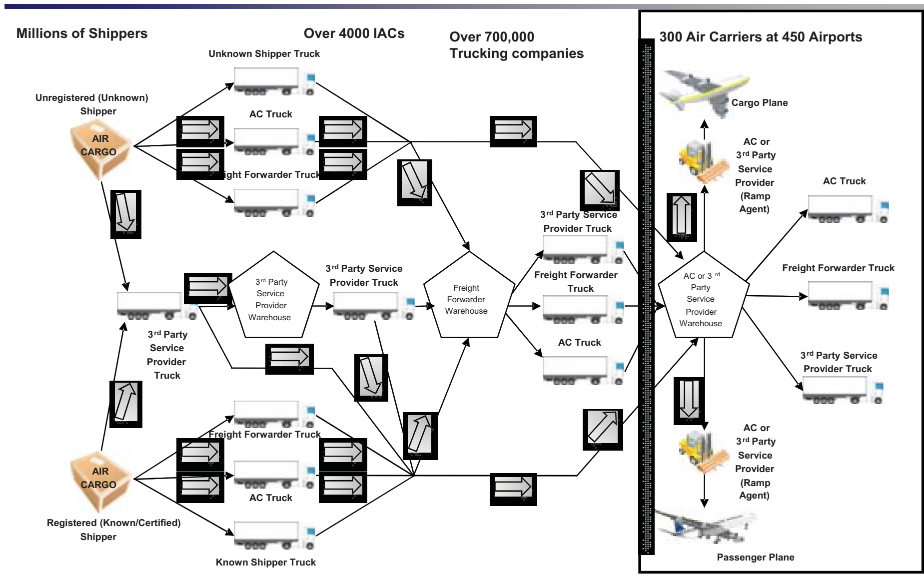
- The following screening methods are approved for passenger air cargo:
  - Physical Search
  - X-Ray
  - Explosives Trace Detection (ETD)
  - Electronic Metal Detection (EMD)
  - Explosives Detection System (EDS)
  - TSA-Certified Canines

  - CO2 Monitors -- All-Cargo carriers (stowaways)

- Additionally, Sec. 1602 of the 9/11 Act states, “The Administrator may approve additional methods to ensure that the cargo does not pose a threat to transportation security and to assist in meeting the [screening] requirements…”

7

Overview of the Air Cargo Supply Chain



8

Tonnage Screened

	2010 Domestic Air Cargo	2016 Domestic Air Cargo
Total	**~250M**	**~300M**
Air Carrier	~160M	~100M
IAC/CCSF	~70M	~150M
Shipper/ICSF	~20M	~50M

Key Point:
Today, CCSFs perform 2/3 of domestic screening

9

ACSQT Redesign Overview

Rolling Submission Process

- Manufacturers may submit white papers for all technology categories throughout the calendar year
- Manufacturers may resubmit devices 90 days from the date of non-approval notification from TSA (formerly, manufacturers would have to wait till a new submission window opened)

TSA issued this Request for Information (RFI) to announce a redesigned Air Cargo Screening Qualification Test (ACSQT) on FedBizOpps.Gov

- https://www.fbo.gov/index?s=opportunity&mode=form&id=8e40c67449f21b6ad34e735942026dd0&tab=core&_cview=0

10

TSA Air Cargo Screening Technology List (ACSTL)

Currently, there are 119 pieces of technology on the list, version 10.2 dated 12/15/2016.

91 X-ray
- 37 qualified x-ray
- 1 approved
- 53 grandfathered (single view)

3 ETD
- 3 grandfathered ETD

15 EDS
- 15 qualified EDS

8 EMD
- 7 qualified EMD
- 1 approved

2 CO2
- 2 qualified CO2 monitors

- Non-SSI version posted on:

https://www.tsa.gov/for-industry/cargo-programs

11

Estimated Tech Count

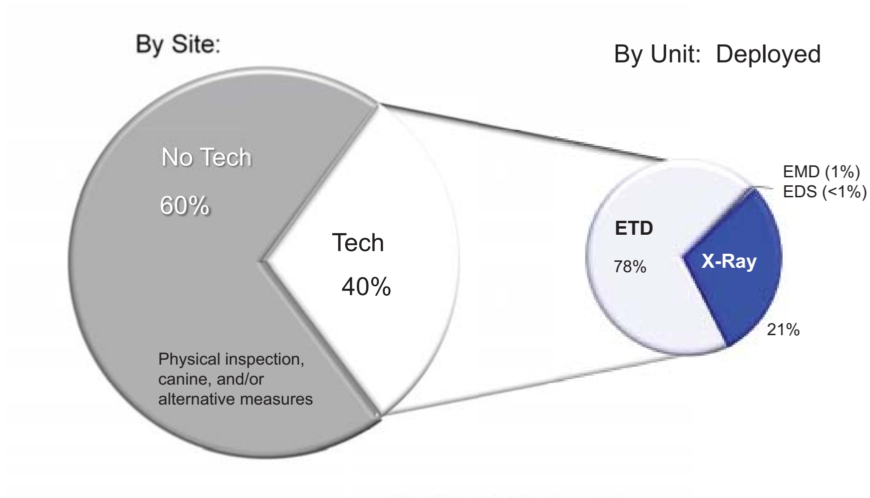
Equipment Quantities, as of July 2016

Domestic Air Cargo Population			
	CCSF	Air Carrier	Total
ETD	354	482	**836**
X-Ray	141	110	**251**
EMD	16	1	**17**
EDS	1	2	**3**
Total	**512**	**595**	**1,107**

Down approximately 150 units from 2012

12

Technology Usage



Total No. of active domestic screening sites: ~2,300
Total No. of Sites using Technology: ~700

13

International Inbound

- TSA has adopted a two-fold approach to implementing 100% screening for international inbound cargo:
  - Increase screening requirements in the airline Standard Security Programs (SSPs)
  - Recognize commensurate foreign air cargo security programs thru the National Cargo Security Program (NCSP) to enable air carriers flying directly into the U.S. to follow only the national cargo security program
- TSA has developing a risk-based strategy based on identifying high-risk cargo for enhanced screening measures
  - Applying knowledge gained from on-going risk assessment and mitigation efforts in domestic air cargo

14

Displacement

Focus on All Cargo as a "soft target"

- Aircraft as a weapon/aircraft is the target
- Similar Security Programs
  - Risk based enhanced screening
- Inspectors
- Larger configurations
- Complex cargo
- Larger threat mass

15

Issues to solve

- COST COST COST
- No silver bullet
- All Cargo screening
- E-Commerce
- Level I detection (EDS)
- Manpower/Human Interpretation

16

Commodities pose significant screening challenges

Supply Chain Challenges	Screening Challenges
• Requires cold chain handling • FDA sealed	• X-Ray may affect shipments • Compromised package integrity
• Requires cold chain handling • Perishable/limited shelf life • USDA/APHIS requirements	• Too dense for X-Ray • Risk of physical search bruising • Difficult for ETD (wet)
• Sealed drums • Possibly toxic if opened • Liquids/powders	• Too dense for X-Ray • No alarm resolution for ETD • Inability to physically screen
• Compromised package integrity • High value security	• Static discharge • Risk of physical search damage
• Sanctity of the remains	• Inability to physically screen
• Varying sizes • Sophisticated packaging • High value	• X-Ray sensitivity • Inability to physically screen

17

Do you know what you are sitting on?

18

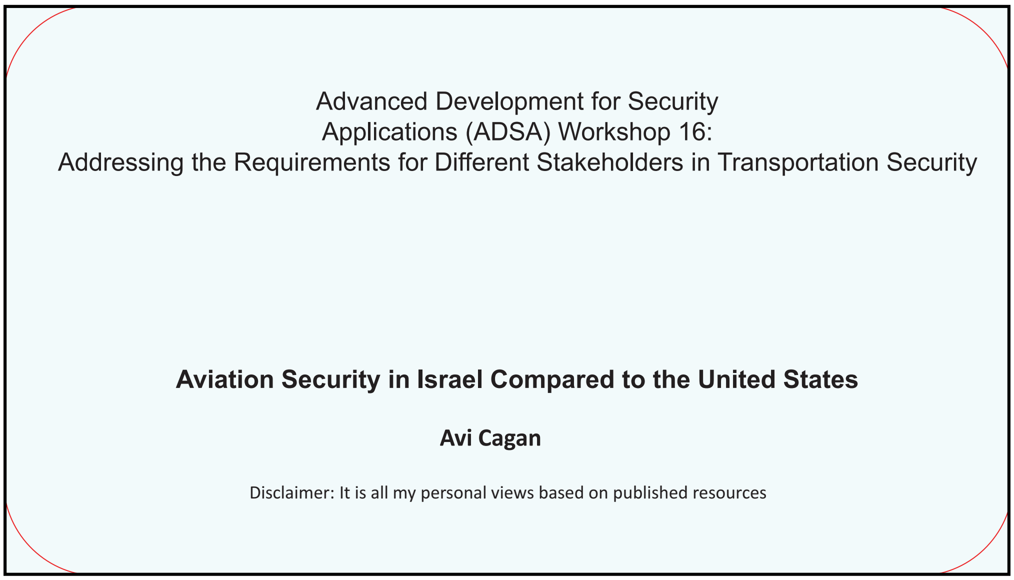
TSA Air Cargo Screening

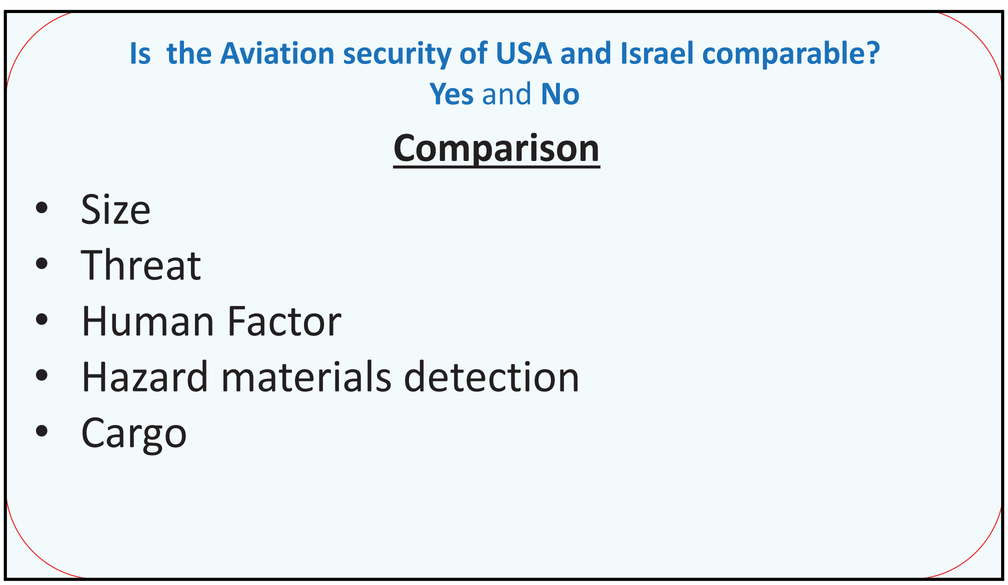
Questions?

Allan Collier
Allan.Collier@tsa.dhs.gov
571-227-1344

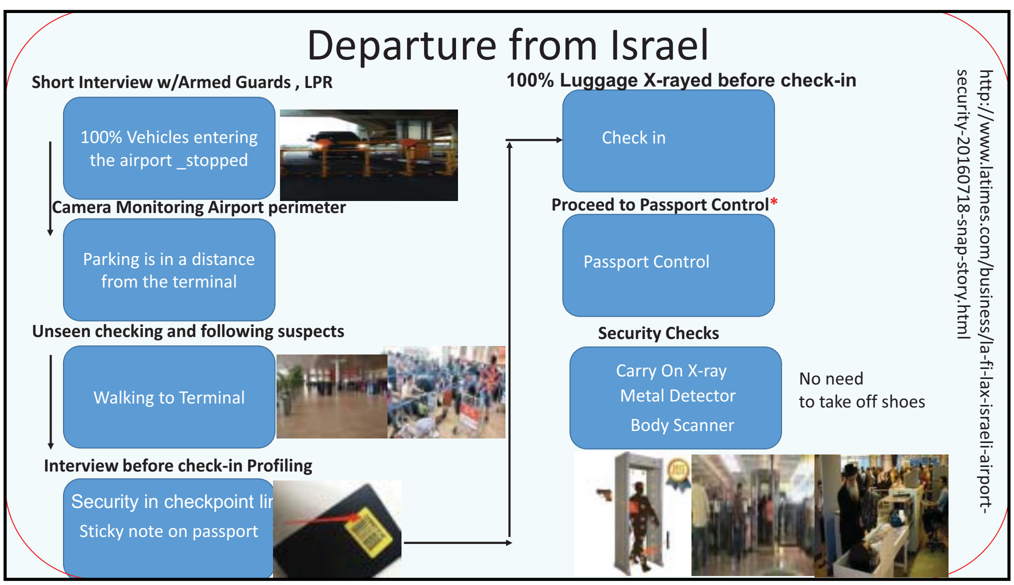
19

16.14 Avi Cagan: Aviation Security in Israel Compared to the United States






Arrival to Israel
Through The Connector
Passport Control
Border Patrol
Collection Of Baggage
Customs
http://www.israelwelcome.com/arrivingpassengers.htm


Departure from Israel
Short Interview w/Armed Guards , LPR
100% Vehicles entering the airport _stopped
Camera Monitoring Airport perimeter
Parking is in a distance from the terminal
Unseen checking and following suspects
Walking to Terminal
Interview before check-in Profiling
Security in checkpoint li
Sticky note on passport
100% Luggage X-rayed before check-in
Check in
Proceed to Passport Control*
Passport Control
Security Checks
Carry On X-ray
Metal Detector
Body Scanner
No need
to take off shoes
http://www.latimes.com/business/la-fi-lax-israeli-airport-security-20160718-snap-story.html

Aviation Security 2017

USA

"What has not changed is that terrorists still consider airlines and airports high-value targets…The U.S. air transportation system, especially passenger airplanes, remain a primary target of every global terrorist network. That has not changed since before 9/11 and will define the threat environment for years, maybe decades, to come."
Former TSA administrator Peter V. Neffenger

https://www.washingtonpost.com/local/trafficandcommuting/trump-budget-eliminates-three-post-911-airport-security-programs/2017/03/16/8c56841a-09aa-11e7-93dc-00f9bdd74ed1_story.html?utm_term=.6f0e615e0c1c

"A lot of what the Israelis are doing has informed what we're doing"…Peter Neffenger
"to adopt most or all of Ben Gurion's security measures at a facility like Los Angeles International Airport likely would mean higher ticket prices to pay for extra screening measures and longer wait times for more intense questioning by security agents, aviation experts say.

http://www.latimes.com/business/la-fi-lax-israeli-airport-security-20160718-snap-story.html

Israel

"Airports are always a target for terror
Any event is drawing global attention…. Fear effect of millions of people
When the airport is closed for long hours , it is considered to be a success to the terrorist".

Background

	Law	
USA	Aviation and Transportation Security	2001
Israel	Aeroports Authority Law	1977
	Airports Security	
USA	US Gov.-Trnasportation Security Agency (TSA) under Department of Homeland Security(DHS)	
Israel	Public Cop.- Israel Airport Authority(IAA) in corporation with Police	
	Security Personnel	TSA officers do not have police authority and must summon local officers when issues arise.
USA	60000	
Israel	1500 out of 3000	

Waiting time in Airport

	Average Waiting Time Minutes	Longest Waiting Time Minutes
Chicago - Midway	8	108
Philadelphia International	14	151
Newark Liberty	15	168
Washington - Dulles	15	90
Dallas - Ft. Worth	20	108
John F. Kennedy International	21	232
Miami International	24	216
Chicago - O'Hare	25	119
LaGuardia	35	142
Los Angeles International	40	141
Tel Aviv	20	360

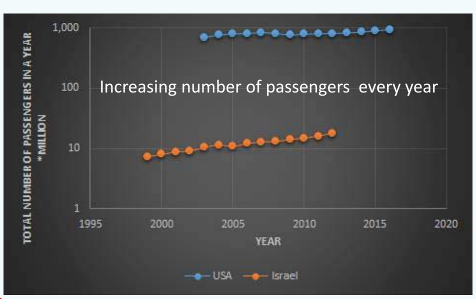
Depends on number of flights

Depends on the interviews and number of flights

https://www.thrillist.com/travel/nation/the-busiest-airports-in-america-ranked-by-security-wait-time 2015
https://travel.stackexchange.com/questions/64314/how-long-are-lines-in-tel-aviv-airport

Size (Absolute numbers) Huge Difference

	Airports	International Airports				
		>17	17M> n>3.5M	3.5M-3.5K	10K-350K	<10K
		Large	Medium	Small	Non-Hub	Reliever
USA	376	29	28	24	7	3
Israel	7	1		3		



Passengers

2016	Domestic	International
USA	700	200
Israel	0.6	17

Population

2016	USA	Israel
Population (M)	323	8.2

Airports

USA: Long distances → Mostly Domestic flights
Israel: Short distances → Mostly International flights

Size (Relative numbers) Getting close …

	USA	Israel
Population(M) /Large International Airports	11.1	8.2
Population(M) /Domestic Passengers (M)	**0.46**	13.67
Population(M) /International Passengers (M)	1.62	**0.48**
International Passengers(M) /Large International Airports	7	17
Passengers / Security Personnel	15000	11733
International Passengers/ Security personnel	3333	**11333**
Domestic Passengers/ Security Personnel	**11667**	400

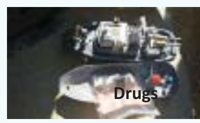
Threat handling in airport
Israel

CT Carry-On

Interview all passengers

Check again all passengers Carry-On

Check all passengers Check-in baggage



3 hours delay

Human Factor > Any machine at present

USA

Screening conducted by federal officials
Model: Max number of passenger per line/time
Interview time : 2 min plus fingerprint

TSA officers may ask you questions about your travel to include identity, travel itinerary and property. TSA may use a variety of screening processes, including random screening, regardless of whether an alarm is triggered. In addition, TSA uses random and unpredictable security measures throughout the airport and no individual is guaranteed expedited screening.

Israel

Profiling

Interview* for 15 min selected persons.
Others pass after a 30 seconds and 2-3 very basic questions.
screener :spot when someone does not belong to the group.
Screener : Must pass all tests

Q: When did you decide to come to Israel?
Q: Who bought the ticket ?
Q: What hotel are you going to ?
Q:What if you gave someone your e-mail or phone number?
Q:A copy of invitation to a conference
Q:Did anyone want to stay in contact with you

A bag which went through X-ray where detonating cord and explosive were not detected was found by the ELAL Selector

- Some people call it interrogation

** started to make feeling guilty.

Detection technologies in Airport

USA

- 100 percent checked baggage screening
- Expansion of the Federal Air Marshal Service
- Reinforced cockpit doors.
- Explosives Detection Systems

Israel

Profiling

1) Entry: : vehicles entering the airport (short interview),LPR
2) Unseen checking and following suspects entering
3) No need to take off shoes
4) Pressure chamber to trigger any possible explosive devices in checked baggage.
5) Monitoring the fence (Airport perimeter) with cameras.

1) ThruVis – Hidden . A sensitive camera which can identify hidden items .
2) Voxpopme- Identify feelings (Video analysis)
3) Affectiva – Identify feelings (face analysis)
4) AVATAR- Lie Detector , Check-in (face, voice and way of standing analysis)
5) AnBot –Robot with digital cameras , deterring by sound and light and can disarm suspects.
6) HBS- a large net of conveyers below the ground , where each bag is checked by few technologies and sent to the plane .

Security Guards

USA

Airport Security Guard

- Perform security patrols of designated areas on foot or in vehicle
- Watch for irregular or unusual conditions that may create security concerns or safety hazards
- Sound alarms or call police or fire department in case of fire or presence of unauthorized persons
- Warn violators of rule infractions, such as loitering, smoking or carrying forbidden articles
- Permit authorized persons to enter property and monitors entrances and exits
- Observe departing personnel to protect against theft of company property and ensure that authorized removal of property is conducted within appropriate client requirements
- Investigate and prepare reports on accidents, incidents, and suspicious activities
- Provide assistance to customers, employees and visitors in a courteous and professional manner

❖ High School, State required Training , driver's license.
❖ Must be US citizen or foreign authorized to work in USA

Armed Guard must have a law enforcement service

Israel

Guards

IAA does not sub-contract its security to private companies

- After military service
- Well trained to interact with a suspect in crowd
- High motivation
- Not recognized as a guard by passengers (No uniform)

Every hour there is an guards' awareness test

Build an unseen concentric circles of security with increased scrutiny as individuals arrive closer to plan

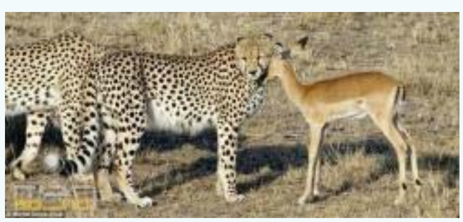
- Challenge: If the event is categorized as " criminal" guard will not attack the suspect unlike if it is " Hostile terrorist action"

Summary

One-size-fits-all security screening →A risk-based, intelligence-driven strategy to improve security and passenger experience

- Entering vehicles prescreening
- Use entry footprint for passengers pre-screening
- Not all officers in uniform
- Passengers Intelligence database (Local data bases?)
- Automatization of all technologies
- Search for workable solution for cargo screening

Thank you



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16.15 David Castañón: Emerging Explosives Detection Technologies for Luggage

Emerging Explosives Detection Technologies for Luggage

David Castañón

May 2, 2017

BOSTON UNIVERSITY

This material is based upon work supported by the U.S. Depart- ment 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 poli- cies, either expressed or implied, of the U.S. Department of Homeland Security.

So What? Who Cares?

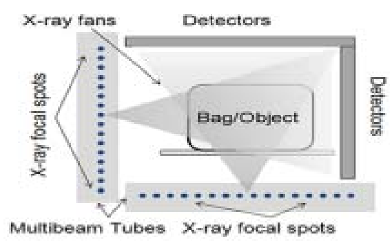
- Current systems have limitations for detecting emerging threats inside of luggage
  - Evolving explosive threats make them harder to distinguish from stream-of-commerce materials using signatures from current generation checked luggage scanners
  - Increased interest in automated CT explosives detection in other domains (hand-carried luggage, air cargo, …) bring new challenges
- Thus, looking for different solutions
  - Hardware/software systems: cheaper, smaller CT architectures suitable for large deployments in checkpoint, air cargo
  - Signatures: Extract more features concerning material properties to separate explosives from non-confusing threats.
- Some interesting ideas being pursued currently
  - But they have limitations
  - Can the limitations be overcome to produce robust, deployable systems?

Some Topics

- Limited Field of View Tomography
- Multi-Energy Tomography
- X-ray Diffraction Imaging and Tomography
- Compton Scatter Tomography
- Other X-ray Signatures: Phase-Contrast Imaging and Dark-field Imaging

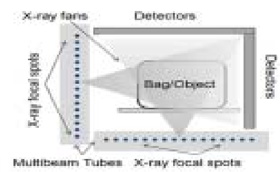
Limited Field-of-View Architectures for X-ray CT

- Motivation
  - Fewer sources, detectors lower cost
  - Non-rotating scanning architectures reduce form factor, simplify mechanical structure
  - New sources enable flexible source placement
  - Designs with as few as 4 source locations
- Variations: slice-by-slice vs. volumetric imaging
  - Motion yields view diversity



XinRay, IEEE Access 2014 (V2)

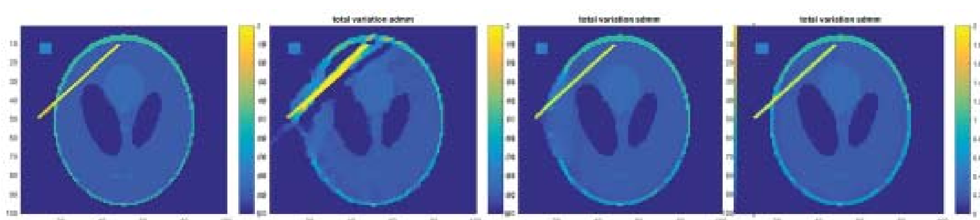
Issues with Limited FoV Architectures



- Image formation requires complex iterative algorithms
  - Strong regularization used to add information that is not in the measured data
  - High-dimensional optimization: number of unknowns if full volumetric imaging
  - High computational cost: hours on CPUs: can be alleviated using GPUs: seconds
- Irregular sampling of geometry can lose observability in areas
  - Thin objects with wrong orientations hard to separate
  - High attenuating objects can create blind spots that are poorly illuminated
- Need enough sources…compressive sensing not a good answer

Illustration: Imaging with limited views

- K views, fan beam, ideal monoenergetic source, total variation reconstruction using ADMM
  - Need enough views and sufficient view diversity

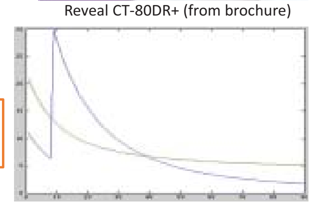


Truth | 15 Source Locations 180 degrees | 50 Source Locations 180 degrees | 50 Source Locations 360 degrees

New Signatures: Multi-spectral CT

- Dual energy systems are available commercially
  - However, the RoR of some explosives and confusers are not well-separated in these features
  - Materials with k-edges in 30-120 KeV are poorly represented in dual energy imaging
- Can use of multi-spectral CT with many spectral bins help?
  - Multiple source spectra, photon-counting detectors, …
  - New features possible → greater separation

Reveal CT-80DR+ (from brochure)

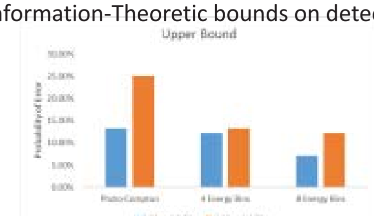


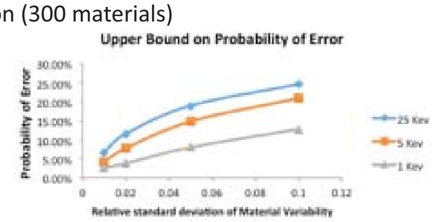
LAC of Baratol (TNT+Barium Nitrate) and best approximation using photoelectric and Compton basis

MultiX ME 100 www.multixdetection.com

Which new features?

- May measure linear attenuation coefficients at various energy bins
  - But, is much of the information redundant? If so, what are the right features to obtain?
- Morpho (Smiths?) study (Skatter et al, 2014 ICCST): germanium detectors used to measure 38 materials, find that only two features are meaningful
  - But no materials in study with k edges in relevant energy region
  - Other studies with more materials suggests 3-4 or more
- Information-Theoretic bounds on detection (300 materials)

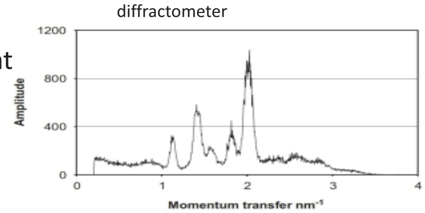




Non-Transmission X-ray Signatures: X-ray Diffraction

- Coherent scatter: momentum transfer to incoming photons from molecular electron cloud change of direction with no loss in energy
  - Primarily forward, at small angles
  - Not the primary interaction: approximately 5% of scatter events above 70 keV
  - Usually results in noise for transmission
- Goal: image the coherent scatter form factor – the distribution of photons that undergo specific momentum transfers

TNT form factor measured with diffractometer



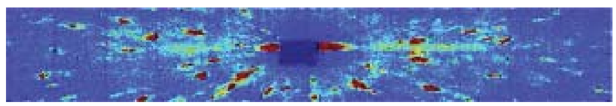
X-ray Diffraction Systems

- Commercial System: ???? XRD 3500™
  - Deployed, uses XRD in secondary mode in combo with transmission image
  - Upgrades in progress to deliver stronger signals
  - Collects scatter at fixed angle, resolves in frequency photon counting detectors
  - Limited viewing geometry susceptible to loss of observability
- Alternative approaches under investigation: XRD tomographic systems using less collimation to capture more photons (based on Duke concepts)
  - Coded aperture collimation, small number of sources
  - Same detector measures photons from different angles, need to solve inverse problem to localize
- Question: used as secondary, or primary imaging?

Issues with XRD - CT

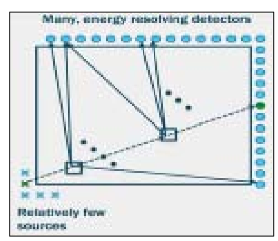
- Advantage: Stronger signals – 1-2 orders of magnitude increase in scattered photons measured vs. collimation architecture
- Disadvantages
  - Energy sensitive attenuation distorts form factors, requires 3-D energy-sensitive attenuation correction – Must fuse with dual-energy transmission imaging
  - Lack of collimation increases noise from Compton scatter, secondary scatter
  - Limited illumination directions can lead to lack of observability
  - High-dimensional inverse problem – 3 space plus spectral dimensions
  - For many materials, form-factor signatures may not be isotropic – and may depend strongly on other factors

2-D coherent scatter intensity from NaCl (J. Greenberg, Duke)



X-ray signatures: Compton scatter

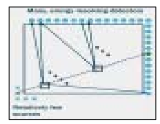
- Concept explored by Tufts, AS&E
  - Much stronger scatter cross section than coherent scatter, at higher energies
  - Strong scatter signature from low Z materials – complement of transmission
- Concept
  - Line scan illumination, with lines scanned from a few source locations, plus wide array of photon counting detectors
  - Energy of scattered photon indicates momentum transfer, identifying direction of scatter and allowing localization
  - Scatter provide “virtual sources” with different orientation directions illuminating volume – fuller angle from limited source points
  - Must compensate for transmission and scatter loss – Requires good knowledge of energy-dependent attenuation

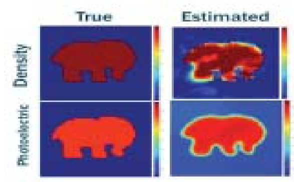


E. Miller (ALERT)

X-ray signatures: Compton scatter - 2

- Research prototype implemented by AS&E
  - Collaboration with Tufts University under DHS BAA 13-05
- Challenges
  - Transmission detector technology different because of signal strength dynamic range
  - Line scan illumination required for well-posed inverse problem, leads to slower coverage
  - Complex inverse problem requires model of energy-dependent Compton scatter cross-section
  - Initial 2D prototypes tested in both simulation nd in hardware by AS&E, Tufts team
- Advantages
  - Better estimation of electron density, effective atomic number with limited angle illumination



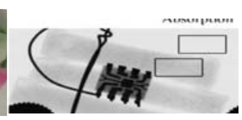


Other X-Ray Signatures

- Phase contrast imaging
  - New developments using gratings and interferometry to avoid use of coherent x-ray sources (e.g. synchrotrons)
  - Enhances contrast when attenuation is similar
  - Demonstrated at low energies (40 keV)

Miller et al., PNNL
Analyzer grating is stepped to collect information that leads to phase contrast imaging

picture



absorption

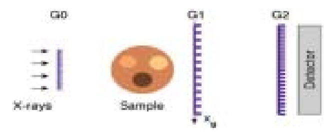
Phase contrast

Miller et al., PNNL

- Issues
  - Higher energies? Clutter effects? Penetration in luggage? Localization in 3-D? Value of signature?
  - May be better suited for separate liquid detection

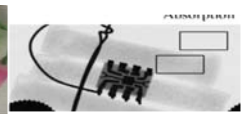
Other X-Ray Signatures

- Dark-field imaging
  - Again using gratings as in phase contrast
  - Objective: measure total amount of coherent scatter (not energy-resolved)
  - Provides measure of texture below detector resolution



Miller et al., PNNL

picture



absorption

Dark-field image

Miller et al., PNNL

- Issues
  - Higher energies? Clutter effects? Penetration in luggage? Localization in 3-D?

Summary

- Discussed some on-going work aimed at enhancing current EDS and AT luggage inspection systems
  - Limited Field of View Tomography, Multi-Energy Tomography, X-ray Diffraction Imaging and Tomography, Compton Scatter Tomography
  - Other X-ray Signatures: Phase-Contrast Imaging and Dark-field Imaging
- Plenty of questions remain as to whether these approaches will be effective at improving performance
  - Must demonstrate ability to generate signal strength in attenuation environments
  - Reliability of signatures to nuisances: clutter, environmental variations
  - Define appropriate regions of responsibility in terms of new features
  - Establish value of signatures for separation of objects of interest from background

16.16 Carl Crawford: Can a Death-Predicting Algorithm Improve Healthcare?

Can a Death-Predicting Algorithm
Improve Healthcare?

Carl R. Crawford
Csuptwo, LLC

1

Future of Medical Imaging

- "… people are being told that it is their right to live to be a hundred in the body of a twenty year-old?"*
- How will medical imaging respond if this right no longer exists?
  - Death Panels?

*http://www.amazon.com/How-Doctors-Think-Jerome-Groopman/dp/0547053649

2

THE WALL STREET JOURNAL.

http://www.wsj.com/articles/can-a-death-predicting-algorithm-improve-care-1480702261

LIFE | IDEAS | ESSAY

Can a Death-Predicting Algorithm Improve Care?

A startup says it can tell which patients will die in the next year and lower their medical costs by providing palliative care in their homes

3

What About Flying on Planes?

- Do you have a right to fly?
- Do you have a right to be perfectly safe when flying?
- Assume that flying perfectly safe today. Could be less safe with reduced TSA budget.
  - How to manage false negatives?
- Should we develop and algorithm to determine how much risk we should take when fly?
  - Then allocate resources accordingly
  - Perhaps allow terrorists a certain amount of success

GOVERNMENT WARNING: (1) ACCORDING TO THE SURGEON GENERAL, WOMEN SHOULD NOT DRINK ALCOHOLIC BEVERAGES DURING PREGNANCY BECAUSE OF THE RISK OF BIRTH DEFECTS. (2) CONSUMPTION OF ALCOHOLIC BEVERAGES IMPAIRS YOUR ABILITY TO DRIVE A CAR OR OPERATE MACHINERY, AND MAY CAUSE HEALTH PROBLEMS. **CONTAINS SULFITES**

4

16.17 Laura Parker: ADSA Workshops - Past, Present and Future

DHS SCIENCE AND TECHNOLOGY

Advanced Development for Security Applications (ADSA) Workshops: Past, Present and Future

May 2, 2017

Laura Parker, PhD
Program Manager
HSARPA Explosives Division (EXD)
Science and Technology Directorate

Homeland Security
Science and Technology

Office of University Programs Centers of Excellence: Focus

Centers of Excellence:

The Centers of Excellence (COEs) develop innovative, customer-driven homeland security science and technology solutions and train the next generation of homeland security experts.

- Each university-based COE is a competitively-awarded consortium
- Network of ten COEs and more than 200 partners

Minority Serving Institutions:

The OUP Minority Serving Institutions (MSI) Programs diversify the academic institutions involved in the homeland security mission and train dedicated professionals who can sustain the homeland security and technology workforce.

- Scientific Leadership Awards – institutional awards to support the development of homeland security science and engineering teaching initiatives
- Summer Research Team Program – grants supporting summer research collaborations that engage early career faculty and students with the COEs

DHS Science and Technology Directorate | MOBILIZING INNOVATION FOR A SECURE WORLD 2

So What? Who Cares?

- ALERT COE Co-director and S&T PM discussed how to best reach out to the Homeland Security Enterprise
- First ADSA Workshop commenced in April 2009 with ~40 people to support DHS's objective to augment the capabilities and capacities of equipment vendors with the involvement of third parties (academia, national labs, other industry)
  - Objective: learn how to involve third parties
- Results
  - Developing unclassified problems using public domain data
  - ADSA 150 attendance: > 150/ADSA, ~1000 on distribution
    - Grown into forum for brain storming and interchange
  - ~10 projects/task orders funded through ALERT
  - ~50 groups associated with ALERT transitioning technologies with vendors, TSA, DHS
- Future of ADSA and Task Orders
  - ADSAs will continue as part of ALERT funding
  - ALERT's funding after present period of performance is not guaranteed
  - Funding third parties may continue using DHS and TSA BAAs

DHS Science and Technology Directorate | MOBILIZING INNOVATION FOR A SECURE WORLD 3

ADSA1 – Lessons Learned

- Need unclassified & unrestricted problem statements and datasets
  - X-rays: detecting Coke in presence of Swiss cheese using scans on a medical CT scanner is a surrogate for TSA problems
  - Other modalities: use test beds, simulants and simulations
- Need to use technology foraging to find researchers/companies
  - PHDs in medical imaging do not read BAAs or speak the same language
- Subject matter expertise (SME) required during onboarding of third-parties

DHS Science and Technology Directorate | MOBILIZING INNOVATION FOR A SECURE WORLD 4

ALERT Task Orders

- Computed Tomography (CT)-based EDS
  - Segmentation algorithms
  - Reconstruction algorithms
  - Automated Target Recognition (ATR)
  - Adaptive ATR (AATR)
- Advanced Imaging Technology (AIT)
  - Advanced reconstruction
- Video analytics
  - Tag and track
  - Reverse flow
  - Tracking passengers and divested objects at the checkpoint
- Trace
  - Sampling improvements

ADSA – Growing Pains

- Growth
  - Safe forum for stakeholders to interact
  - Participants expanded from purely technical to include US and Foreign government, business development, airlines, airports, policy makers, etc.
- Pains
  - Difficult to satisfy all attendees all the time
  - Difficult to change scope

ADSA and Third Parties - Future

- Open discussion – DHS and ALERT want to hear from you.

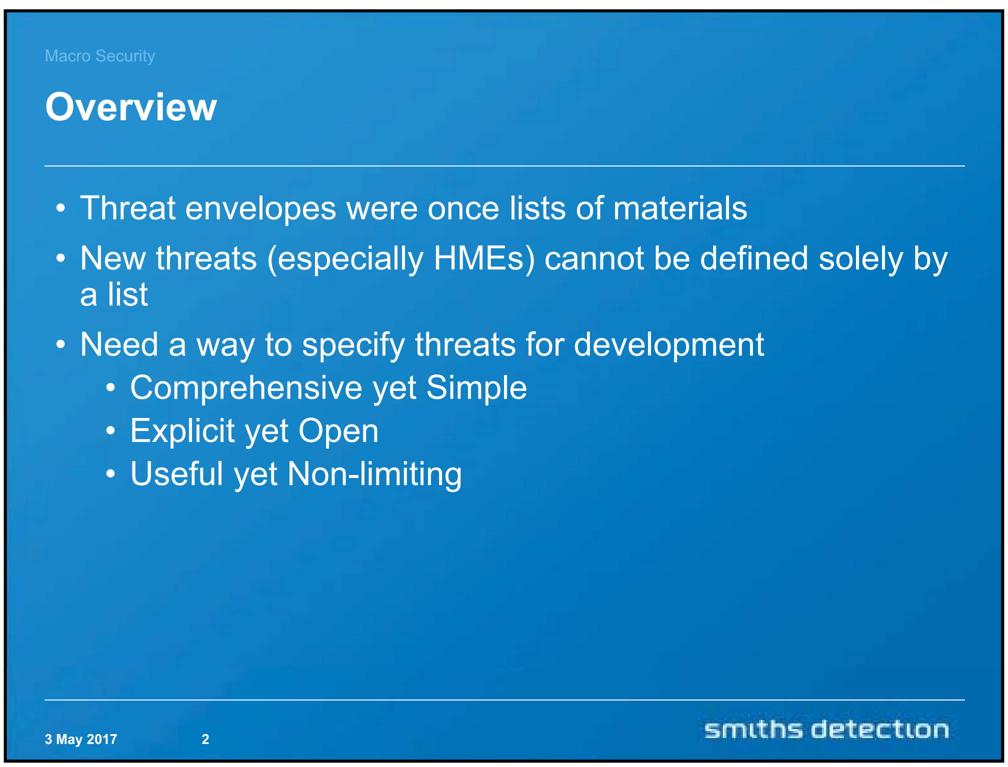
DHS Science and Technology Directorate | MOBILIZING INNOVATION FOR A SECURE WORLD 7

Homeland Security

Science and Technology

8

16.18 Matthew Merzbacher: Specifying a Jell-O™ Detector



Jell-O™ Specification

Why Specify?

- Historically
  - Detection requirements were a list of materials
  - Used empirical data for threat characterization
    - Build device, scan library, enter test
    - What you see is what you detect
- Some threats (especially certain HMEs) are challenging
  - Cost
  - Safety
  - Time
  - Variability
  - Maintenance
  - Presentation
  - Repeatability
- **As threats evolve, exclusively gathering empirical data is no longer feasible**

3 May 2017 3 smiths detection

Jell-O™ Specification

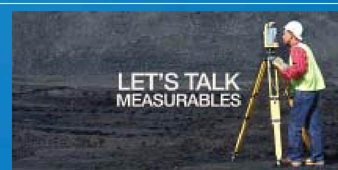
Why talk about Jell-O?

- Can't always talk as openly about threats as we'd like
  - I'd really like to talk about how to specify a MATERIAL-X detector
- Jell-O is a convenient short-hand
  - Looks sufficiently like certain threats, depending on properties
  - A solution to specification for Jell-O will probably work for real threats
  - Looks like other stuff that one might find in luggage (e.g., toiletries)
  - Can mix in other stuff for texture / inclusions
  - Moldable and easily containerized
- Easily synthesized to validate that specification works
- **There's always room for Jell-O!**

3 May 2017 4 smiths detection

Jell-O™ Specification

What needs to be specified?



- What is Measured?
  - Quantity: Mass and Volume
  - Measuring technology
  - Physical Characteristics
    - Density, Z_{eff}, etc. (whatever those mean)
    - Variability tolerances (min, max)
    - Change over time
  - Presentation
    - Critical dimensions (min & max), including shape
    - Contiguousness
    - Concealment
    - Containerizability
    - Homogeneity

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Jell-O™ Specification

Measured is not the same as Measurable

- Do I care that Jell-O can be red, green, or blue?
- **Key Observation: Specification informed by detection technology**
  - **Vicious cycle of specification and potentially stifles innovation**

- But wait, there's more!
  - Homogeneity
    - Interior versus surface
  - Do Homemade and Commercial Jell-O differ?
  - Detection expectation (P_D)
    - Is all Jell-O considered equal?
  - Distribution across the domain
    - Even a few characteristics lead to an intractable problem

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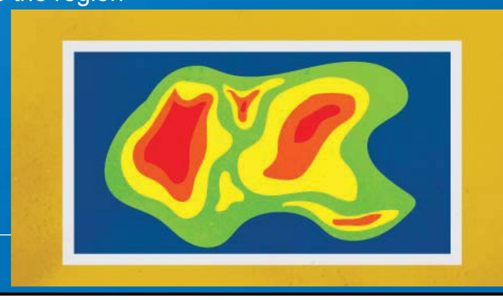
Jell-O™ Specification

The distribution problem

- Imagine two features
  - Let's call them "ρ" and "Z"
- Jell-o has a min & max for those features
  - Does <u>not</u> imply that all possible combinations are viable
  - Does <u>not</u> imply that all possible combinations are equally likely
- Need an n-dimensional "heat map"
  - **Testing should reflect heat map**
  - Don't test the borders to validate the region
- May need sub-regions
  - How many? (2 / 3 / 4)
- Gets messy fast



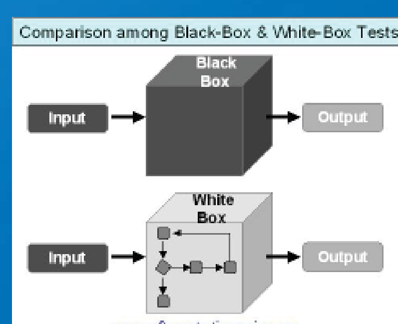
3 May 2017 7

Jell-O™ Specification

Other implications

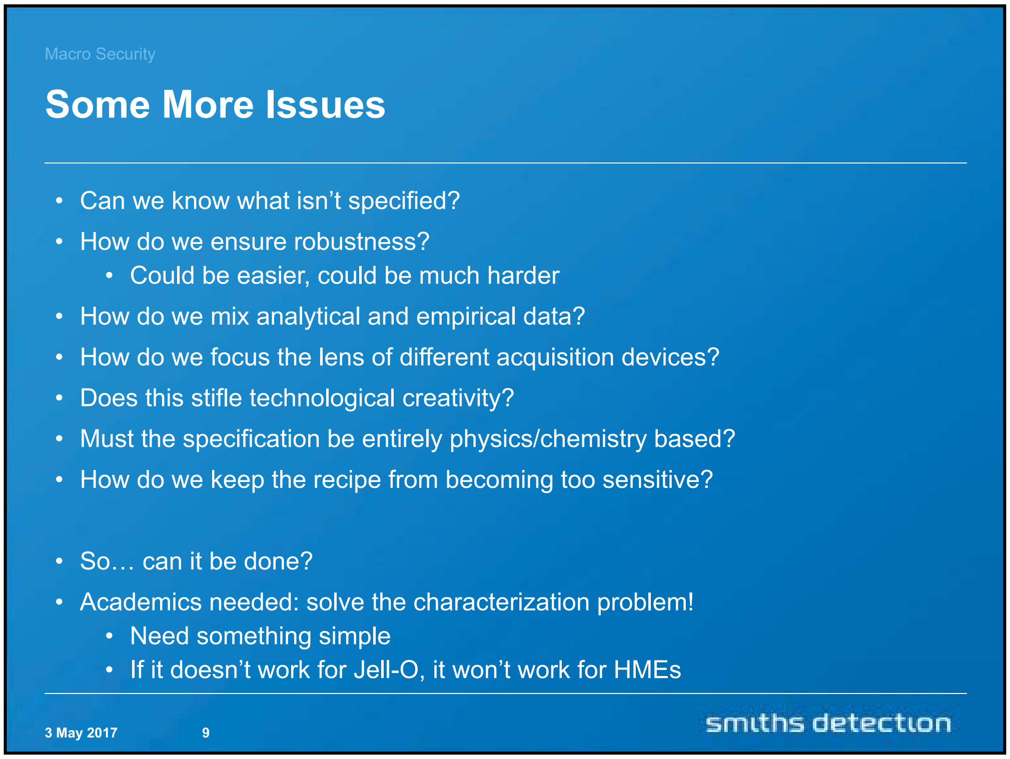
- Having a specification enables a mix of white-box ("in the know") and black-box ("in the dark") testing
  - Black-Box: based on problem specification
  - White-Box: based on solution approach

Enables the creation of "legitimate" simulants that follow the spec
Customers include vendors and validators



3 May 2017 8

smiths detection


Macro Security
Some More Issues
• Can we know what isn't specified?
• How do we ensure robustness?
• Could be easier, could be much harder
• How do we mix analytical and empirical data?
• How do we focus the lens of different acquisition devices?
• Does this stifle technological creativity?
• Must the specification be entirely physics/chemistry based?
• How do we keep the recipe from becoming too sensitive?
• So… can it be done?
• Academics needed: solve the characterization problem!
• Need something simple
• If it doesn't work for Jell-O, it won't work for HMEs
3 May 2017
9
smiths detection

16.19 Harry Martz: Regions of Responsibilities, Transfer Functions and the Role of Simulants

Regions of responsibilities, transfer functions and the role of simulants

ADSA 16 Workshop

Harry E. Martz, Jr.

May 2-3, 2017

Lawrence Livermore National Laboratory

Nondestructive Characterization Institute

LLNL-PRES-730393

This work was performed under the auspices of the U.S. Department of Energy by Lawrence Livermore National Laboratory under contract DE-AC52-07NA27344. Lawrence Livermore National Security, LLC

Conclusions

- Vendors want data for training ATRs
  - Boxes containing all explosives that will be on tests
  - Vendors pack and scan on their own systems
  - Test feedback
- Cannot give the vendors what they want
  - Some explosives dangerous to formulate and handle
  - Expensive to provide all explosives to all vendors

- Proposed solutions
  - Provide limited or no explosives to vendors
  - Scan other explosives on none vendor systems, e.g., sm. samples on MicroCT
  - Use simulants or theoretical data
  - Provide boundaries of features (e.g., density and atomic number) – denoted as regions of responsibility (RORs)
  - System to system transfer functions

LLNL-PRES-730393 2

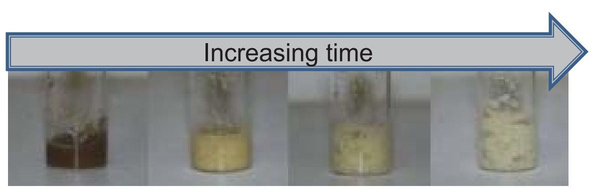
Why Do Vendors Want Boxes of Explosives?

- See the population of explosives in test
- Train directly from scans on their systems
  - No need to transfer data from other systems

LLNL-PRES-730393 3

Why Can't Gov't Give Vendors What They Want?

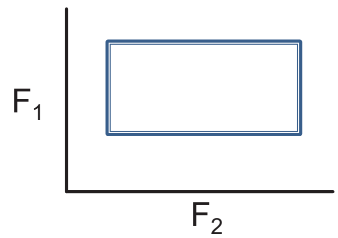
- Expense
- Safety
- Time



LLNL-PRES-730393 4

How to Create RORs

- Inputs from TSA and Intel
- Theoretical data of explosive threats
- Formulation of small amounts of explosives for scanning
  - Also evaluate safety, detonability and explosive performance
- Scans on MicroCT and vendor CT
- Create boundary around above information
  - Inform vendors what is on test
  - Used for quality control
  - Bounds the space
  - F1 & F2: Al, C, PE, Comp, ρ_e, Z_e, etc.



What Could Simulants Be Used For?

- Depending on the explosive features they mimic (and how well they mimic them), simulants can be used for
  - Training
    - Dogs
    - X-ray inspection systems
    - Carry-on baggage inspection system operators
  - Red team testing
  - Certification
  - Research

Issues with RORs, MicroCT, Simulants and Theory

- Vendors have to translate ROR/MicroCT or theory to their scanner
  - May be differences in resolution, scatter, kV, noise, artifacts, etc.
  - Transfer function required
    - May be difficult to create/implement and will add errors to the data
- All features used in a vendor's ATR may not be captured in ROR
  - For example, texture and corner cases
- Simulants may not be what is in the test
- If MicroCT, simulants, or theory are used, not clear what happens for real explosives in luggage

Futures

- Develop ATRs only using RORs from perhaps MicroCT or theory
  - If RORs are developed on MicroCT a transfer function is needed
  - Allow vendors to provide materials for scanning on MicroCT for transfer function
- If simulants are good enough, vendors may choose to train ATR using them
  - Safer, cost benefits, speed to deployment
  - DHS S&T with other agencies are developing an accreditation program

Conclusions

- Vendors want data for training ATRs
  - Boxes containing all explosives that will be on tests
  - Vendors pack and scan on their own systems
  - Test feedback
- Cannot give the vendors what they want
  - Some explosives dangerous to formulate and handle
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  - Provide limited or no explosives to vendors
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  - System to system transfer functions

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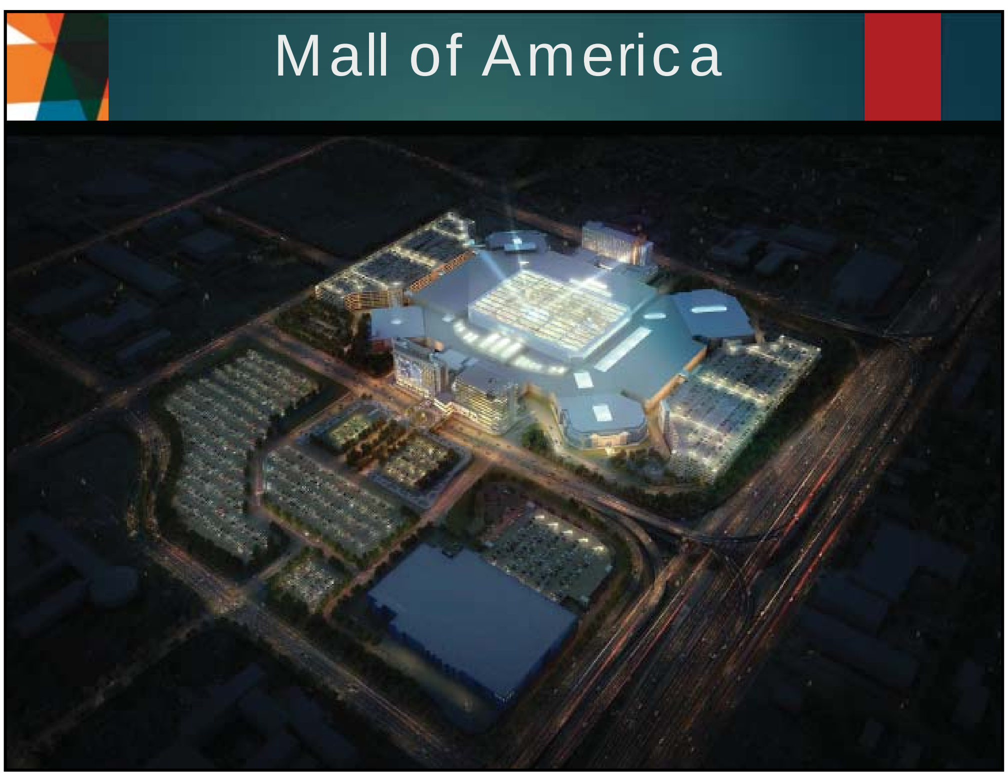
9

Lawrence Livermore
National Laboratory

16.20 Ashly Helser: Mall of America Security



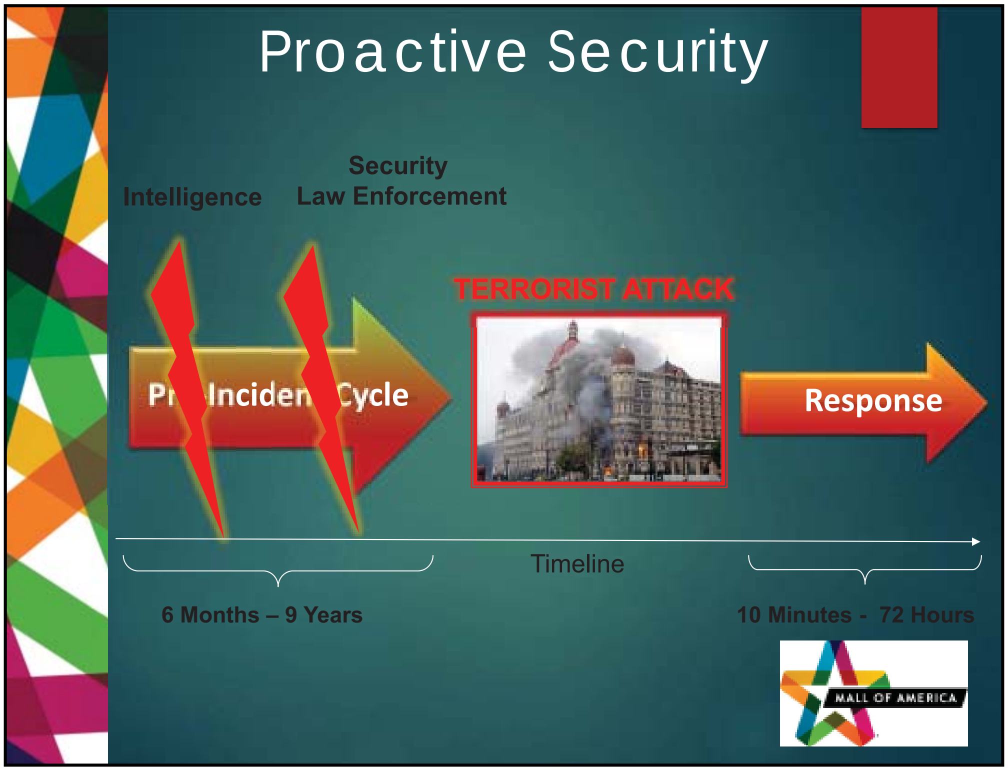
Security Department

Holistic Security Approach

- Training
- Patrol
- Field Training Officer (FTO)
- Bike
- Parental Escort Policy (PEP)
- Traffic
- K-9
- Behavior Detection
- Dispatch
- Intel analyst

MALL OF AMERICA


Each year MOA Officers spend over 4,500 hours working the 400 annual special events
MALL OF AMERICA


Proactive Security
Security
Intelligence
Law Enforcement
TERRORIST ATTACK
Pre Incident Cycle
Response
Timeline
6 Months – 9 Years
10 Minutes - 72 Hours
MALL OF AMERICA

RAM Method

- Identifying Possible Aggressors Methods of Operation (AMOs)
- Focusing on Intentions vs. Means (only)
- Working "Clandestine" – Visibly Undercover
- Detecting and Engaging Suspicious Indicators based on Behavior
- Using Covert and Overt Elicitation Techniques
- Applying Security Interviewing Technique
  - 1,400 interviews annually
    - 90-91% Refuted
    - 8-9% Criminals
    - <1% Originated cases with terrorism nexus

MALL OF AMERICA

Explosive Detection K9

MALL OF AMERICA

Explosive Detection K9

- 15 canine teams
- Started in 2002
- Handler takes the dog home after each shift
- Respond to 4 - 6 calls per day / 1,700 annually
- Support Behavior Detection
- NORT & USPCA certified
- Licensed to hold explosives
- Peroxides through FBI
- Train 5-6 hours a week

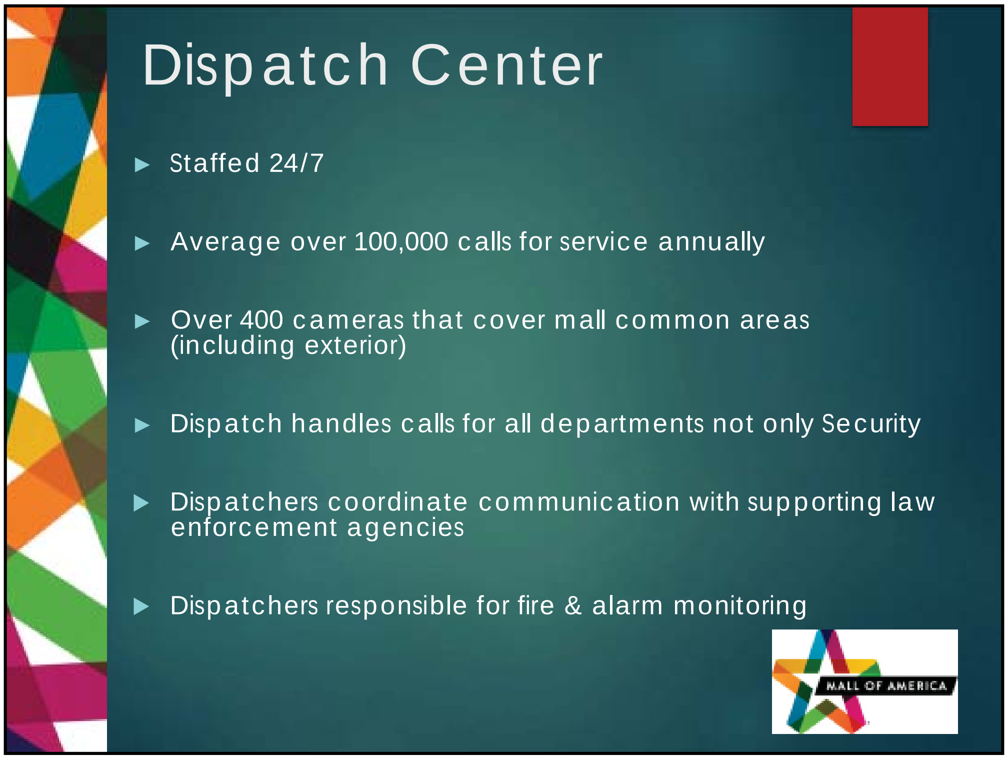
Partnerships and Outreach

- Bloomington Police
- Metro Transit Police
- Federal Bureau Investigation (FBI)
- Department of Homeland Security (DHS)
- Transportation Security Administration (TSA)
- Airport Police
- Domestic Security Alliance Council (DSAC)
- Hennepin County (CISA)
- St. Paul Police Department
- Minneapolis Police Department
- State Law Enforcement (Bureau of Criminal Apprehension)
- Minnesota Join Analysis Center (MNJAC)
- Federal Air Marshals
- Community and Corporate Partnerships

MALL OF AMERICA


Questions?
MALL OF AMERICA


MALL OF AMERICA
EST.
1992
SECURITY
Ashly Helser
ashly.helser@moa.net
952-883-8677
MALL OF AMERICA


Dispatch Center
Staffed 24/7
Average over 100,000 calls for service annually
Over 400 cameras that cover mall common areas (including exterior)
Dispatch handles calls for all departments not only Security
Dispatchers coordinate communication with supporting law enforcement agencies
Dispatchers responsible for fire & alarm monitoring
MALL OF AMERICA

16.21 Fred S. Roberts: Venue Public Security & Stadium Access Security

Venue Public Security & Stadium Access Security

Fred S. Roberts

CCICADA Director

froberts@dimacs.rutgers.edu

May 3, 2017

Command, Control, and Interoperability Center for Advanced Data Analysis

1

CCICADA

- Founded 2009 as DHS University COE
  - Based at Rutgers University; many partners
  - Data analysis, modeling, and simulation; information-based decision making and planning
- ***Here a selection of CCICADA projects relevant to transportation security:***
  - ***Port Authority Bus Terminal NYC*: Modeling & simulation; "what-if" planning for evacuation, active shooter, emergency situations, crowd management**
  - ***Modeling tools for design/redesign of facilities* with safety in mind**
  - ***Patron screening tools* developed for and used by all major sports leagues – for planning & investment**
  - ***How WTMDs work in real-world stadium situations*: Experimental Results**

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2

Evacuation Planning Tool

Credit: Wikipedia Commons

- Work with 6 NFL teams & Super Bowls
- CCICADA component of the work: behavioral aspects of stadium evacuation

3

CCICADA: From Evacuation to a Large Stadium Security Program

Engagement with stadiums and Super Bowl through "sport evac" process led to connections to stadium security: ***work with all major sports leagues***

- ***All aspects of stadium security***
- **"Best Practices for Stadium Security"** with DHS Office of SAFETY Act Implementation (OSAI) – ***on OSAI website***
  - Widely used. E.g, new Little Caesars Arena, Detroit
- OSAI II: ***Metrics***, Effectiveness, and Training for Inspections and Credentialing **-** – ***on OSAI website***
- OSAI III: ***randomnes***s: ongoing
- ***Crowd Management***

4

I. Port Authority Bus Terminal

- PABT in NYC: world's busiest bus terminal
- Critical transit facility to move people between NYC and NJ
- Central part of any emergency evacuation scenario for Manhattan
- Our stadium work led to a project for PABT:
  - ***LiDAR to produce Building Information Model***
  - ***Crowd Management Simulation Software***
-

Credit: online.WSJ.com

Credit: Wikipedia

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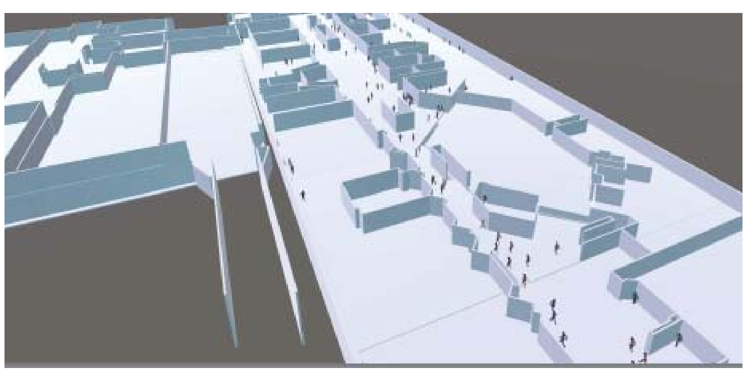
5

Why Crowd Simulation?

- Evaluate surveillance and inspection strategies
- Evacuation scenarios and extreme conditions
- Study queuing and crowd management strategies
- Structural changes, construction and gate reassignment
- Impact on retail and commercial venues



6

Port Authority Bus Terminal Scenarios

- We built a detailed model of the Port Authority Bus Terminal
  - Used CAD drawings, improved by LiDAR
  - Used detailed information including:
    - pedestrian arrivals/departures
    - origin/destination information
    - subway arrivals
    - bus schedules
  - To do "what if" experiments for scenarios such as:
    - Evacuation
    - Active Shooter
    - Delayed bus departures due to weather or accident

7

Agent Based Models

- Comprehensive agent-based models; each pedestrian modeled individually
- Level of detail provides many advantages:
  - Can study heterogeneous crowds with different behaviors:
    - Carrying suitcase
    - In a wheelchair
    - Family group
    - Emergent properties arising from individual behaviors
  - Can study interaction between individuals
  - Can study interaction between individual & building geometry
- Here part of an evacuation simulation

8

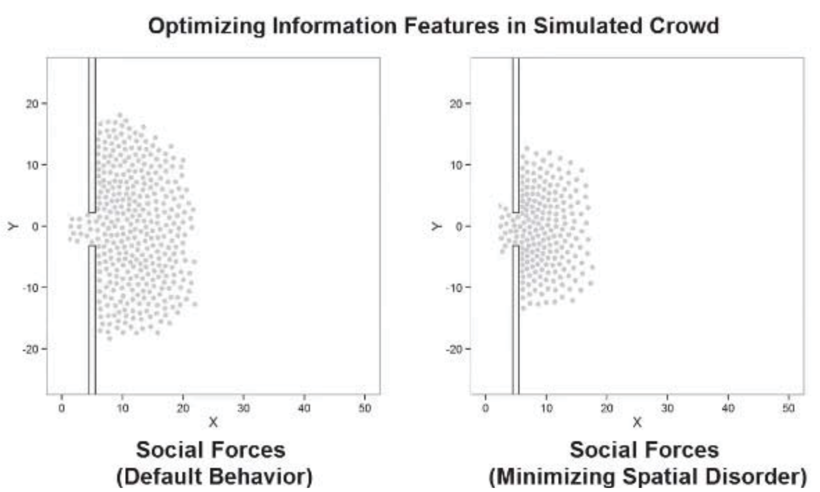
Behavior of Simulated Pedestrians

- Simulated pedestrians can visit different places: restaurant, vendor, restroom, ticket machine, … - depending upon
  - Time until bus
  - Distance
  - Capacity
- Desires based on parameterized distributions
  - Updated dynamically

9

II. Simulation-based Crowd Management and Environment Design

- Tools to automatically discover crowd behaviors to optimize certain criteria
- On the right, cooperation to exit narrow bottleneck faster

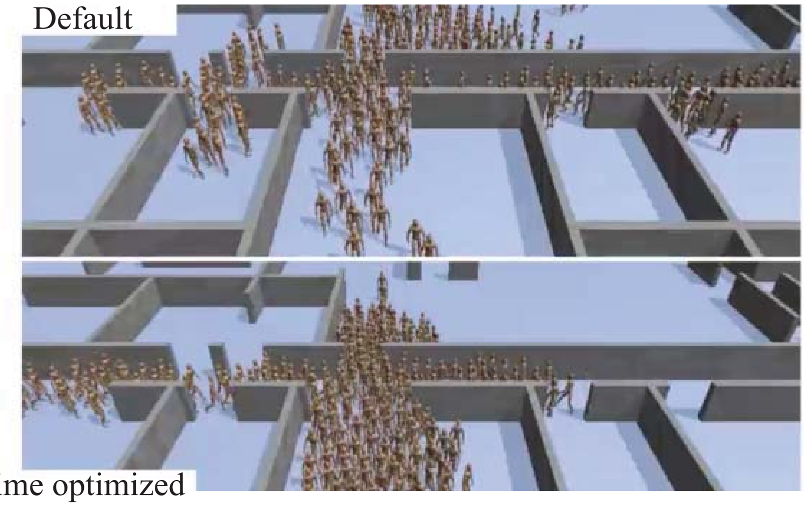


10

Office Evacuation

- Our tools helped design an optimized evacuation of 1000 people from office building.
- Time optimized model evacuates building in half the time.

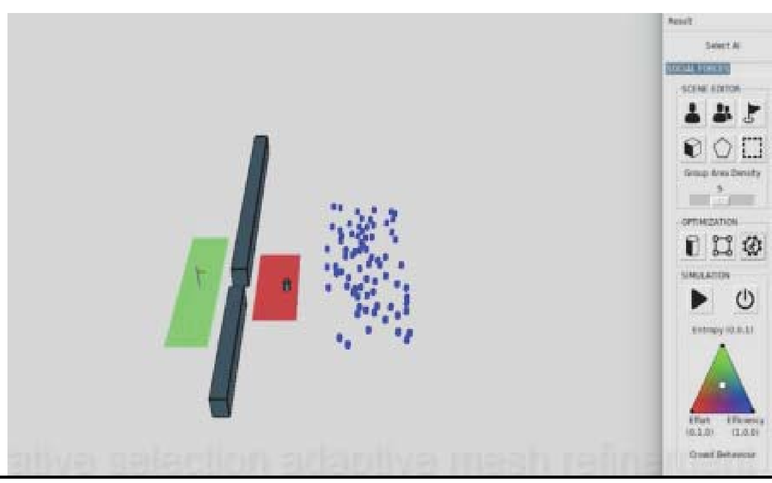
Default



11 Time optimized

Tools for Designing Environments

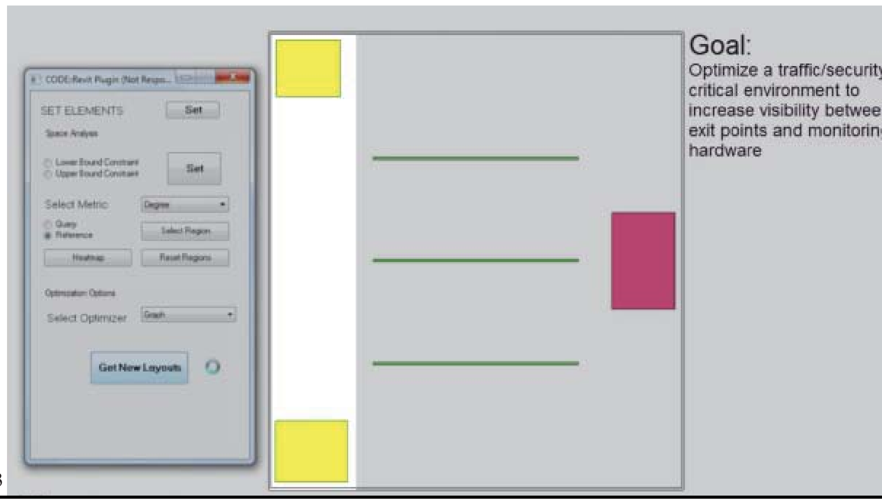
- We are developing tools for designing environments to achieve goals
- Here, studying effect of pillar design on crowd movement to exit
- Goal in green, crowd in blue, pillar in red



12

Reconfiguring an Airport Concourse to Maximize Visibility of Exit from Fixed Cameras

- Three green barriers can be moved to different locations
- Goal: Move barriers so fixed yellow cameras see red exit to optimize visibility



13

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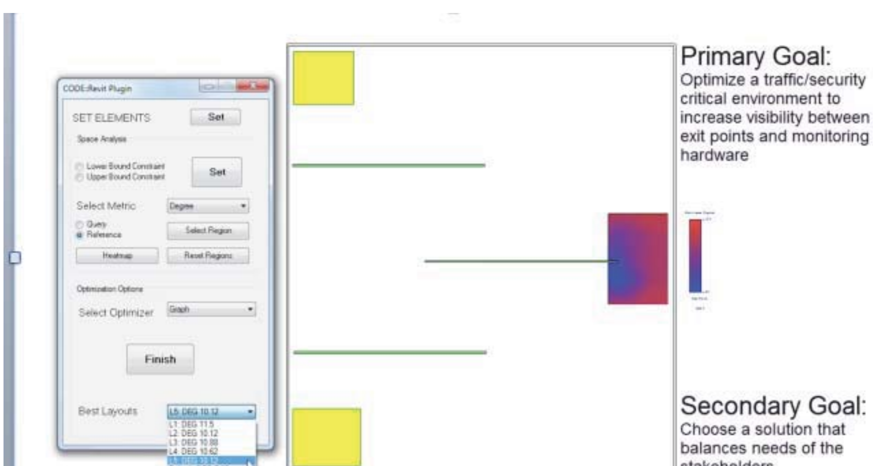

14 The set of solutions is optimal for a given metric and diversity

III. CCICADA Stadium Simulator

- ***Developed to simulate patron screening processes when MetLife Stadium investigated WTMD Issues:***
  - How many WTMDs needed?
  - How many screeners needed?
  - What is the "throughput"?
  - Performance in bad weather?

- Observed experimental WTMD use at MetLife
  Preliminary conclusion: Small # of WTMDs unlikely to get everyone through quickly enough.
- Now usable for many screening methods
- ***Used at various stadiums for investment and screening design choices***

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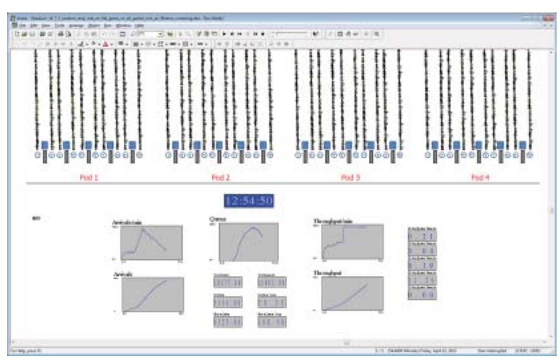
15

15

The Stadium Simulator

Most of the parameters can be obtained by ***choosing a representative game***



- Parameters
  - Arrival rates
  - Number of lanes
  - Wanding times
  - Pat-down times
  - WTMD times
- Screening Strategy
  - Switching inspection type (Y/N)
    - Number of patrons in queue to switch the process, or
    - Time of switch
  - Does phase 2 include randomization? (Y/N)
    - Ratio of patrons in each type of inspection in the randomization

The model output file includes
- **In Queue @ kickoff**
- **Queue clearance time**
- **Max Waiting Time per patron**
- **Max Queue length**

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A Department of Homeland Security Center of Excellence

16

Newer Features of the CCICADA Stadium Simulator

- Some of the new features added:
  - Randomly select patrons for secondary inspection
  - Additional WTMDs can be rolled out during inspection if lines get too long
  - Additional WTMDs can be rolled out at prescribed time based on planning for arrival rates and minimizing staff time
  - Reversing inspection and ticket scanning to gain information about patrons
  - Extra perimeter for bag-check
  - Change security settings on WTMDs at random times
  - Randomly select patrons for secondary screening
  - Check impact of incentives to get patrons in early

17

IV. Performance of WTMDs in Real Stadium Applications

- WTMDs rolled out by major sports leagues
- Don't work the way they do in the lab
- Extensive CCICADA experiments: Effect of:
  - o Height & Orientation
  - o Proximity of other metal objects
  - o Human gait
  - o Speed
- Leading to need to rethink NIST standards

18

Height and Orientation Results

- Summary of Medium sized NILECJ test objects (A & B) and Small test object (A) – WTMD Brand *anonymized here for security reasons*

Medium A

WTMD Brand 3

Orientation	Height E Trials Passed	Height F Trials Passed	Height G Trials Passed
A	100.0%	100.0%	100.0%
B	100.0%	100.0%	100.0%
C	100.0%	100.0%	100.0%

WTMD Brand 2

Orientation	Height E Trials Passed	Height F Trials Passed	Height G Trials Passed
A	100.0%	100.0%	100.0%
B	100.0%	100.0%	100.0%
C	100.0%	100.0%	100.0%

WTMD Brand 1

Orientation	Height E Trials Passed	Height F Trials Passed	Height G Trials Passed
A	25.0%	100.0%	95.0%
B	30.0%	100.0%	100.0%
C	85.0%	100.0%	100.0%

Medium B

WTMD Brand 3

Orientation	Height E Trials Passed	Height F Trials Passed	Height G Trials Passed
A	0.0%	5.0%	90.0%
B	0.0%	0.0%	0.0%
C	5.0%	5.0%	60.0%

WTMD Brand 2

Orientation	Height E Trials Passed	Height F Trials Passed	Height G Trials Passed
A	100.0%	100.0%	75.0%
B	40.0%	60.0%	50.0%
C	100.0%	100.0%	75.0%

WTMD Brand 1

Orientation	Height E Trials Passed	Height F Trials Passed	Height G Trials Passed
A	100.0%	100.0%	35.0%
B	10.0%	100.0%	25.0%
C	100.0%	100.0%	0.0%

Small A

WTMD Brand 3

Orientation	Height E Trials Passed	Height F Trials Passed	Height G Trials Passed
A	35.0%	95.0%	100.0%
B	100.0%	100.0%	100.0%
C	50.0%	100.0%	100.0%

WTMD Brand 2

Orientation	Height E Trials Passed	Height F Trials Passed	Height G Trials Passed
A	100.0%	100.0%	100.0%
B	100.0%	100.0%	100.0%
C	100.0%	100.0%	100.0%

WTMD Brand 1

Orientation	Height E Trials Passed	Height F Trials Passed	Height G Trials Passed
A			
B			
C			

Green = successful detection 19 out of 20 trials
Red = failure

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Speed Results

WTMD - Brand 1, Height E

Orientation	Test Object	Speed 1 Pass	Speed 2 Pass	Speed 3 Pass
A	Medium B	70%	90%	60%
B	Medium B	100%	70%	50%
B	Medium A	80%	100%	100%
C	Medium B	100%	90%	80%

WTMD - Brand 1, Height G

Orientation	Test Object	Speed 1 Pass	Speed 2 Pass	Speed 3 Pass
A	Medium B	50%	0%	80%
A	Medium A	10%	50%	50%
B	Medium A	70%	50%	70%
C	Medium A	0%	60%	80%

WTMD - Brand 2, Height E

Orientation	Test Object	Speed 1 Pass	Speed 2 Pass	Speed 3 Pass
A	Medium B	100%	100%	100%
B	Medium B	100%	100%	100%
B	Medium A	100%	100%	100%
C	Medium B	100%	100%	100%

WTMD - Brand 2, Height G

Orientation	Test Object	Speed 1 Pass	Speed 2 Pass	Speed 3 Pass
A	Medium B	100%	100%	100%
A	Medium A	100%	100%	100%
B	Medium A	0%	100%	100%
C	Medium A	90%	100%	100%

WTMD - Brand 3, Height E

Orientation	Test Object	Speed 1 Pass	Speed 2 Pass	Speed 3 Pass
A	Medium B	100%	100%	100%
B	Medium B	100%	100%	100%
B	Medium A	0%	0%	0%
C	Medium B	100%	100%	100%

WTMD - Brand 3, at Height G

Orientation	Test Object	Speed 1 Pass	Speed 2 Pass	Speed 3 Pass
A	Medium B	100%	100%	100%
A	Medium A	50%	40%	20%
B	Medium A	0%	0%	0%
C	Medium A	50%	30%	20%

Green = successful detection 19 out of 20 trials
Red = failure

20

Relevance to Aviation Security

- Modeling & simulation for crowd management allows for ***detailed planning of responses in emergency situations in transportation facilities***
- Modeling & simulation can be used to ***design/redesign aviation facilities with security in mind***
- Modeling & simulation allow the user to experiment with many alternative screening protocols and ***to predict the impact on security of investments in security technologies***
- Security technologies such as WTMDs ***do not always work as well "in the field" as they do in the laboratory.***
    - New standards are called for for WTMDs in various real-world situations.

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21

Acknowledgements

- DHS Office of University Programs
- DHS Office of SAFETY Act Implementation
- Port Authority of NY/NJ
- CCICADA REU program for financial support
- MetLife Stadium and many stadium partners
- Rutgers University Police Department and Rutgers OEM
- Special thanks to Dennis Egan for collaboration on an earlier version of this presentation.
- Kostas Bekris for PABT slides
- Mubbasir Kapadia for Crowd Management & Environmental Design Slides
- Christie Nelson, Jon Erdman, Vijay Chaudhary for WTMD slides
- Kostas Bekris, Mubbasir Kapadia, Thanasis Kontiris, Andrew Dobson, Brian Ricks, Trefor Williams, Jie Gong, Peter Jin, Jim Wojtowicz, and many others for PABT research
- Brian Nakamura, Thanasis Krontiris, Kevin McInerny for stadium simulation work

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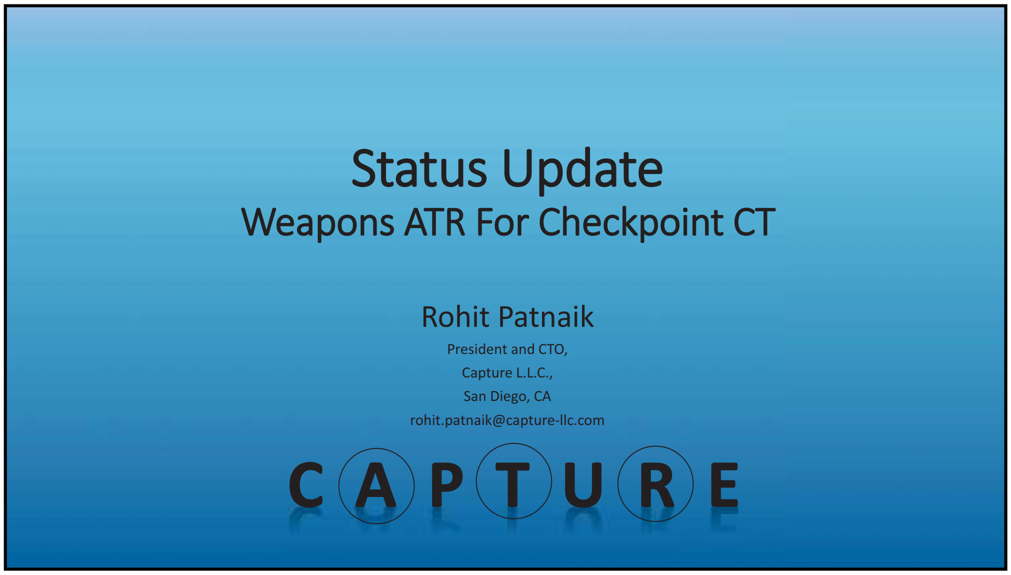
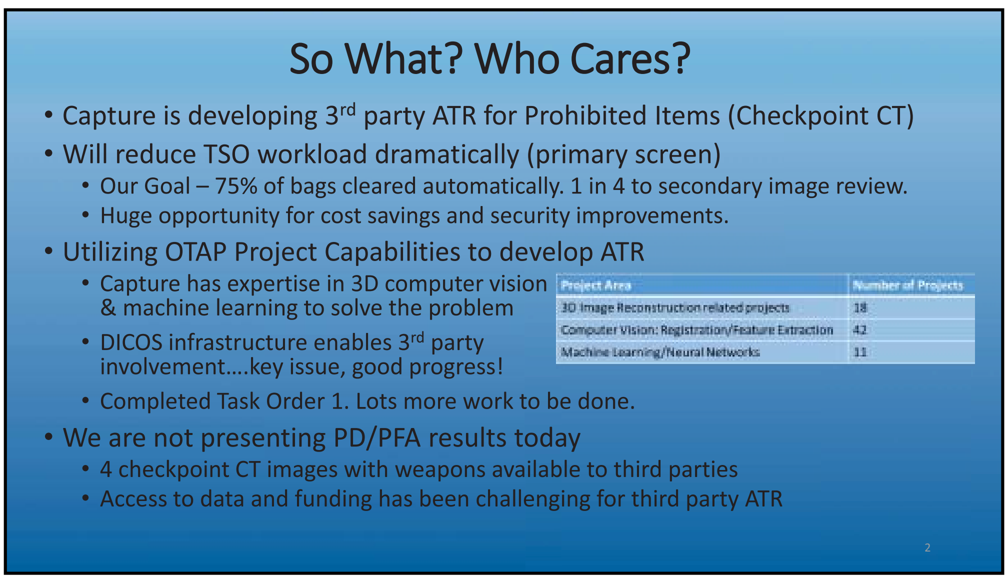
16.22 Rohit Patnaik: Status Update - Weapons ATR For Checkpoint CT

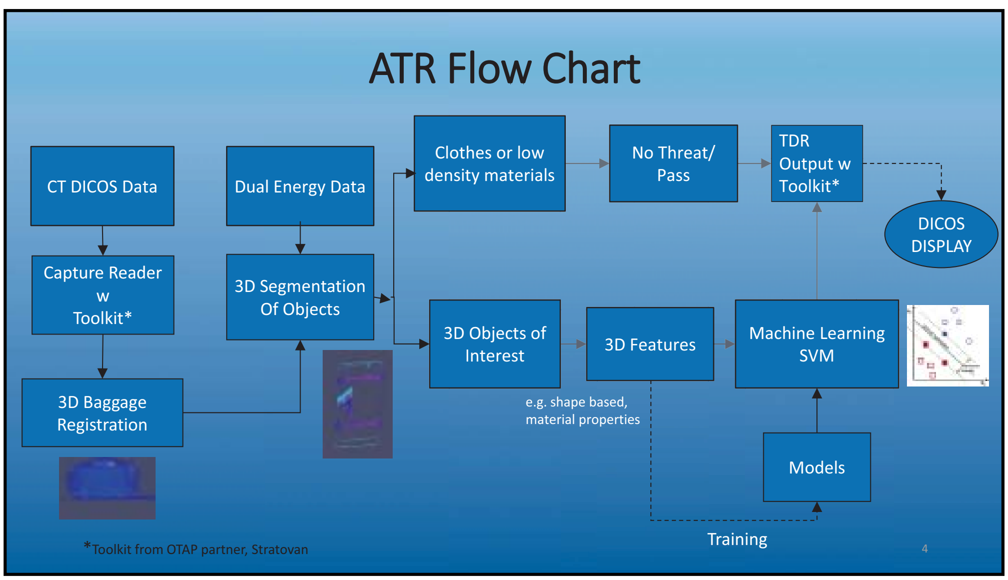




OTAP Task Order 1 - Scope

- Current Task Order is for proving DICOS data flow from OEMs to 3rd Party Developers to Output
- We use Capture's existing ATR component technologies utilizing object feature extraction and machine learning
- Initial scope is Assembled Guns and Open Knives
  - Types of weapons to be determined at next data collection
  - Extend to other prohibited items in future
- 11 images so far (including 4 weapons)
  - More images will be acquired in May, July and August with OTAP
- We are delivering a pre-beta prototype ATR in May (completing task 1 goal)
- Next task order will provide additional funding for algorithm development
  - Would like to utilize Deep Learning approaches in the future
- Lots more work to do !!

3



Future :Deep Convolutional Neural Networks

- We think that deep learning convolutional neural networks can provide a broader, more generalized solution.
  - Needs more data but we have strategies to manage with less.
  - We can utilize SOC data.
- The CNN will extract its own feature maps and decide what is important.
  - Hundreds of hidden layers
  - GPU's are a big enabler to train these networks
- Feature extraction is a highly skilled and difficult problem and requires large investments to come up with the right features.
  - Checkpoint bag objects are unpredictable
  - Huge variation in objects (including threat and non threat)
  - More training data can capture object variation
- It is now possible to visualize and make sense of the data through the layers – not so much of a black box anymore.
- It is also possible to keep deep learning networks modular and add new capabilities without re-training already certified models.

5/6/2017 CAPTURE L.L.C 5

Thoughts On Challenges Ahead …

- Algorithm Approach Will be based on available Funding
  - Feature extraction – short term cheaper
    - Easier to demonstrate short term progress
    - Leverage existing algorithms, Add new ones
  - Deep Learning – long term cheaper
    - Higher upfront costs for architecture, data collection, labeling and computing resources
    - Can be modular and scalable
- Data collection – Feature Extraction + Machine Learning
- Data collection – Deep Learning
  - We have strategies of how to address large data requirements with less data – both in labeling as well as well as variation.
  - Data acquired could be shared with other third parties.

- Which Guns and Knives to include
  - Limit scope in Data collection 1 to reduce cost and demonstrate progress
  - Focus on assembled guns and knives for now that are size appropriate for checkpoint bags
  - Will depend on what is available on site and/or local borrowed/rented sources
- PD/PFA
  - Archive data from operational trials at real airports
  - This SOC data can be used to improve algorithm

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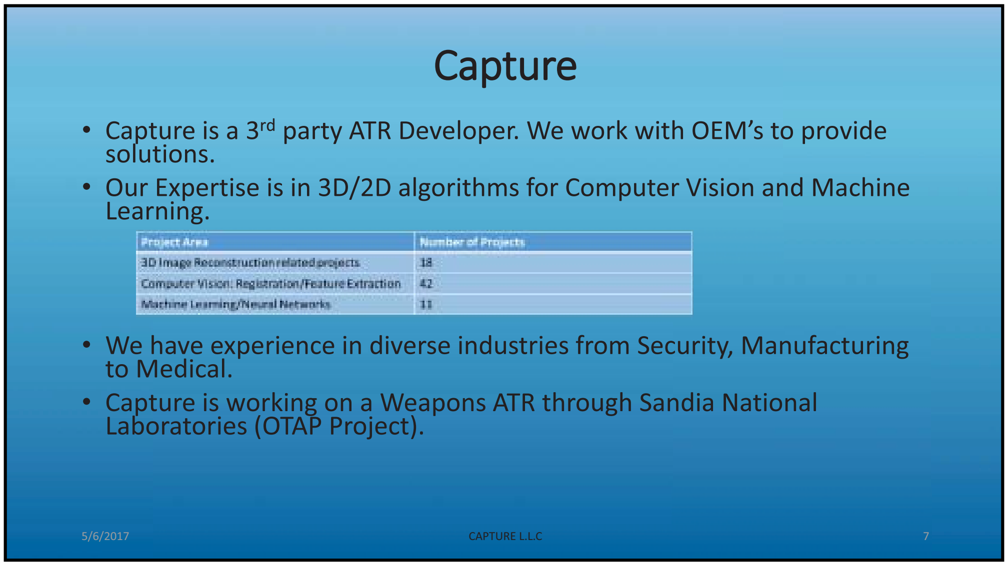

Capture
• Capture is a 3rd party ATR Developer. We work with OEM's to provide solutions.
• Our Expertise is in 3D/2D algorithms for Computer Vision and Machine Learning.
Project Area
Number of Projects
3D Image Reconstruction related projects
18
Computer Vision: Registration/Feature Extraction
42
Machine Learning/Neural Networks
11
• We have experience in diverse industries from Security, Manufacturing to Medical.
• Capture is working on a Weapons ATR through Sandia National Laboratories (OTAP Project).
5/6/2017
CAPTURE L.L.C
7

16.23 Harry Martz: Dual-Energy Decomposition Methods for Accurate Material Discrimination

LLNL-PRES-731203

Dual-Energy Decomposition Methods for Accurate Material Discrimination

ADSA 16

Kyle Champley, Harry Martz

May 3, 2017

LLNL-PRES-731203

This work was performed under the auspices of the U.S. Department of Energy by Lawrence Livermore National Laboratory under contract DE-AC52-07NA27344. Lawrence Livermore National Security, LLC

Lawrence Livermore National Laboratory

Nondestructive Characterization Institute

(ρ_e, Z_e) is useful for precise and accurate material discrimination

Physical properties provide a system independent feature space.

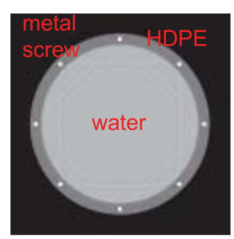
Different dual-energy decomposition methods available.

Propose an adaptive method for a system-to-system transfer function.

Reduced artifacts and errors over entire material range may lead to increased P_D and lowered P_{FA}.

Single-Energy:
Artifacts hide features

Dual-Energy:
Reduces artifacts



Absolute relative error of LAC estimate at 44 keV

Basis Type	HDPE (Z_e=5.4)	Water (Z_e=7.45)	Al (Z_e=13)	Brominated Delrin (Z_e=17.0)
LAC (PCD)	0.10 %	0.18 %	0.03 %	3.28%
Adaptive	0.16 %	0.14 %	0.10 %	0.17 %

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2

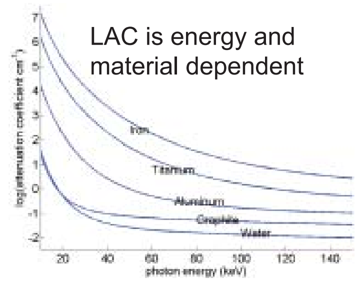
Approximate Multi-Spectral CT Model

Multi-spectral decomposition approximates energy- and spatial- dependent linear attenuation coefficients (LAC) with a separable basis expansion:

$$\mu(E,x) \approx \sum_i b_i(E) c_i(x)$$

x-ray energy — spatial location — basis function — basis coefficient

LAC is energy and material dependent



Effectiveness of multi-spectral decomposition depends on the accuracy of the above basis expansion

Pros and Cons of Two Common Bases

Alvarez and Macovski, Phys. Med. Biol., 1976
Ying, Naidu, & Crawford, J. X-ray Sci. and Tech., 2006
Azevedo et al., IEEE Trans. Nucl. Sci., 2016

Compton/ photoelectric basis

- Pros
  1. Works well for materials with effective-Z between 5 and 18
     1. Relative absolute error is < 1.3%
  2. Mostly commonly used and well-understood
- Cons
  1. Does not correctly measure the Compton or photoelectric coefficients
  2. Photoelectric coefficient is noisy, which limits it practical use

Basis Materials

Roder, Proc. SPIE, 1979

- Pros
  1. Coefficients have some physical relevance, e.g., C and Al
     1. Interpolates well within narrow range, relative error is < 0.4%
  2. Noise levels of coefficients roughly match noise levels of measured data
- Cons
  1. Error increases rapidly outside narrow range

Principal Component Analysis (PCA) Basis

- Effectiveness of multi-energy basis approximation driven by the following approximation

$$\mu(E,x) \approx \sum_i b_i(E) c_i(x)$$

- We may choose a basis by minimizing the error in the above approximation for a specified range of materials
- Principal Component Analysis enables us to choose the *best* basis possible because it minimizes the Mean Square Error
  - 3-element PCA basis derived from LAC values of Z = 6, 7, 8, 13, 26, 36; relative absolute error is < 1% from Z range 5 to 35
  - While Compton, photoelectric, iron bases error is < 3% from Z range 5 to 35

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Transformation to LAC/ Mono-Energy Basis

LAC basis is simply a **linear transformation** of any given basis, e.g., Compton/ photoelectric, material basis, etc

To use LAC basis, one must choose a basis and a pair of energies, E_1 and E_2

Then basis coefficients are LAC values at E_1 and E_2

$$\mu(E,x) \approx b_1(E)\mu_1(x) + b_2(E)\mu_2(x)$$
$$\mu(54,x) \approx 0\mu_1(x) + 1\mu_2(x)$$
$$\mu(95,x) \approx 1\mu_1(x) + 0\mu_2(x)$$

No matter what basis is used, transformation to LAC basis gives you:
- Basis functions that are unitless
- Basis coefficients that are in LAC units (mm^{-1})

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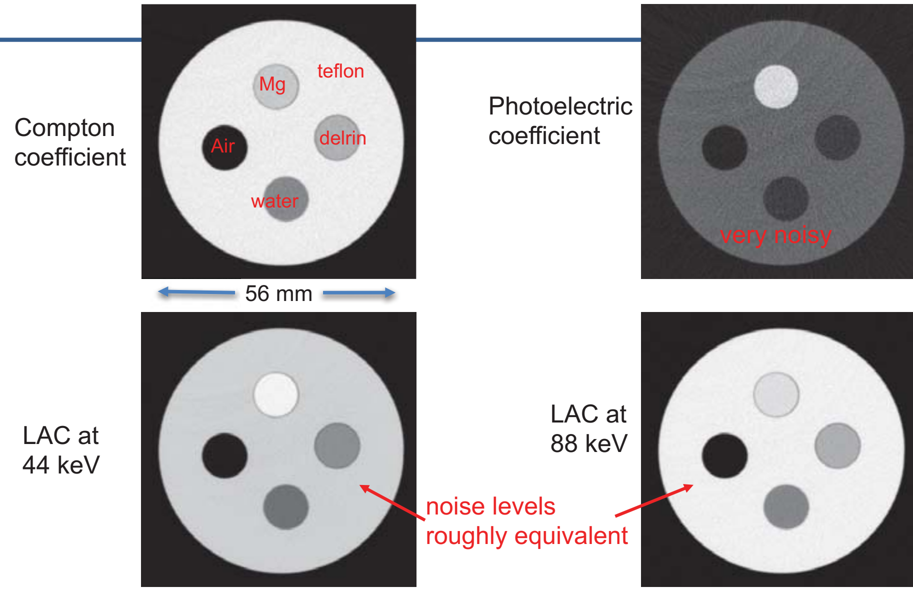
6

Comparison of Compton/ photoelectric and LAC basis results with Real Measured Data



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7

Adaptive Dual-Energy Decomposition

Form multiple LAC bases from different basis representations, e.g. bases composed of all pairs of elements that could be present in luggage

For each dual-energy measurement, perform multi-energy decomposition with each LAC basis and choose the result with the lowest residual error

Thus each ray-sum measurement pair could be decomposed using a different set of basis materials

LAC basis is necessary because it maps all bases to a common unit system that can be reconstructed; you cannot reconstruct if each measurement pair lies in a different space

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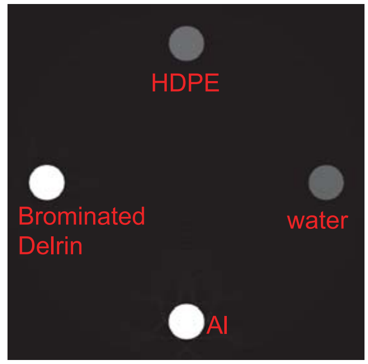
8

Dual-Energy Decomposition Experiment with Simulated Polychromatic Data

Spectrum 1:
100 kV, 2 mm Al filter

Spectrum 2:
160 kV, 2 mm Al, 2 mm Cu filters



all objects have 1" diameter

Dual Energy Decomposition Results

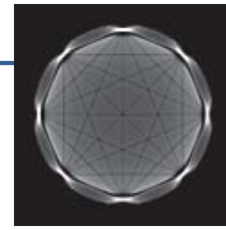
Absolute relative error of LAC estimate at 44 keV

Basis Type	HDPE (Z_e=5.4)	Water (Z_e=7.45)	Al (Z_e=13)	Brominated Delrin (Z_e=17.0)
LAC (Compton/ photoelectric)	0.10 %	0.18 %	0.03 %	3.28%
Adaptive	0.16 %	0.14 %	0.10 %	0.17 %

LAC basis derived from PCA performed on par with
LAC basis derived from Compton/ photoelectric basis

(ρ_e, Z_e) is useful for precise and accurate material discrimination

Single-Energy:
Artifacts hide features



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LAC (PCD)	0.10 %	0.18 %	0.03 %	3.28%
Adaptive	0.16 %	0.14 %	0.10 %	0.17 %

Questions?

Backup Slides

Multi-Spectral CT for Baggage Inspection

Provides more material features and reduces artifacts

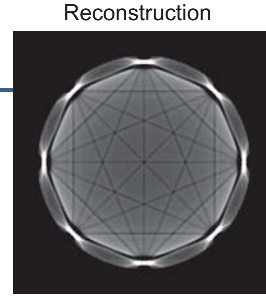
- better material discrimination
- improved accuracy and precision
- lower P_{FA}/ higher P_D

Current methods

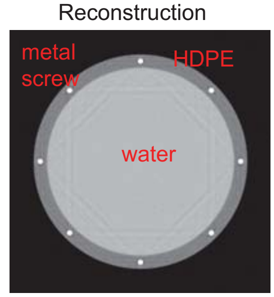
- work well for materials with a narrow range of atomic number
- do not provide results with specified units

We develop new multi-spectral methods that produce results with specified units and are accurate for materials with a wider range of atomic number

Single Energy Reconstruction



Dual Energy Reconstruction



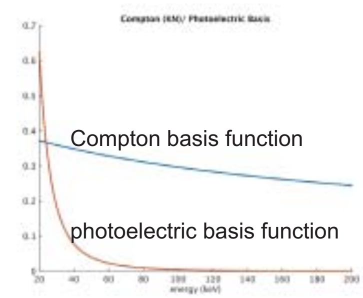
Common Dual-Energy Models

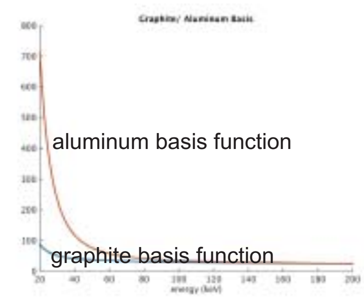
Compton/ Photoelectric Basis

Compton basis function is based on the total Klein-Nishina cross section and photoelectric basis function is E^{-3}

Basis Materials

Basis functions are the LAC curves of any two materials

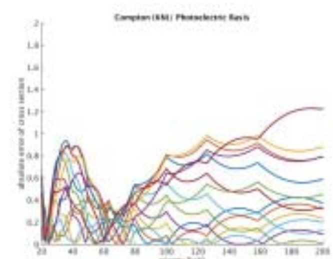


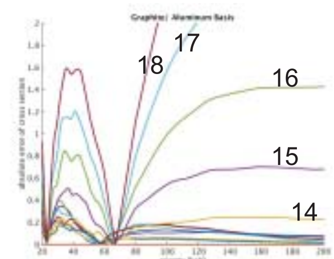


Accuracy of Common 2-Element Bases v.s. Theoretical Values

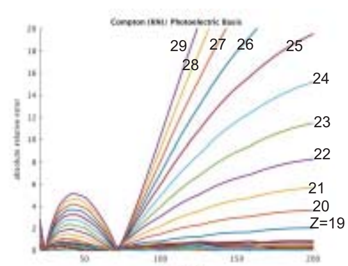
$$\text{relative error} = 100\left|\frac{Basis - Theory}{Theory}\right|$$

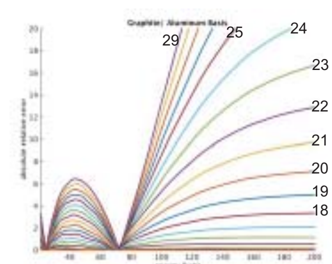
Z: 5-18





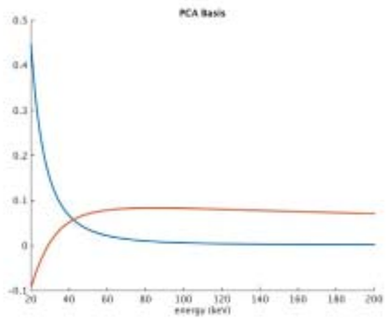
Z: 5-29





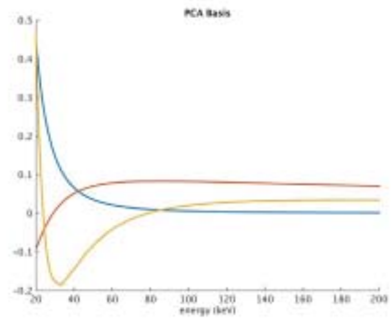
Principal Component Analysis (PCA) Basis

Dual-Energy PCA Basis



2-element PCA basis
derived from LAC
values of Z = 6, 7, 8, 13

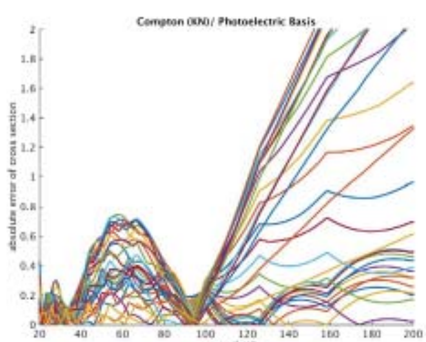
Triple-Energy PCA Basis



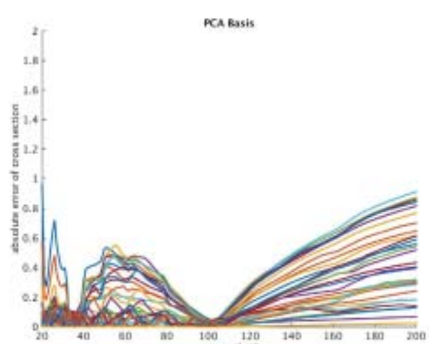
3-element PCA basis
derived from LAC values
of Z = 6, 7, 8, 13, 26, 36

Accuracy of 3-Element Bases for Elements 5 - 36

- Dual-energy: PCA basis does not outperform conventional bases
- Triple-energy: PCA basis outperforms conventional bases

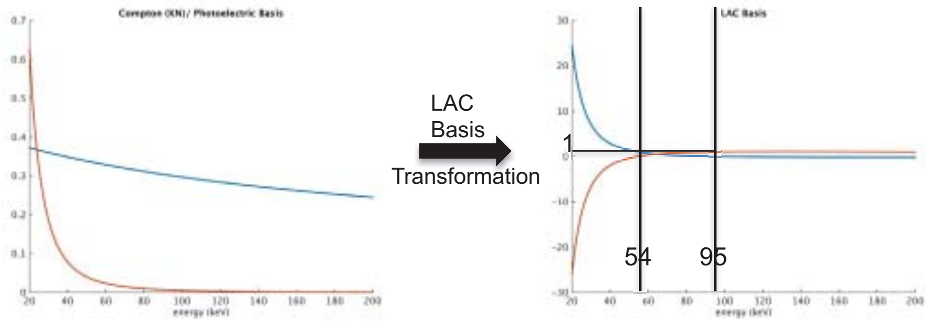


Compton, photoelectric, iron basis set



3-element PCA basis derived from LAC values of Z = 6, 7, 8, 13, 26, 36

LAC basis plots



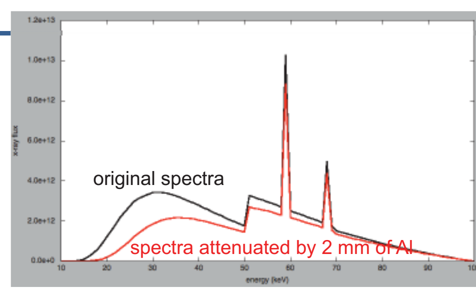
LAC basis here is a transformation of Compton/ photoelectric basis

$$\mu(E,x) \approx b_1(E)\mu_1(x) + b_2(E)\mu_2(x)$$
$$\mu(54,x) \approx 0\mu_1(x) + 1\mu_2(x)$$
$$\mu(95,x) \approx 1\mu_1(x) + 0\mu_2(x)$$

Conventional Single Energy CT

Bremsstrahlung x-ray sources provide a polychromatic spectra

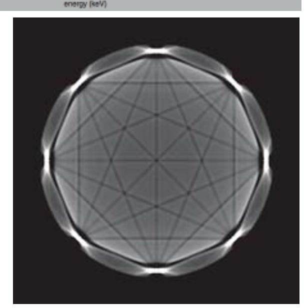
Lower energies are preferentially absorbed



Polychromatic x-ray CT is a non-linear inverse problem

Conventional methods solve a linearized approximation

Leads to cupping, streaking, loss of quantitative accuracy

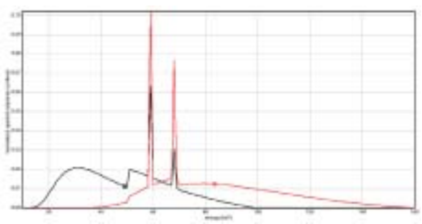


Multi-Energy CT

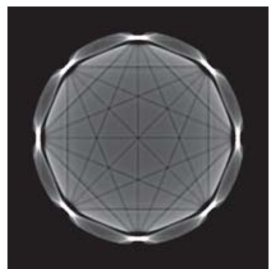
Multi-energy CT entails measuring attenuation of two or more x-ray spectra by an object

This information may be used to remove beam hardening artifacts, improve quantitative accuracy, and enable more x-ray features to be extracted

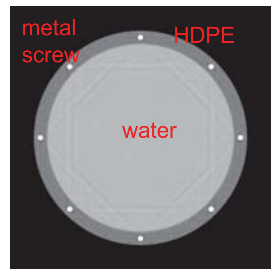
Plot of Two X-ray Spectra



Single Energy Reconstruction



Dual Energy Reconstruction



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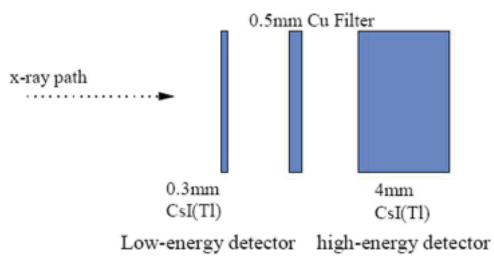
21

Collecting Multi-Spectral CT Data

1. Scan same object twice with different spectra

2. Sandwich detectors



3. Multi-energy spectral x-ray detector
   energy of each detected photon is estimated

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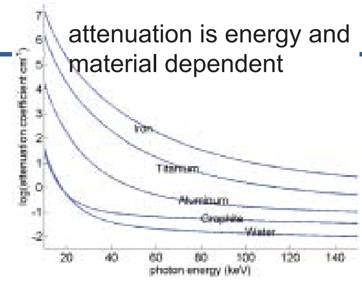
Polychromatic CT Model

attenuation is energy and material dependent



spectral response

Spatial- and energy-dependent linear attenuation coefficient (LAC)

$$g = -log\left(\int s(E) e^{-\int_L \mu(E,x)dx}\, dE\right)$$

attenuation data

x-ray energy

x-ray trajectory

Three or More Energies

- Triple energy decomposition results are on par
- with adaptive basis results from previous slide
- Decomposition requires solving a non-convex cost function, so converges to local minimum with a poor initialization
- Results with high Z materials (higher than 54) are variable because low energy bins have no signal
- If using a multi-spectral detector, one may be able to use adaptive binning to ensure all channels have sufficient statistics

Approximate Polychromatic CT Model

Approximate LAC by a separable basis expansion

$$\mu(E,x) \approx \sum_i b_i(E)c_i(x)$$

Attenuation data can then be approximated by

$$g \approx -log\left(\int s(E)e^{-\sum_i b_i(E)\int_L c_i(x)\,dx}\ dE\right)$$

$$= -log\left(\int s(E)e^{-\sum_i b_i(E)a_i(L)}\ dE\right)$$

Multi-energy Decomposition

Suppose one has measured a collection of data, (g_1, …, g_N), measured with spectra (s_1, …, s_N)

Then one may decompose the data into components (a_1, …, a_N)
By minimizing the following cost function

$$C\left(\begin{bmatrix} a_1 \\ \vdots \\ a_N \end{bmatrix}\right) := \frac{1}{2}\sum_{j=1}^{N}\left[g_j + log\left(\int s_j(E)e^{-\sum_i b_i(E)a_i(L)}\ dE\right)\right]^2$$

Decomposition: (g_1, …, g_N) $\rightarrow$ (a_1, …, a_N)

Transformation to LAC basis

Consider the Compton/ photoelectric basis (b_c, b_p) and corresponding coefficients (c_c, c_p) and energy pair (E_1, E_2). Then

$$\mu(E,x) \approx b_c(E)c_c(x) + b_p(E)c_p(x)$$

We define

$$\mu_1 := b_c(E_1)c_c + b_p(E_1)c_p$$
$$\mu_2 := b_c(E_2)c_c + b_p(E_2)c_p \rightarrow \begin{bmatrix}\mu_1\\ \mu_2\end{bmatrix} = \begin{bmatrix}b_c(E_1) & b_p(E_1)\\ b_c(E_2) & b_p(E_2)\end{bmatrix}\begin{bmatrix}c_c\\ c_p\end{bmatrix}$$

and thus

$$\begin{bmatrix}c_c\\ c_p\end{bmatrix} = \begin{bmatrix}b_c(E_1) & b_p(E_1)\\ b_c(E_2) & b_p(E_2)\end{bmatrix}^{-1}\begin{bmatrix}\mu_1\\ \mu_2\end{bmatrix}$$

$$b_c(E)c_c(x) + b_p(E)c_p(x) = \begin{bmatrix}b_c(E) \; b_p(E)\end{bmatrix}\begin{bmatrix}b_c(E_1) & b_p(E_1)\\ b_c(E_2) & b_p(E_2)\end{bmatrix}^{-1}\begin{bmatrix}\mu_1\\ \mu_2\end{bmatrix}$$

$$=: b_1(E)\mu_1 + b_2(E)\mu_2$$

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LAC Basis is Just a Linear Transformation

LAC basis is simply a **linear transformation** of a given basis, e.g., Compton/ photoelectric, material basis, etc

If one performs multi-energy decomposition with a given basis and then transforms to an LAC basis (with a simple matrix multiplication), one get the same result by doing the multi-energy decomposition directly with an LAC basis and vice versa

No matter what the root basis used, transformation to LAC basis will give you results in LAC units

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Transforming LAC basis coefficients to Electron Density and Effective Atomic Number

electron density electron cross section

One may approximate LAC by

$$\mu(E,x) \approx \mu\big(E, Z_e(x)\big) = \rho_e(x)\sigma_e(E, Z_e(x))$$

effective-Z

where non-integer Z_e defined by linear interpolation

If one has dual energy data one can estimate electron density and effective atomic number (effective-Z) by solving

$$\mu_1 = \rho_e\sigma_e(E_1, Z_e)$$
$$\mu_2 = \rho_e\sigma_e(E_2, Z_e)$$

Example of a Main Title and Content [Calibri Font]

Use 24-pt "Regular" (no bold) subtitles to provide additional detail

- Laboratory budgets over the last 15 years
- How does this affect my program?
- What are the relative values of our investments? (Discussion)
- Three critical issues to be decided:
  - Size of effort
  - Organization and R2A2
  - Funding mechanisms
- Wrap-up

Summary box has a full-width bleed.
Delete if not needed.


Lawrence Livermore
National Laboratory

16.24 Robert Klueg: TSL Basis Material Decomposition for CT Analysis

DHS SCIENCE AND TECHNOLOGY

TSL Basis Material Decomposition for CT Analysis

Homeland Security
Science and Technology

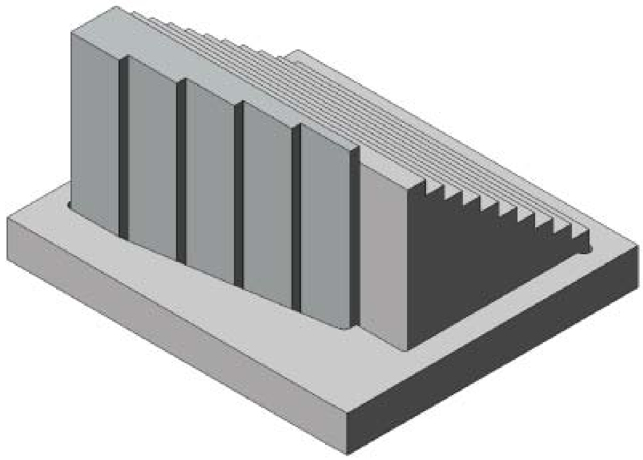
ADSA16
May 3, 2017
Ronald Krauss, Robert Klueg (DHS S&T)
Joseph Palma (Battelle)
Alex DeMasi (Signature Science)
Transportation Security Laboratory
Applied Research Division

Conclusion

- Dual-energy CT based BMD results in material features (electron density, effective atomic number) that are reasonably system-independent
  - No need for beam hardening compensation
- Photon counting CT based BMD also results in material features that are commensurate with DECT based BMD
  - System dependence less of an issue due to photon counting
  - No need for beam hardening compensation
  - Single-row MultiX CZT detectors are reasonable to use for our purposes
  - Detector response imperfections cancel out when determining features, including LAC(E)
- Discussion: are these methods relevant and applicable to security screening systems?

DHS Science and Technology Directorate | MOBILIZING INNOVATION FOR A SECURE WORLD 2

Part 1: DECT BMD



DHS Science and Technology Directorate | MOBILIZING INNOVATION FOR A SECURE WORLD 3

Introduction

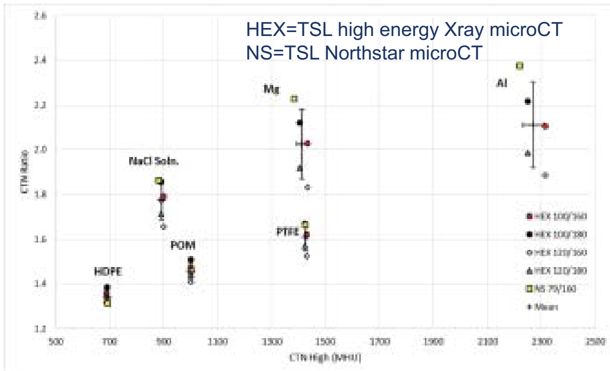
- TSL MicroCT X-ray systems support material characterization studies
- TSL MicroCT systems are similar to systems at Tyndall Reactive Materials Group (TRMG) and Lawrence Livermore National Laboratory (LLNL), and results can be compared.
- Although each location uses standardized processes and procedures, results vary because of the system-dependent factors
- Basis Material Decomposition (BMD) is being developed as a method to reduce system-dependent factors and provide consistent measurements across different platforms at various labs.
- Sponsored by S&T HSARPA Explosives Division (EXD)
  - Awarded to Battelle
  - Phase 1 Complete
  - Phase 2 Ongoing

4

Motivation: Reduce System-Dependent Factors

MicroCT system-dependent factors:

- system geometry
- applied voltage
- X-ray Tube characteristics
- incident-beam filtration
- collimation
- detector characteristics
- signal processing methods
- beam-hardening correction



5

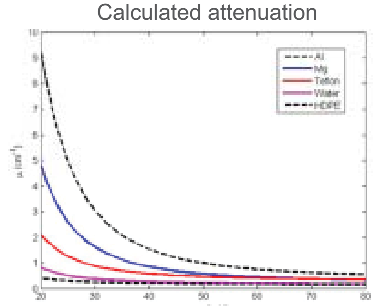
What is BMD?

- BMD is an X-ray imaging technique that characterizes materials in terms of the equivalent **mass density** (ρ) of two (or more) known and well-characterized basis materials
- In practice, two basis materials that have largely different mass attenuation coefficients work best
- For this study, Aluminum and HDPE were selected.

The attenuation of an arbitrary material (i.e. explosives or simulants) is represented as a linear combination of the two basis materials:

$$\frac{\mu(E)}{\rho} = a_1 \frac{\mu_1(E)}{\rho_1} + a_2 \frac{\mu_2(E)}{\rho_2}$$

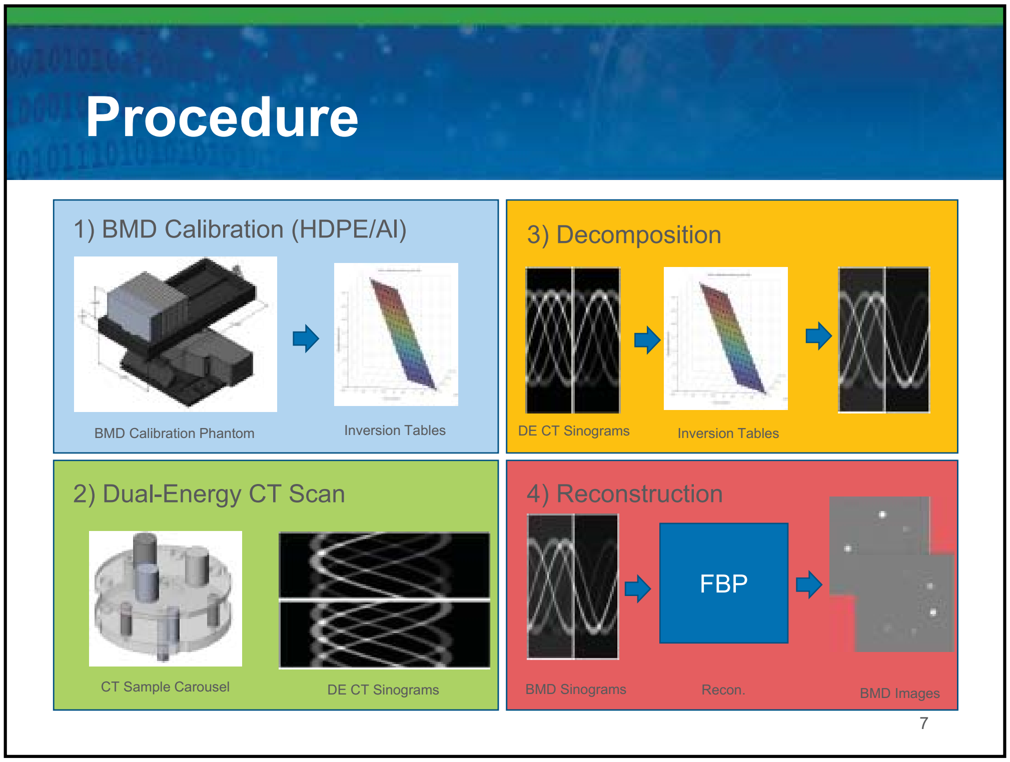
Calculated attenuation

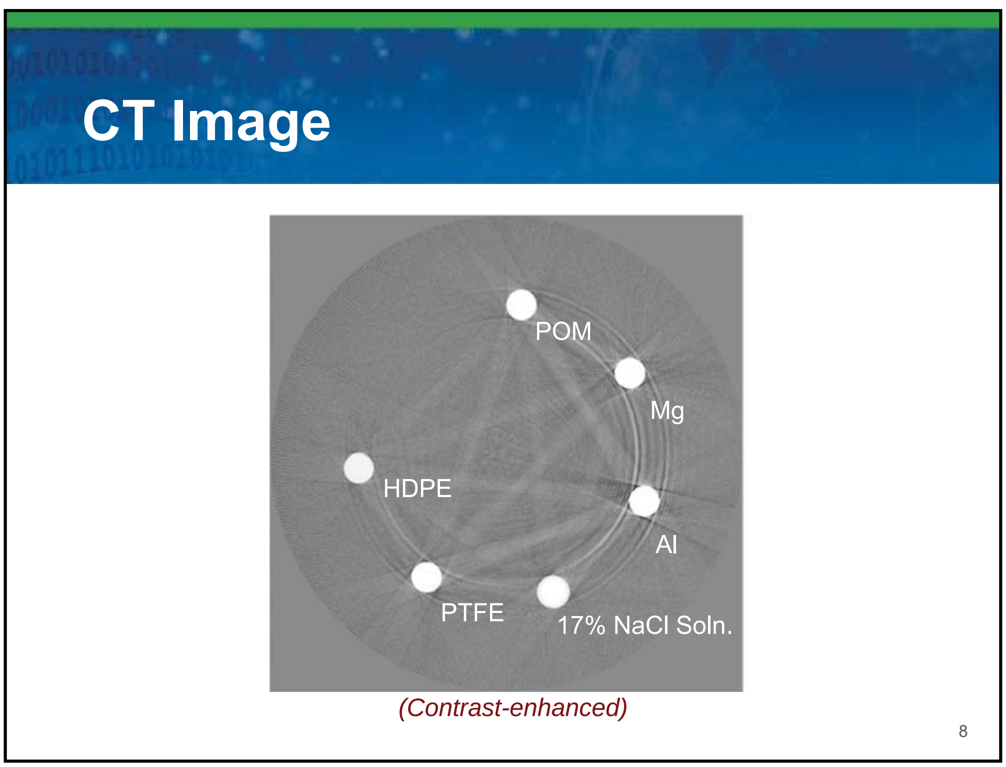


BMD coefficients

Material	a_1	a_2	RMS
HDPE	1.000	0.000	0.000
Water	0.867	0.126	0.005
Teflon	0.678	0.195	0.006
Mg	0.211	0.776	0.007
Al	0.000	1.000	0.000

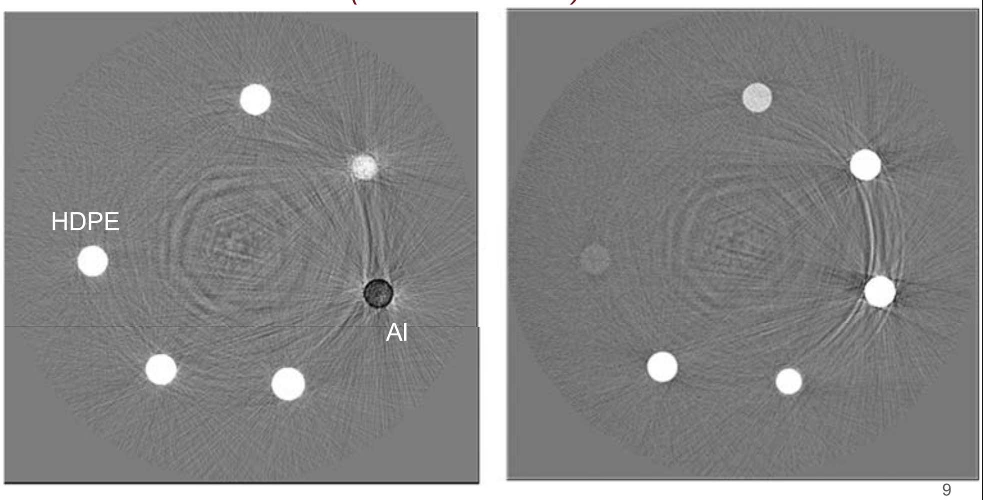
6


Procedure
1) BMD Calibration (HDPE/Al)
BMD Calibration Phantom
Inversion Tables
3) Decomposition
DE CT Sinograms
Inversion Tables
2) Dual-Energy CT Scan
CT Sample Carousel
DE CT Sinograms
4) Reconstruction
FBP
BMD Sinograms
Recon.
BMD Images
7


CT Image
POM
Mg
HDPE
Al
PTFE
17% NaCl Soln.
(Contrast-enhanced)
8

Basis Images

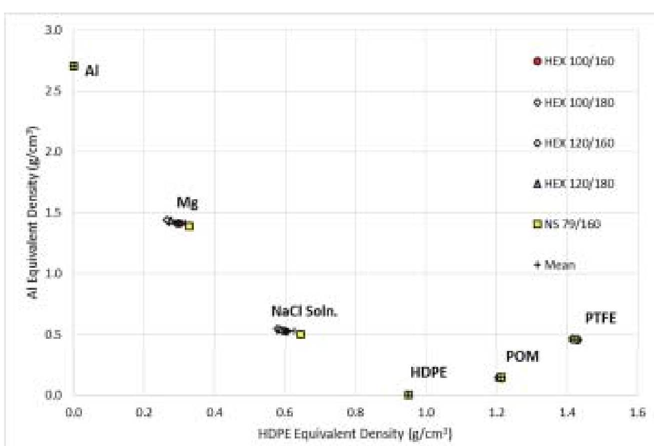
HDPE *(Contrast-enhanced)* Aluminum



9

BMD Results: Equivalent Density

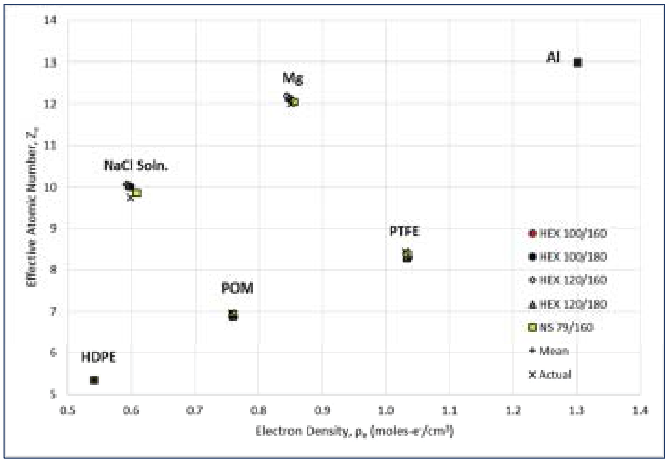
BMD Equivalent Density Feature Space



10

BMD Results: ρ_e and Z_e

Optional Step: convert to Z_e and ρ_e Feature Space



11

Summary of Phase 1 Results

- ρ_e
  - inaccuracy < 1.1% for all materials expect 1" Al (3.1%)
  - Standard deviation < 1%
- Z_e
  - inaccuracy was under 2% for all materials
  - Standard deviation < 1%
- Materials characterization results were system–independent comparable to LLNL SIRZ (photoelectric/Compton decomp)
- Satisfactory results were obtained without the need for beam-hardening compensation

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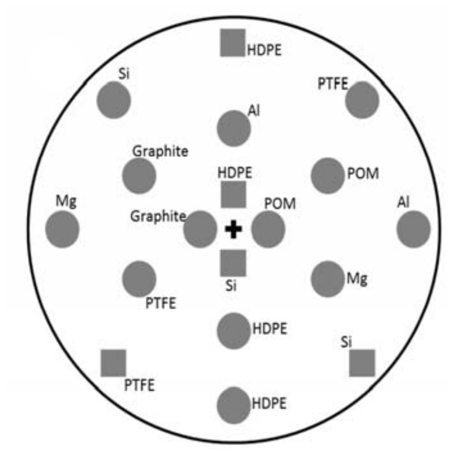
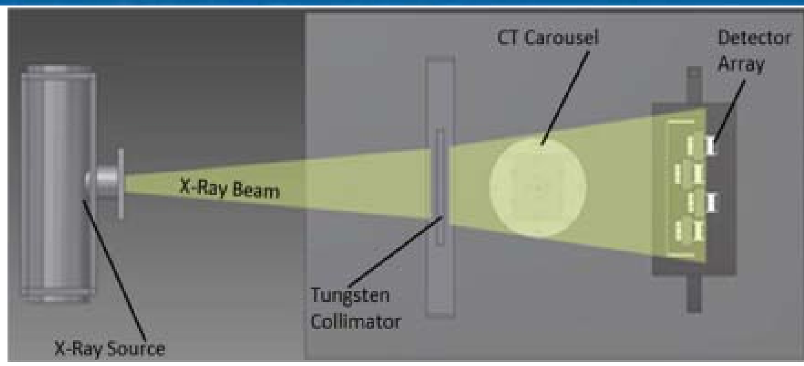
Part 2: Photon Counting BMD



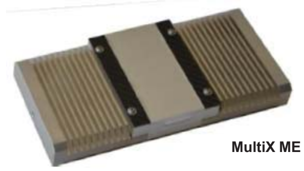
Introduction

- TSL was in possession of a MultiX ME100 photon counting detector array
- Photon counting is used in the medical field, but it is unknown whether it would be beneficial to security CT screening, whether to replace or supplement integrating detectors
- Project sponsored by TSL internal R&D
    - awarded to Signature Science
    - Phase 1 complete
    - Phase 2 ongoing

Spectral CT System

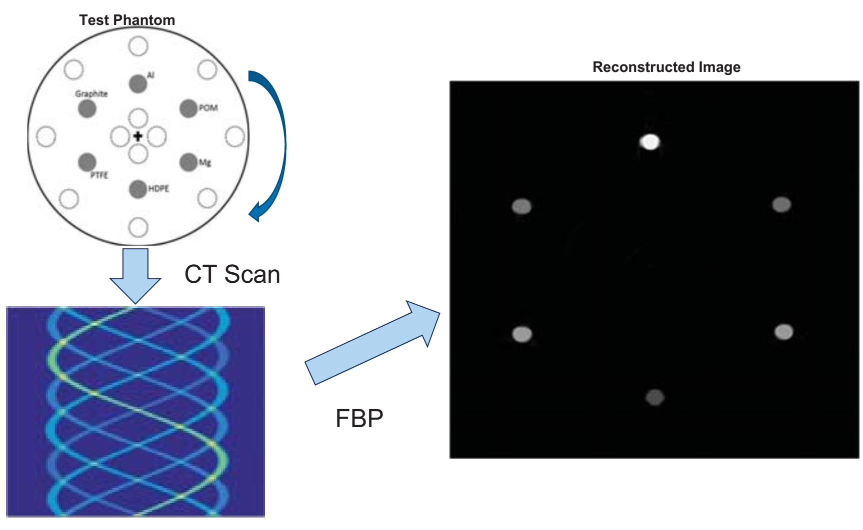


- 4 photon-counting linear detector arrays with 800µm resolution
- Attenuation information from up to 128 energy bins (20-160keV) is available.



MultiX ME 100

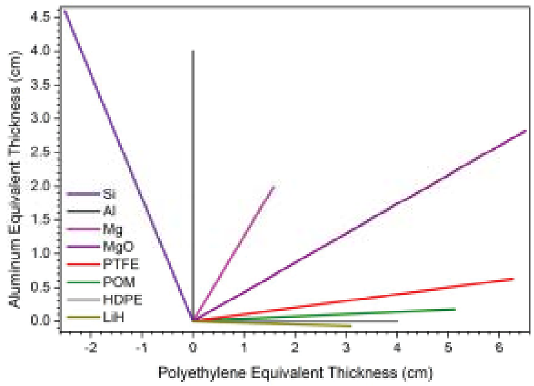
Emulate Current Integration



16

Basis Material Decomposition (BMD)

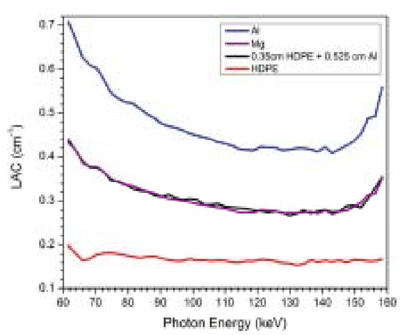
- HDPE and Aluminum again used as basis materials
- Calibration uses simple step wedges
- Materials outside the ρ_e,Z_e space of basis materials can have negative density/thickness



17

Example: Magnesium

- Magnesium decomposition is valid over a wide range of energies, i.e. measurement matches prediction based on HDPE and Al
- $\mu_{Mg} = 0.35\ \mu_{HDPE} + 0.525\ \mu_{Al}$



18

Basis Material Decomposition (BMD)

- Decomposed sinograms are noisy, but noise is correlated.
- Each basis material is mostly absent from the other basis material reconstructions
- Data is renormalized according to the basis materials, HDPE and aluminum, present in the test phantoms.
- Reconstructed objects are segmented and basis material equivalent thicknesses are converted to ρ_e,Z_e values
- Using energy-dependent LACs of the basis materials, basis material equivalent thicknesses for a material are used to estimate its energy-dependent LAC
    - Traditional dual-energy CT can also calculate LAC values but only at two “effective” energies, using several reference materials

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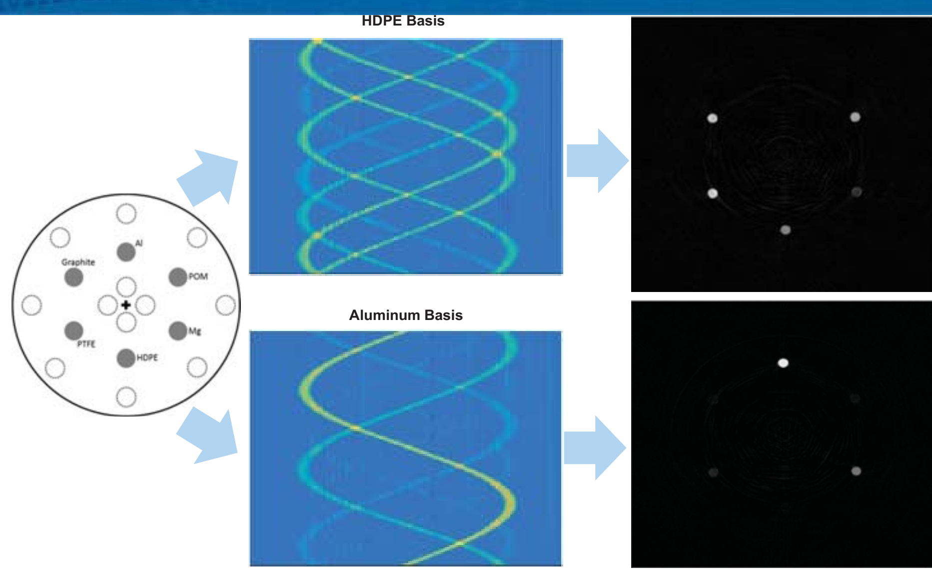
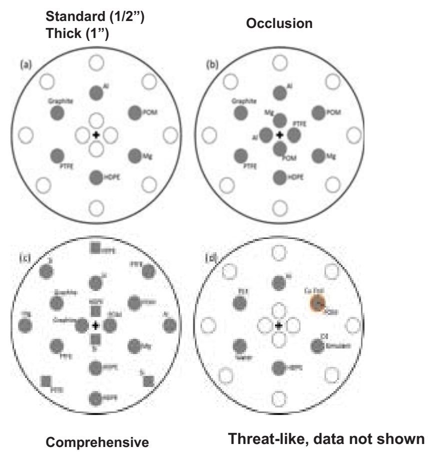
Basis Material Decomposition (BMD)



Phantoms

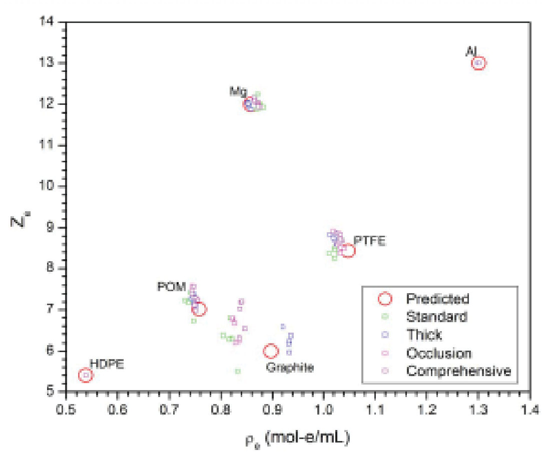
- 5 phantoms of increasing complexity were used



21

Phase 1 Results: ρ_e and Z_e

- Little variation in ρ_e,Z_e for POM, PTFE, and Mg despite the range of scattering environments

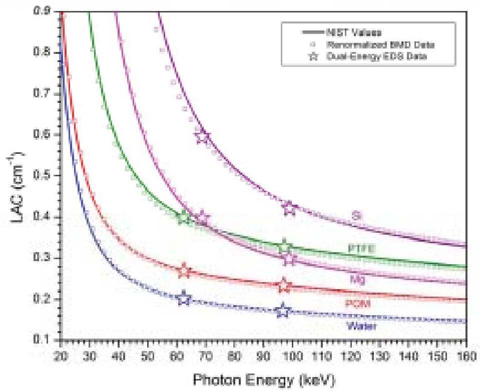


Graphite, in retrospect, was a poor choice of test material.

22

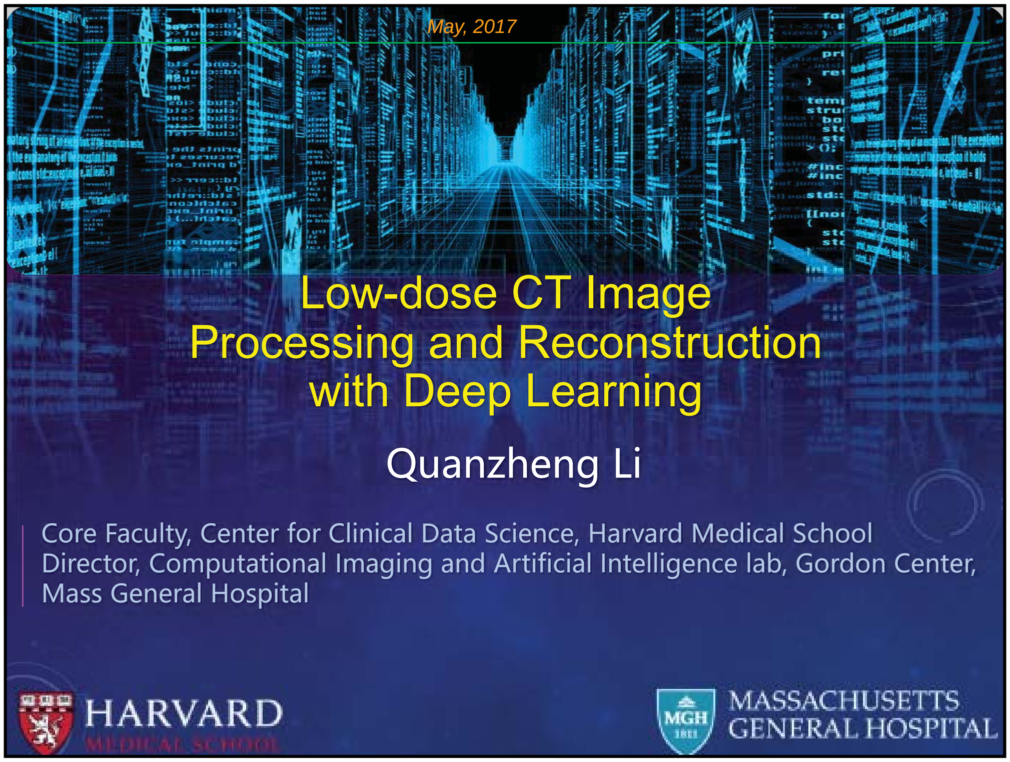
Phase 1 Results: LAC

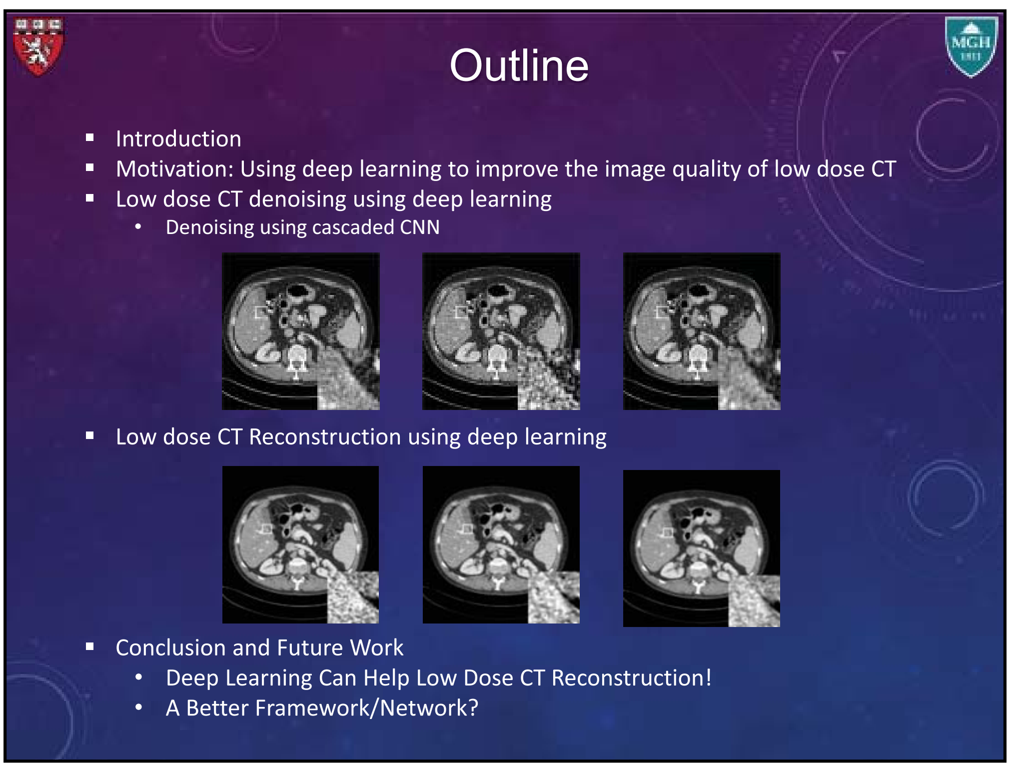
- Excellent agreement between NIST and BMD-derived LAC throughout energy range

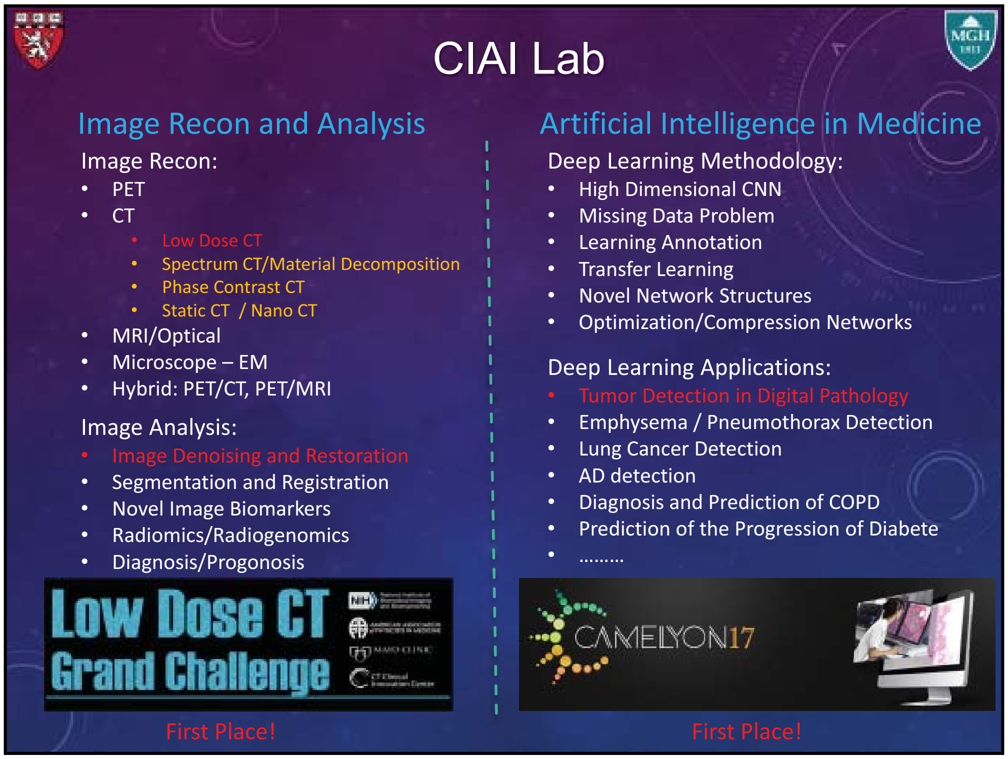


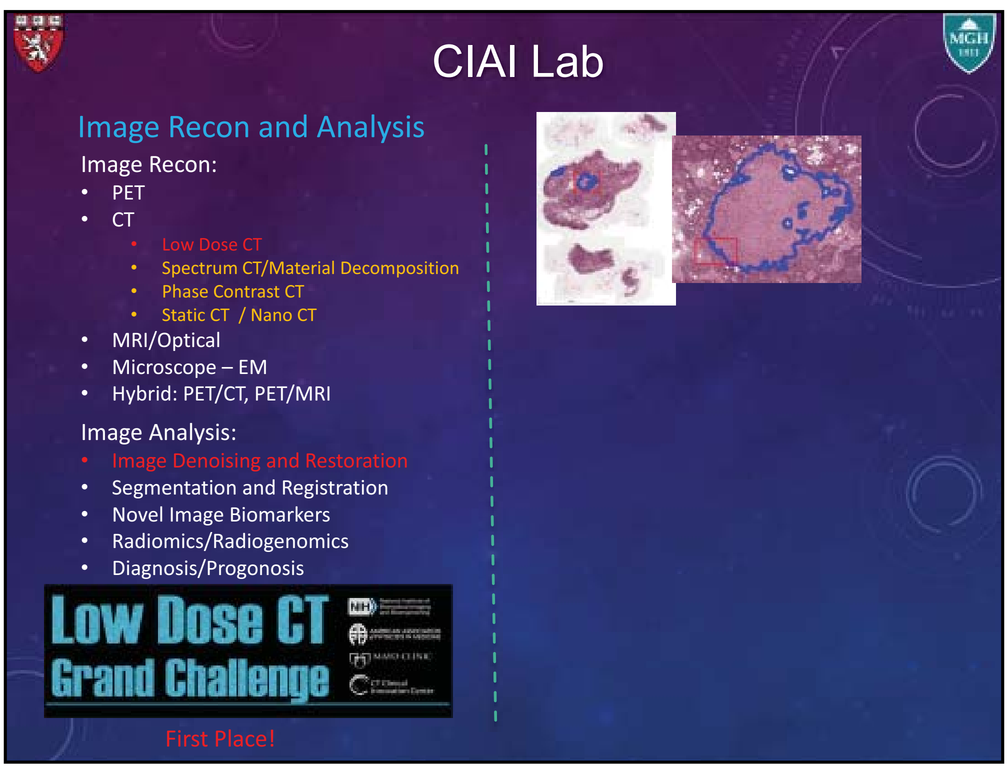
23

16.25 Quanzheng Li: Low-dose CT Image Processing and Reconstruction with Deep Learning






CIAI Lab
Image Recon and Analysis
Image Recon:
• PET
• CT
• Low Dose CT
• Spectrum CT/Material Decomposition
• Phase Contrast CT
• Static CT / Nano CT
• MRI/Optical
• Microscope – EM
• Hybrid: PET/CT, PET/MRI
Image Analysis:
• Image Denoising and Restoration
• Segmentation and Registration
• Novel Image Biomarkers
• Radiomics/Radiogenomics
• Diagnosis/Progonosis
Low Dose CT Grand Challenge
First Place!
Artificial Intelligence in Medicine
Deep Learning Methodology:
• High Dimensional CNN
• Missing Data Problem
• Learning Annotation
• Transfer Learning
• Novel Network Structures
• Optimization/Compression Networks
Deep Learning Applications:
• Tumor Detection in Digital Pathology
• Emphysema / Pneumothorax Detection
• Lung Cancer Detection
• AD detection
• Diagnosis and Prediction of COPD
• Prediction of the Progression of Diabete
• ....
CAMELYON17
First Place!


CIAI Lab
Image Recon and Analysis
Image Recon:
• PET
• CT
• Low Dose CT
• Spectrum CT/Material Decomposition
• Phase Contrast CT
• Static CT / Nano CT
• MRI/Optical
• Microscope – EM
• Hybrid: PET/CT, PET/MRI
Image Analysis:
• Image Denoising and Restoration
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• Radiomics/Radiogenomics
• Diagnosis/Progonosis
Low Dose CT Grand Challenge
First Place!

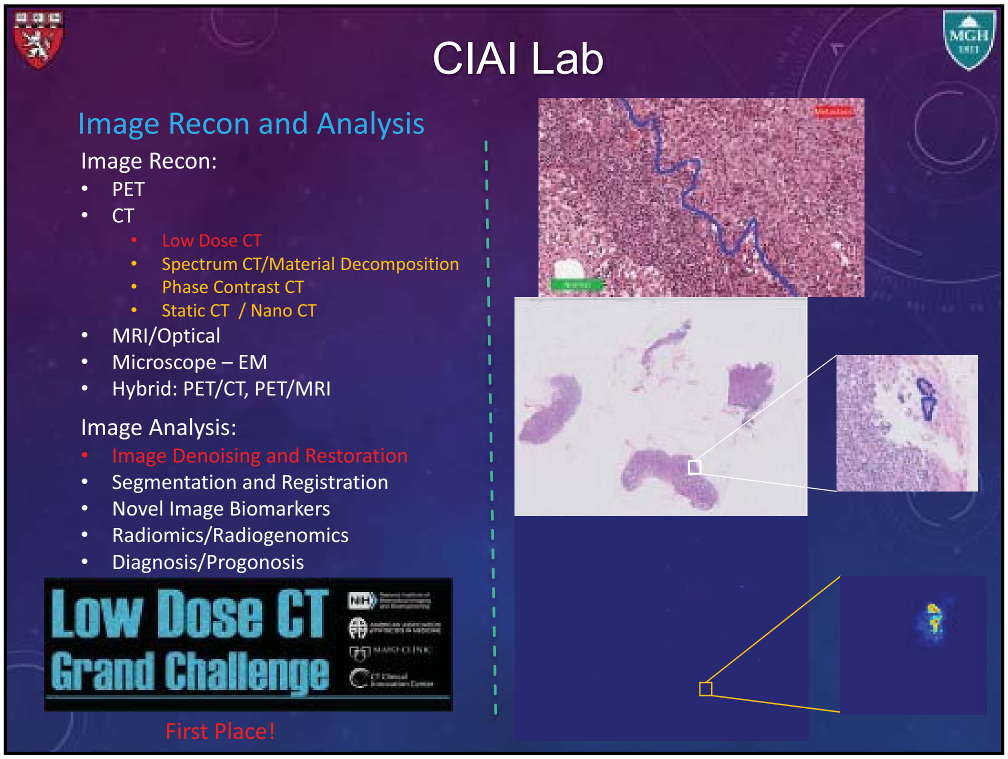
CIAI Lab
Image Recon and Analysis
Image Recon:
• PET
• CT
• Low Dose CT
• Spectrum CT/Material Decomposition
• Phase Contrast CT
• Static CT / Nano CT
• MRI/Optical
• Microscope – EM
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Image Analysis:
• Image Denoising and Restoration
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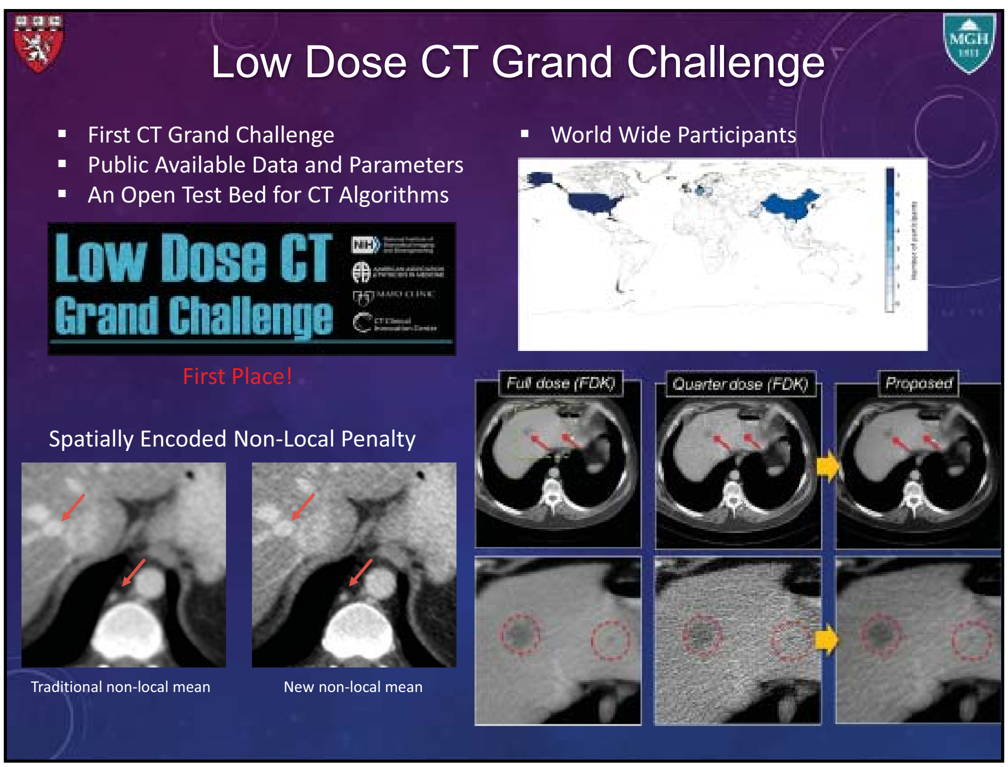
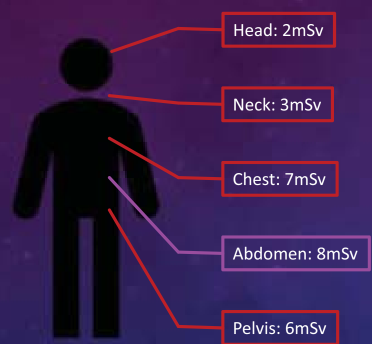
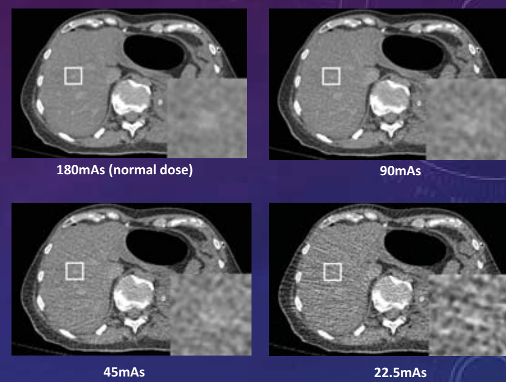
• Diagnosis/Progonosis
Low Dose CT Grand Challenge
First Place!


Low Dose CT Grand Challenge
▪ First CT Grand Challenge
▪ Public Available Data and Parameters
▪ An Open Test Bed for CT Algorithms
Low Dose CT Grand Challenge
First Place!
▪ World Wide Participants
Spatially Encoded Non-Local Penalty
Traditional non-local mean
New non-local mean
Full dose (FDK)
Quarter dose (FDK)
Proposed

Typical Low-dose CT





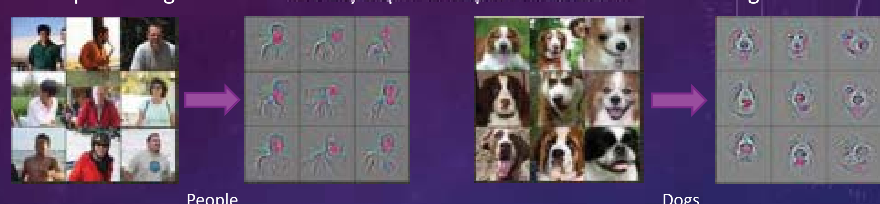
*ICRP recommended 1-year public dose limit: **1mSv***

Method	Assumption	Pros	Cons
Mean Filter	I.i.d. Gaussian noise	Simple	Severe Blurring
Total Variation	Piecewise constant	Edge-preservation	Staircase artifacts
Non-local Mean	Self similarity	Better performance	Edge blurring
KSVD	Image patches are low-rank	Even better performance	Time-consuming

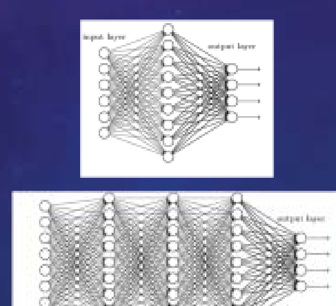
Mettler Jr F A et al. Effective doses in radiology and diagnostic nuclear medicine: a catalog 1. Radiology, 2008, 248(1): 254-263.

Deep Learning

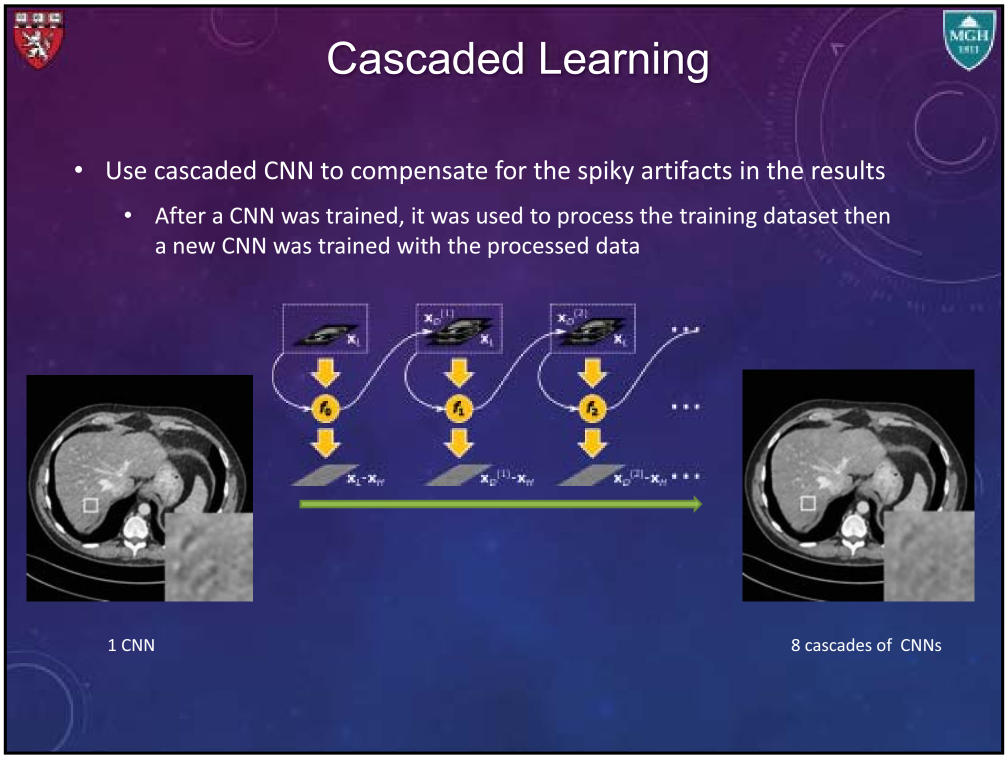
- Deep learning can automatically capture important features in the images

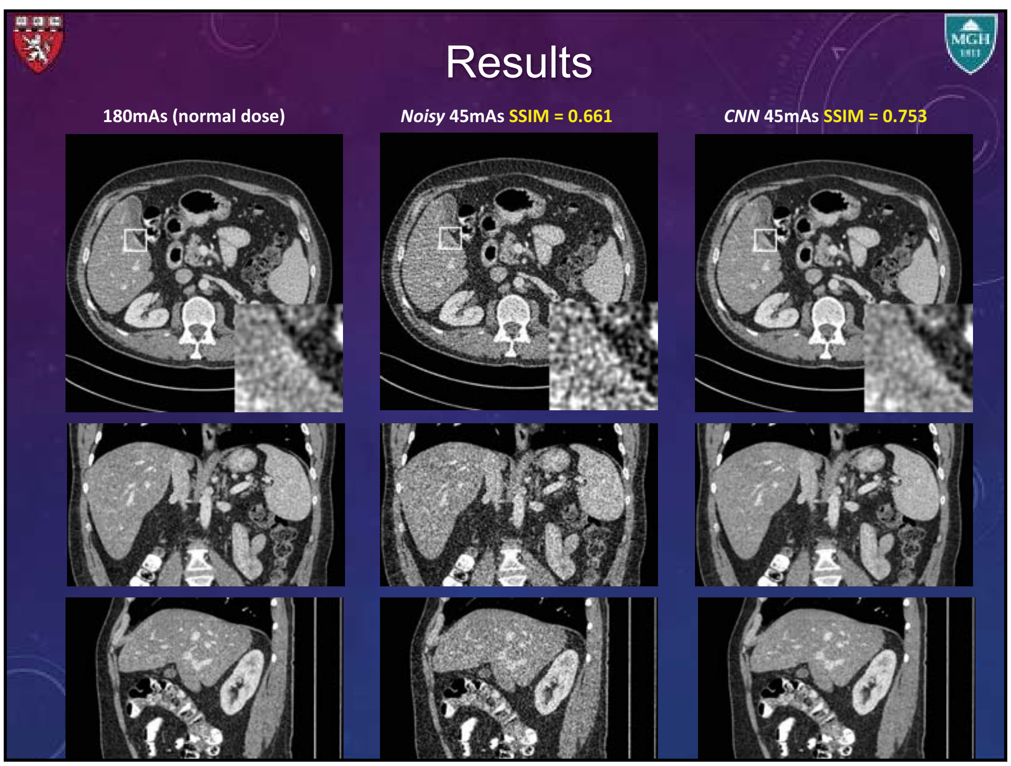


- Deep learning is a subset of machine learning that uses many layers (>= 3 except for input and output layers) of nonlinear units for feature extraction



Zeiler M D, Fergus R. Visualizing and understanding convolutional networks. European conference on computer vision. Springer International Publishing, 2014: 818-833.

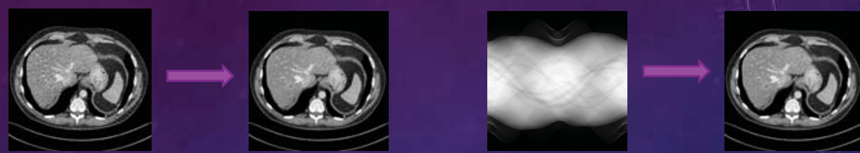

Cascaded Learning
• Use cascaded CNN to compensate for the spiky artifacts in the results
• After a CNN was trained, it was used to process the training dataset then a new CNN was trained with the processed data
1 CNN
8 cascades of CNNs


Results
180mAs (normal dose)
Noisy 45mAs SSIM = 0.661
CNN 45mAs SSIM = 0.753

Deep Learning Based CT Recon

Image Denoising

Image Reconstruction



Pros:
- Real time
- Greatly improved SNR

Cons:
- Chances for generating false positivity
- "What was lost is lost"

Pros:
- Better image quality
- Lower false positivity rate

Cons:
- Slow
- Image noise changes during iterations

- Iterative CT image reconstruction problem is usually formulated as

$$\mathbf{x} = \arg\min \quad \|\mathbf{Ax} - \mathbf{p}\|_{\mathbf{w}}^2 \quad + \quad \lambda R(\mathbf{x}; \boldsymbol{\theta})$$

Fidelity term with system matrix **A**, raw data **p** and noise matrix **w**

Penalty term with penalty function *R*, its parameters **θ** and hyperparameter **λ**

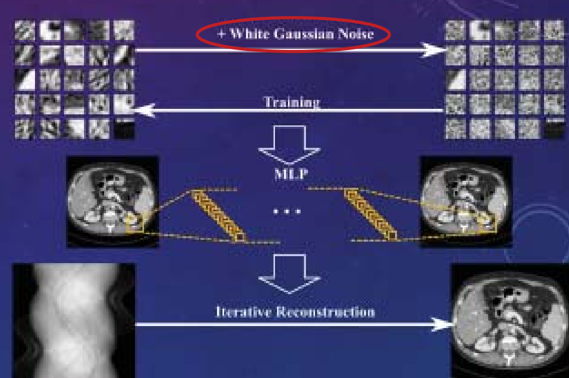
Train Prior Functions with Deep Learning

- Because noises in **x** changes during the iterations, it has to be learned in an **unsupervised** way;
- A solution with denoising autoencoders:

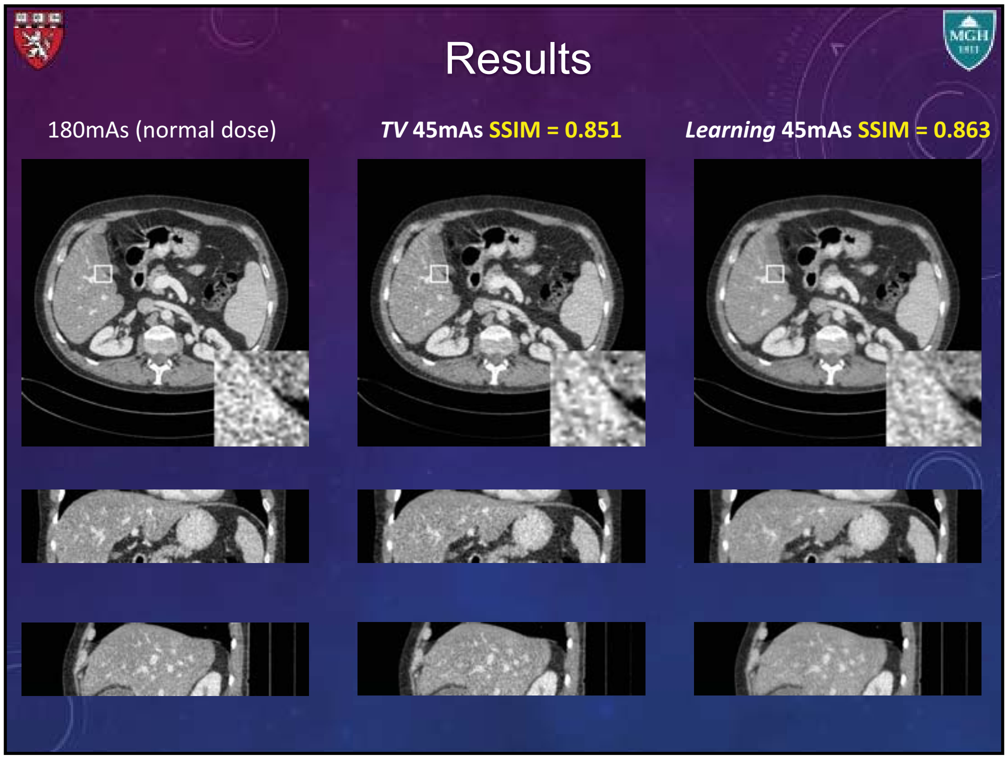
$$\mathbf{x} = \arg\min \|\mathbf{Ax} - \mathbf{p}\|_{\mathbf{w}}^2 + \lambda \|\mathbf{x} - f(\mathbf{x})\|_2^2$$

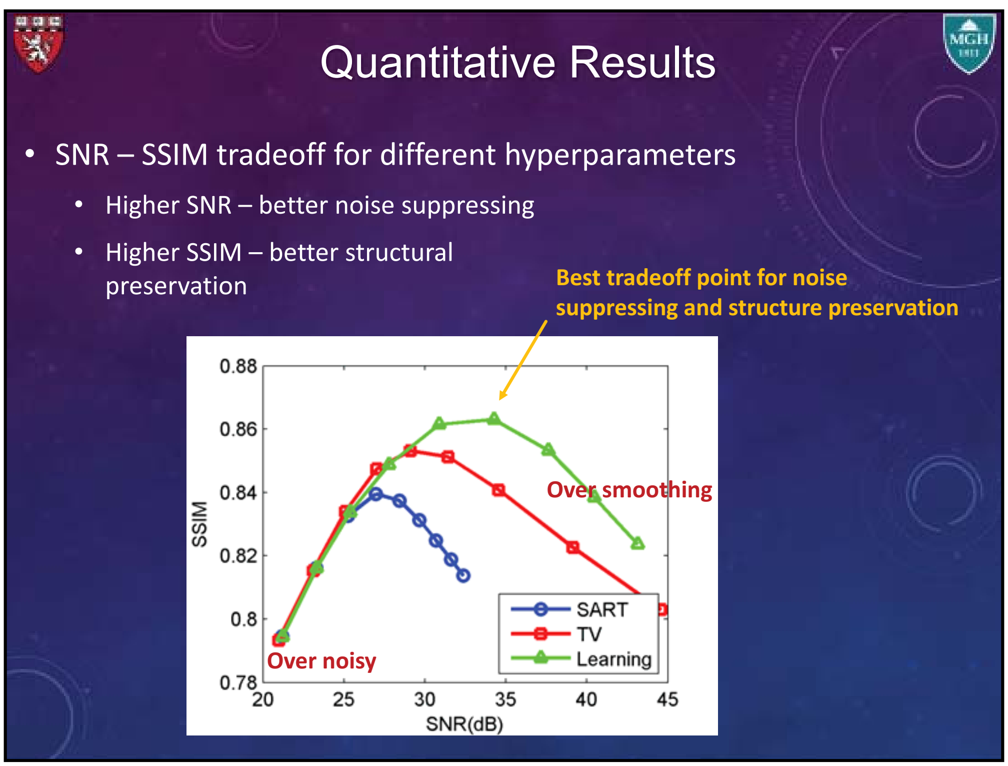
f(**x**) is the trained neural networks

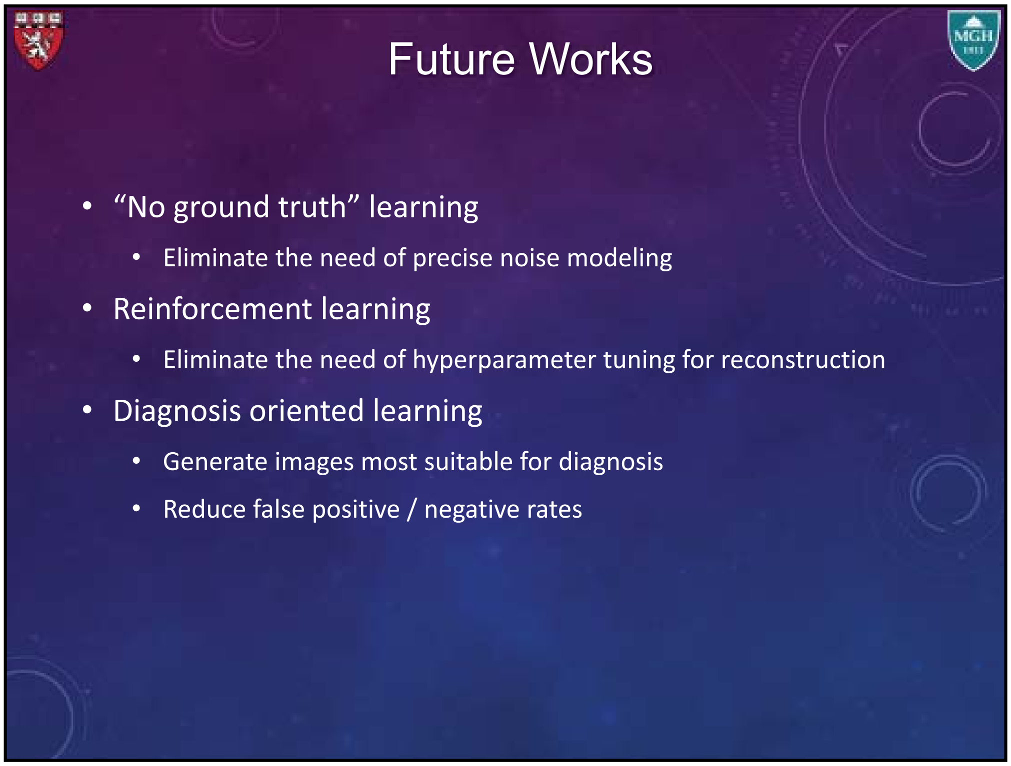
No need for noise simulation

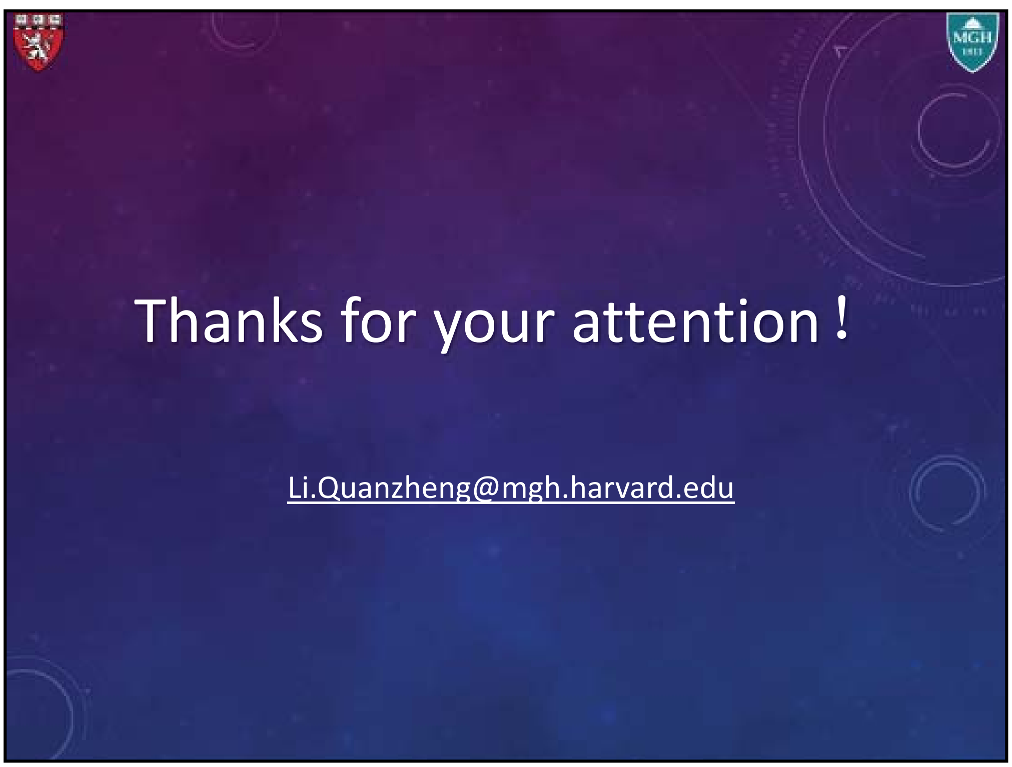


Wu D, et al. Iterative Low-dose CT Reconstruction with Priors Trained by Artificial Neural Network. Transactions on Medical Imaging (submitted).

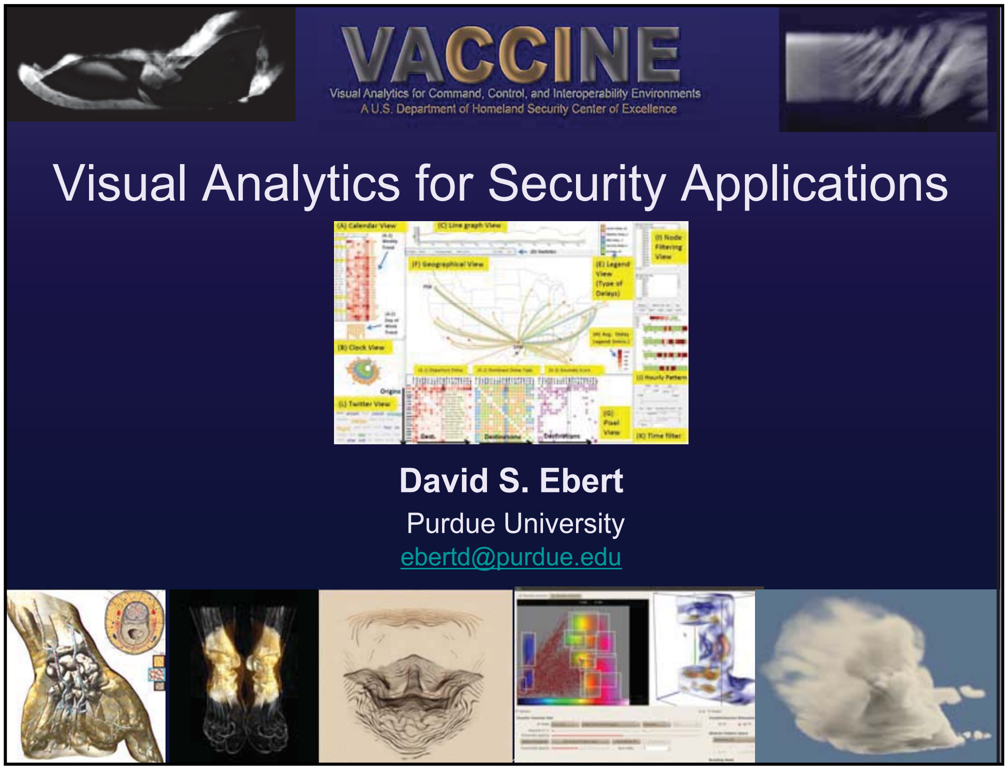

Results
180mAs (normal dose)
TV 45mAs SSIM = 0.851
Learning 45mAs SSIM = 0.863

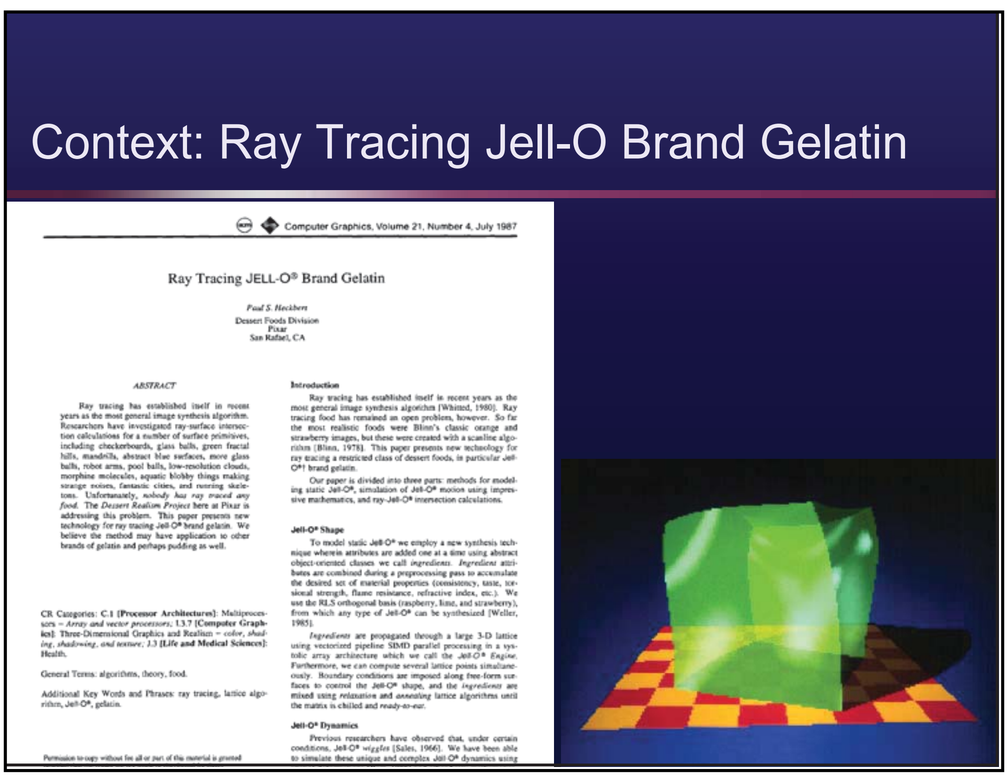

Quantitative Results
SNR – SSIM tradeoff for different hyperparameters
Higher SNR – better noise suppressing
Higher SSIM – better structural preservation
Best tradeoff point for noise suppressing and structure preservation
Over smoothing
Over noisy
SSIM
SNR(dB)
SART
TV
Learning


Future Works
• "No ground truth" learning
• Eliminate the need of precise noise modeling
• Reinforcement learning
• Eliminate the need of hyperparameter tuning for reconstruction
• Diagnosis oriented learning
• Generate images most suitable for diagnosis
• Reduce false positive / negative rates


Thanks for your attention !
Li.Quanzheng@mgh.harvard.edu

16.26 David S. Ebert: Visual Analytics for Security Applications



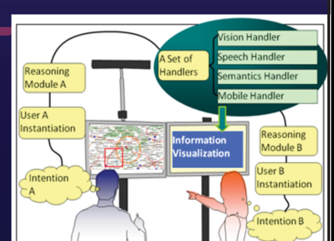


So What? Who Cares? Visual Analytics for Transportation Security

- Problem:
  - Flood of data
  - Automated analysis without context
  - Inability to fuse/correlate information
  - Utilize real-time, streaming data
  - Need data-driven policy and decision-making

- Solution:
  - Provide actionable information
  - Shared, synchronized situational awareness
  - Intuitive, user-guided decision-making environment
  - Harnesses decision-makers knowledge and experience
  - Incorporate predictive, task-guided, tailored analytics

Human-Computer Collaborative Decision-Making Environments



Balance of automated computerized analysis and human cognition to amplify human-centered decision making

Leverage both
- Human knowledge and visual analysis to increase analytical efficiency and guide simulations and analysis
- Interactive simulations, dimensional reduction, clustering, analytics to improve decision making

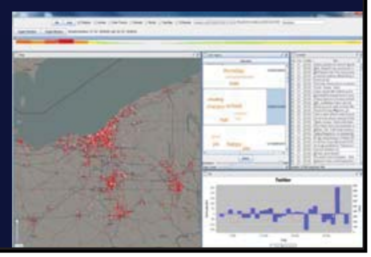
Create interactive operational, planning & decision making environments

VACCINE

May 2017

Visual Analytics Uses for Public Safety

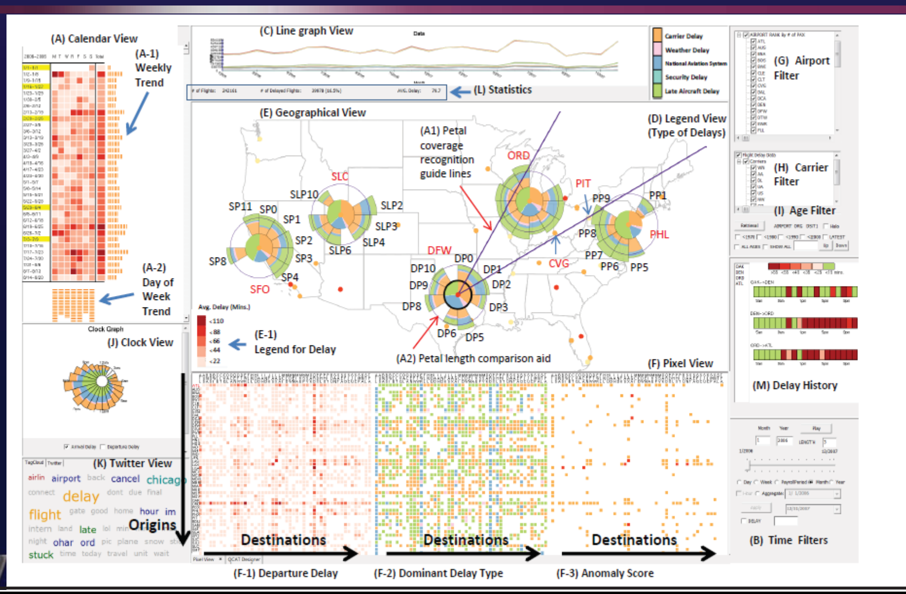
- Risk visualization and analysis
- Predictive analytics
- Uncertain decision making
- Alternative evaluation and consequence investigation
- Trend analysis, clustering, anomaly detection
- Multisource, multimedia massive data integration & analysis
- Purpose: Planning for resiliency, training, detection, investigation, response, recovery, remediation



VACCINE

May 2017

Example: Airport Delay VA-
Multivariate Network Analytics with Information Theory Anomaly Detection

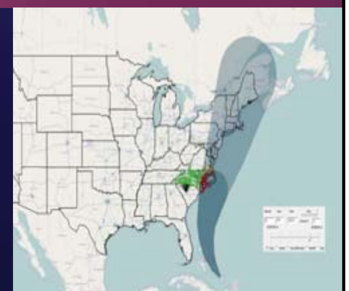


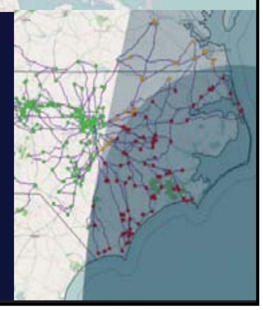
Example: VASA
Visual Analytics for Simulation-Based Action

Collaborating Institution(s): Purdue, Minnesota, UTexas, UNCC + German universities
End-User(s): Fast-food restaurant chain, emergency management and planning personnel

Impacts and Accomplishments:

- Support decision-making for extreme weather and natural disaster scenarios
  - Combine real and simulation data
  - Allow "what-if" exploration
- **System of systems**: binds together multiple simulations models from collaborators into coherent whole
  - **Minnesota**: food distribution model
  - **Texas**: simulated and historical weather (hurricanes, storms)
  - **UNCC**: critical infrastructure
  - **Purdue**: roads + interaction visual analytics tool
- **Challenge**:
  Combine interactive VA with complex simulation models





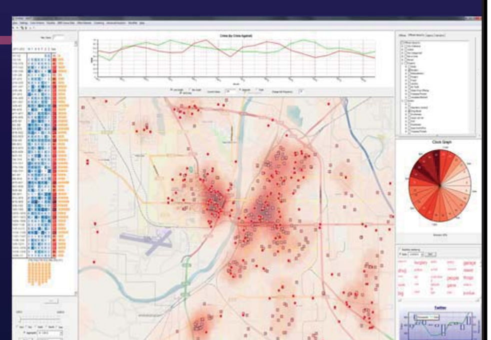
VACCINE

May 2017

Example: Visual Analytics Law Enforcement Toolkit (VALET, iVALET)

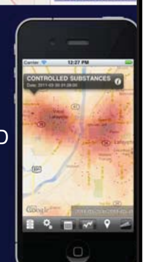
Impacts:

- In use to analyze crime patterns and to connect strings of activities (200+ downloads)
- Investigating correlation factors
- Analyzing time of day problems and improving accuracy of police record management system
- Novel statistical predictive model incorporated for planning
- Incorporating predictive alerts



VALET delivered:
- Spring 2011: WL, Lafayette Police
- Fall 2013: Ohio State Highway Patrol
- Spring 2014: NYPD
- Fall 2014: Evansville PD, New Albany PD

iVALET delivered:
- October 2011: Purdue, WL Police, Lafayette PD



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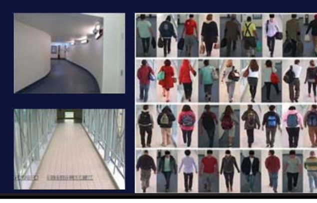
May 2017

Catching Criminals on Video: Video Be on the Lookout (vBOLO)

- Collaborators:
  - Northeastern University
  - Purdue University
  - Rensselaer Polytechnic Institute
  - University of Notre Dame

- Current vBOLO system can currently find the correct person in a lineup of 10 automatically-detected candidates greater than 90% of the time for one camera

- Partner: Greater Cleveland Regional Transit Authority (GCRTA)



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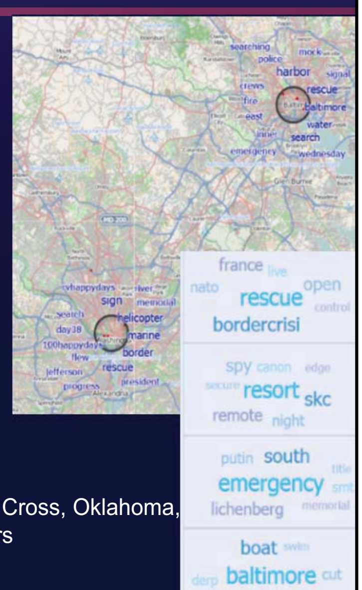
May 2017

Social Media Analysis and Reporting Tool

Partners: Purdue, U. Stuttgart, Penn State, USCG LANT, PAC, D8; Purdue Police, IMPD, BSA

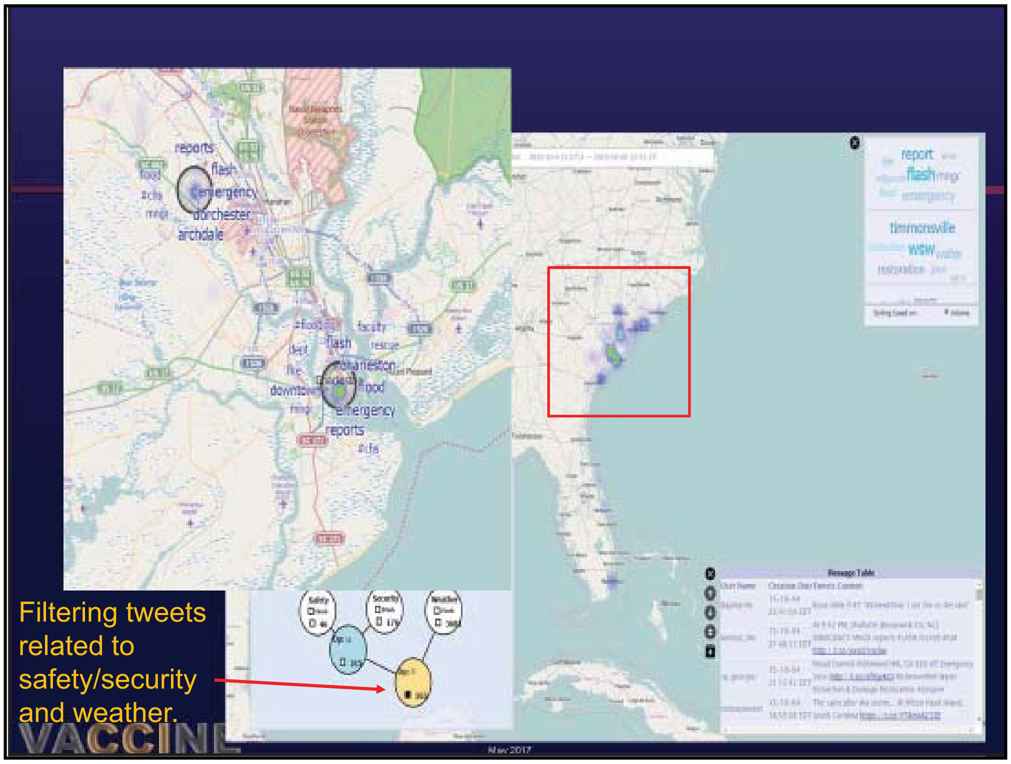
IMPACTS:

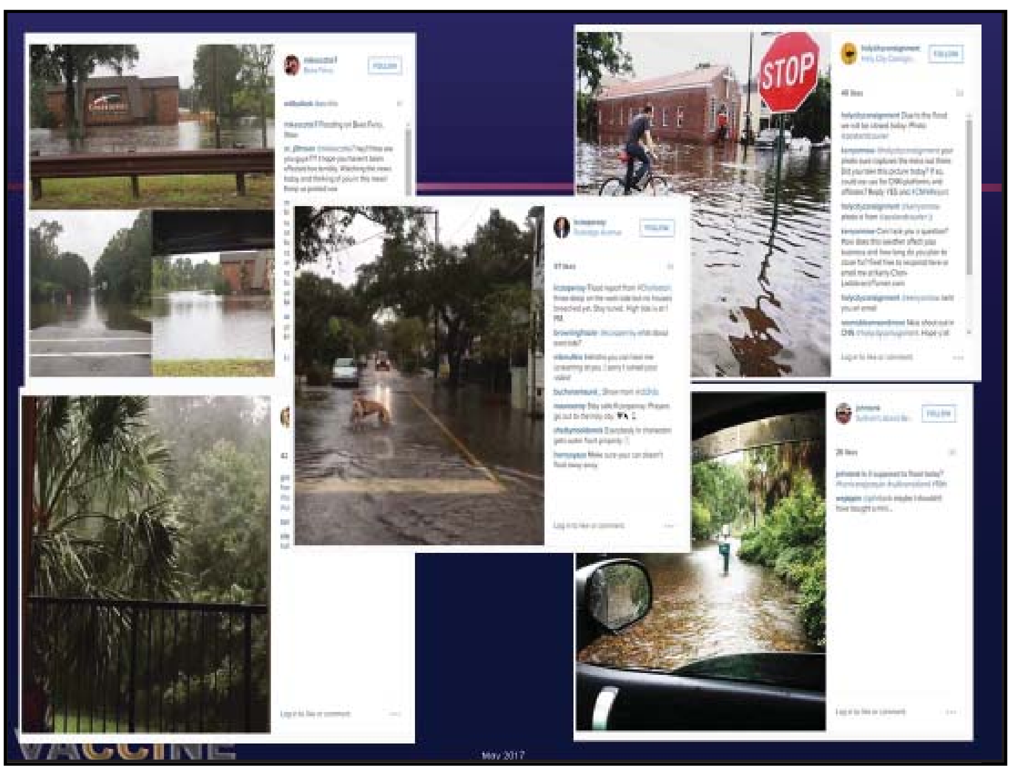
- Used at Boy Scouts of America Jamboree 2013
- Used by U.S. Coast Guard
  - District 8 for events in 2014 -2017: Detected 3 gang related activities to date
  - PAC for Fleet Week October 2014, Kayactivists 2016
  - LANT for SAR hoax call investigations
- Presidential Inauguration 2017
- Purdue Police for home football games Fall 2014-2016
- Indianapolis Metropolitan Police for special events
- US CBP for investigations Fall 2014 (Boston, AMOC)
- USCIS with open source news
- Republican National Convention 2016
- Ohio State Football – more successful than commercial tools
- Others: Lafayette PD, USCIS, St. Clair County, American Red Cross, Oklahoma, Madison Wisconsin, and Tennessee Intelligence Fusion centers



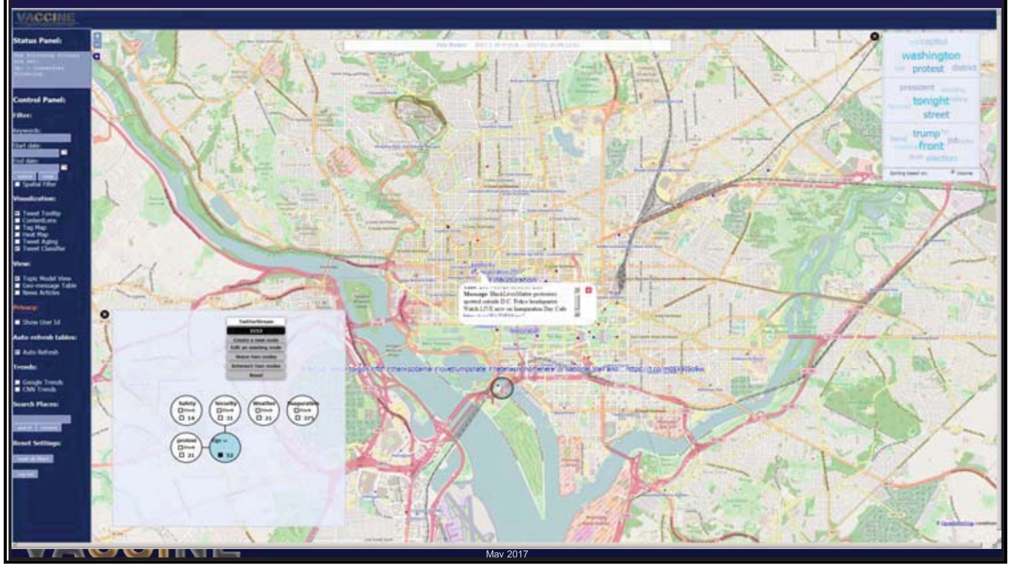
VACCINE

May 2017

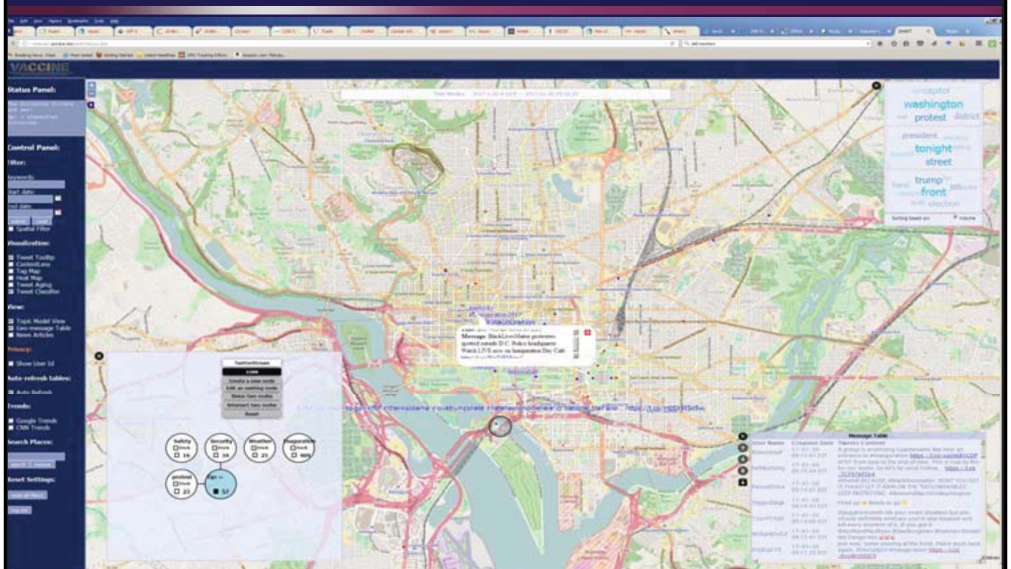

Filtering tweets
related to
safety/security
and weather.
VACCINE
May 2017


STOP
VACCINE
May 2017

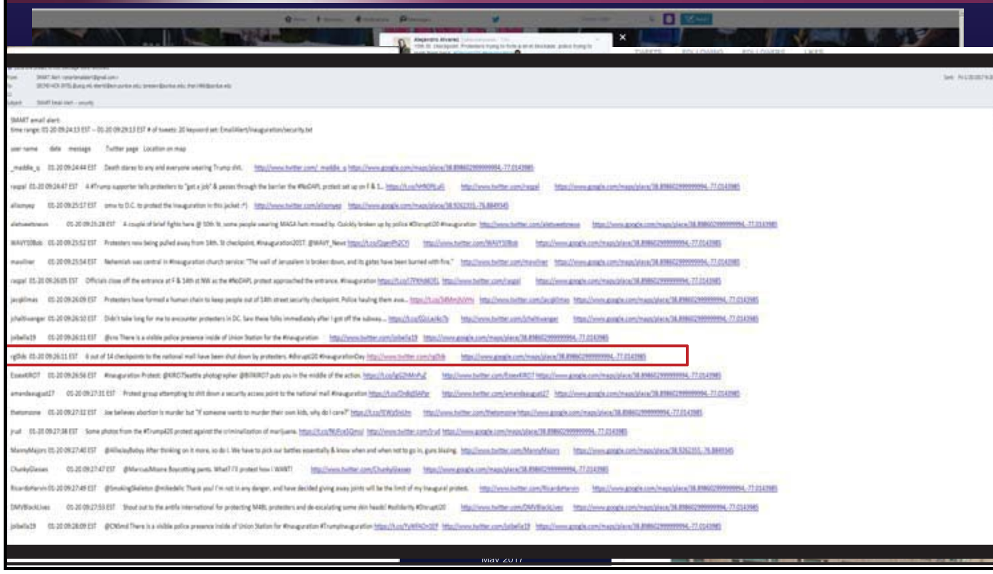
Presidential Inauguration and Protests



Presidential Inauguration and Protests



Presidential Inauguration and Protests

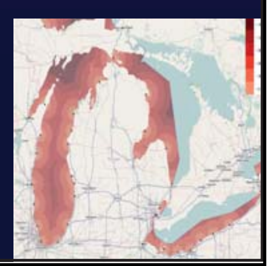


U.S. Coast Guard COAST/ SARVA (cgSARVA)

Partners: USCG LANT 7, USCG HQ 771 , USCG D9, USCG D5, RDC

IMPACTS:

- Analyzed impact of CG auxiliary stations on search and rescue mission in Great Lakes
- Used for resource allocation for SAR
- Provided new insights to SAR mission
- Hurricanes Sandy and Irene resource allocation decisions based on cgSARVA analysis and visualization
- Informed Commandant's budget testimony to Congress
- Key component of USCG D9 reallocation plan for 2011-12
- Key component of Coastal Operations Allocation Suite of Tools (COAST) – USCG HQ



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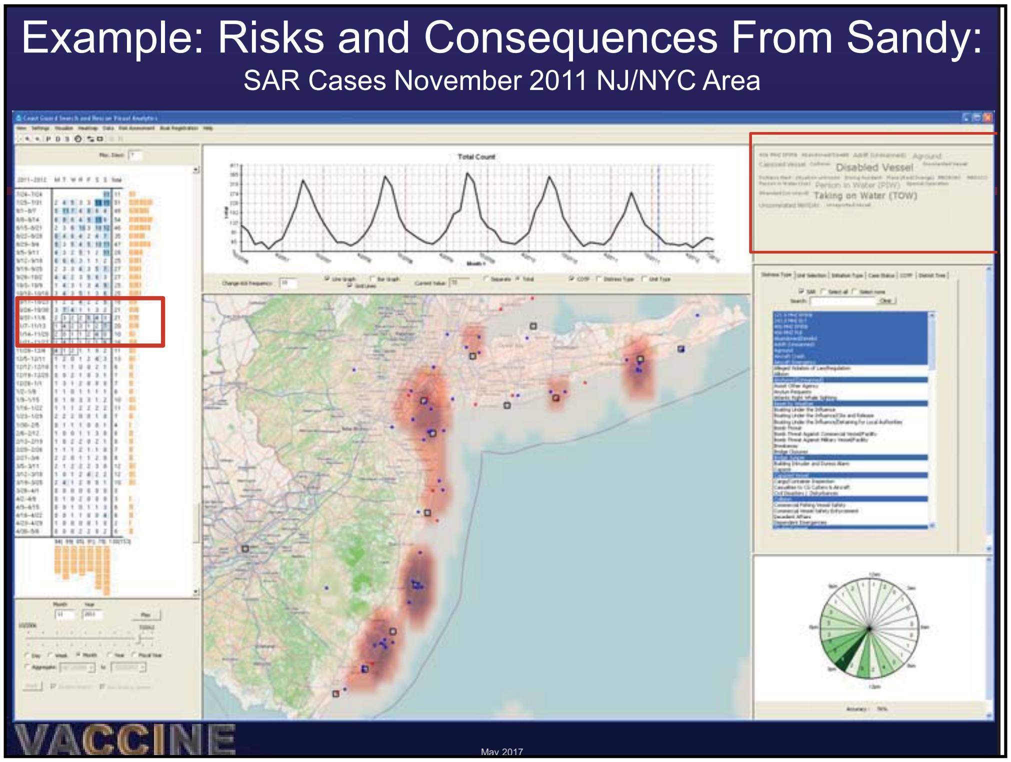
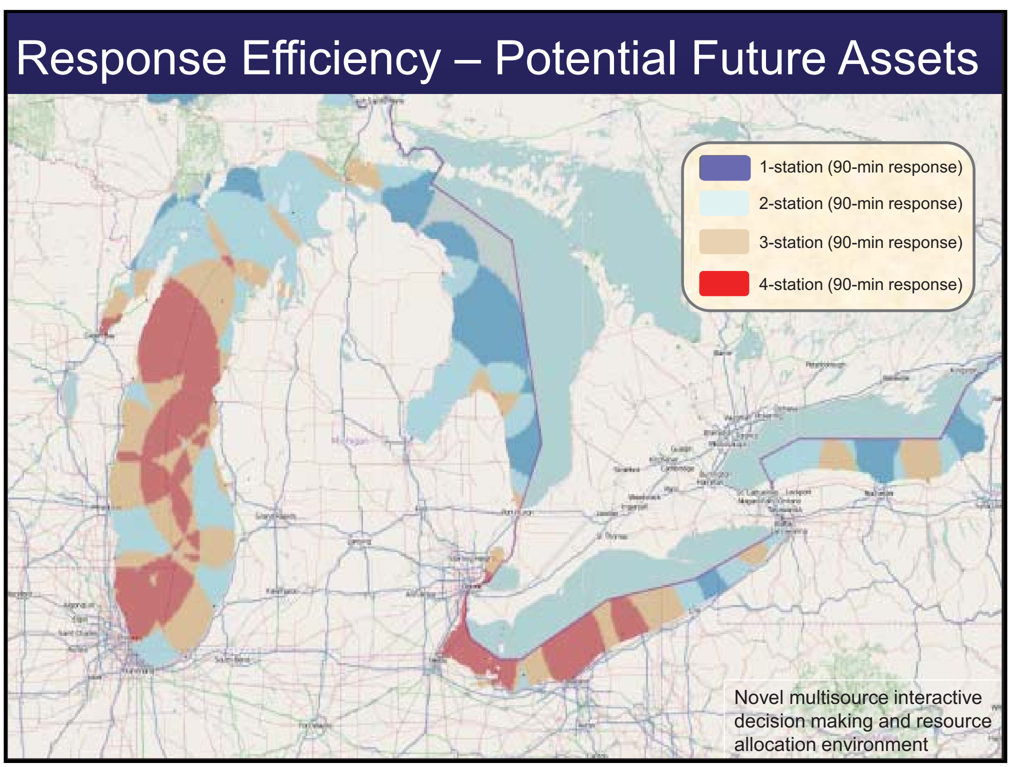
May 2017


Example: Risks and Consequences From Sandy:
SAR Cases November 2011 NJ/NYC Area
Total Count
Disabled Vessel
Taking on Water (TOW)
VACCINE
May 2017


Response Efficiency – Potential Future Assets
1-station (90-min response)
2-station (90-min response)
3-station (90-min response)
4-station (90-min response)
Novel multisource interactive decision making and resource allocation environment

Conclusion: What Our Visual Analytic Solutions Offer

- **We** enable users to be more effective through innovative interactive visualization, analysis, and decision making tools
- Provide the right information, in the right format within the right time to solve the problem
- Turn data deluge into actionable knowledge
- Enable users to be more effective
- Enable effective communication of information

VACCINE

May 2017

For Further Information

www.VisualAnalytics-CCI.org

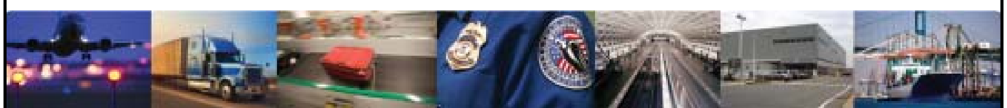
16.27 Doug Bauer: DICOS Status Update

DICOS Status Update

ADSA16 Conference - Boston, MA

Steve Skrzypkowiak and
Doug Bauer

May 2017



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DICOS Elevator Summary

- v02 launched and OEM experiences and recommendations assembled
- v02A issued April, 2017.
- v03 will address new modalities and functionalities.
- Interested parties ENCOURAGED to participate and provide recommendations.
- DICOS is increasingly linked to key TSA objectives.

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So What? Who Cares?

- Supports TSA OSSA initiative.
- Facilitates inter-operability ("plug and play")
- Helps integration of various sensors, e.g. CAT, Intel to provide more complete situational awareness.
- Supports remote maintenance.
- Could facilitate more selective component replacement of scanners, algorithms, graphic user interface displays as they approach end-of-life, rather than block obsolescence.

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Conclusions and Accomplishments Update

- DICOS v02A has been approved in balloting and is awaiting final publication.
  - Addresses many of the issues experienced by implementers for DICOS v02:
    - Open Platform Software Library (OPSL).
    - Common Graphical User Interface (CGUI).
    - TSA Original Equipment Manufacturer (OEM) implementations.
    - Limited private tag attributes usage.
- Stratovan under contract review to enhance and maintain the DICOS v02 SDK and toolkit to the DICOS v02A Standard.
- Activity generated Threat Detection Reports (TDRs) for Level-2 and Level-3 screening activities.
- Requesting OEM and third party participation in DICOS v03.
- Activity addressing the NEMA membership yearly dues.

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Topics Addressed in DICOS v02A

- Multi-energy X-ray detectors.
- Multi-view and multi-energy image encoding.
- Voxel and Pixel value representation (16-, 32-, and 64-bit and float and double).
  - Update DX to include:
  - Z-eff
  - Density
  - µ support
- Pixel Spacing for image display.
- Enhanced and redefined selected tag attributes:
  - Different Time-out mode
  - Different Bar code type
  - Raw and bag path

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DICOS v02A Activities

- Started the development of a Website where implementers could submit and review FAQs.
  - Reviewed bugs and recommended fixes and incorporated them into v02A.
    - Bug reporting form with recommended changes made by the submitter.
  - Complied a list of improvements for the DICOS v02A SDK and Toolkit for Stratovan to incorporate into the DICOS v02.
    - Generate the DICOS SDK and Toolkit for Operating Systems not listed.
- Bi-weekly meetings of the DICOS Technical Committee to address discovered issues and required enhancements. Instead of waiting for a formal meeting to address and finalize the issues.

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DICOS Development Aids

- TSA has funded Stratovan to enhance and maintain a DICOS v02A development suite which includes:
  - User-Level, Module-Level, and Tag-Level API headers
  - Static and shared libraries (Windows/Linux)
  - Documentation
    - User Guide
    - API documentation
    - Real world examples
    - FAQs
  - A DICOS Image Viewer
  - Compliance and Conformance-checking software
- Using the DICOS v02A SDK and toolkit allows OEMs and Third party Implementers reduce development times and testing abilities.

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Stakeholders Activities

In order for DICOS to be successful, OEMs and third party implementers need to:

- Report DICOS implementation issues to the DICOS Technical Committee and to Stratovan for documentation, quick review and uniform resolution.
- Participate actively in the DICOS Technical Committees.
- Recommend to the DICOS Technical Committee features and attributes which should be included in future revisions of the DICOS Standard.

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DICOS v03 Future Directions

- **Topics and Issues that are under investigation for DICOS v03 include:**
  - **Additional Modalities**
    - Differential Phase Contrast (DPC)
    - Coded Aperture Imaging (CAI)
    - Phase Contrast Imaging (PCI)
    - Air Cargo
    - Bottle Liquid Screener (BLS)
    - X-ray Diffraction (XRD)
    - Explosives Trace Detection (ETD)
  - **TDR Enhancements**
    - Prohibitive item reporting
    - Deep Learning
    - Third party ATR support for reporting results
    - Aggregated TDRs from all TSEs
      - Passenger
      - Baggage screening results
  - Assignment of extension **dcs** to denote a **DICOS** encoded file.

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Questions

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Backup Slides

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Topics for this Presentation

- DICOS v02A Activities
- Topics Addressed in DICOS
- DICOS Development Aids
- Stakeholders Activities
- DICOS v03
- Backup Slides

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So What? Who Cares? (Additional)

- Facilitates *horizontal* and *vertical* communication between TSE and various TSA leadership levels; *horizontal* communication between different TSEs.
- Supports innovation (third party participation in, say, algorithms).

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NEMA DICOS Press Release

Original v02 Press Release, August 29, 2012

ROSSLYN, Va., -National Electrical Manufacturers Association (NEMA) has published NEMA IIC 1 v02 Digital Imaging and Communications in Security (DICOS) Information Object Definitions (IODs).

Known informally as DICOS v02, this revised standard maintains the extensible, interoperable data format that enables the integration of security screening technologies across multiple vendor platforms and facilitates wider participation in the development of improved security screening technologies and systems specified in its predecessor, DICOS v01. DICOS v02 now includes:
· an additional screening technology, known as Advanced Imaging Technology or AIT, which is used to examine passengers at airports, and
· a more complete definition of one type of Threat Detection Report (TDR), known as Operator.

"NEMA is proud of this newly revised standard as it is evidence of the continued success of joint efforts between manufacturers and the Department of Homeland Security's Science and Technology Directorate and its Transportation Security Administration to improve the safety of air travel," said NEMA President and CEO Evan R. Gaddis.

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NEMA DICOS Press Release (continued)

DICOS v02 retains the features of its predecessor, including:
· a data format for computed tomography (CT) images and x-ray radiographs that result from airport security examination of checked and carry-on baggage; and
· a common format for threat detection reports that capture data resulting from the use of automated threat detection methods to evaluate checked and carry-on baggage.

DICOS is inspired by, and relies heavily on, elements of Digital Imaging and Communications in Medicine (DICOM), which is used in virtually all hospitals worldwide. DICOS continues to adapt DICOM as necessary to accommodate the unique needs of an airport security screening application. Both DICOM and DICOS permit images and data to be sent from, and viewed and received by, equipment of various types-similar to the interoperability of PDF (portable document format) images on a variety of personal computers.

DICOS was developed by NEMA's Industrial Imaging and Communication Section in cooperation with the U.S. Department of Homeland Security's Science and Technology Directorate and Transportation Security Administration. DICOS serves as an ongoing, effective example of government-industry cooperation in standards development. See DICOS v02 to view the contents and scope. A hard or electronic copy may be purchased for $215 by visiting global.ihs.com, or by contacting IHS at 800-854-7179 (U.S. only) or 303-397-7956 (international).

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Location of Stratovan DICOS SDK and Toolkit

Go to: www.Stratovan.com; click on ~ Products; select ~ Security, DICOS; complete form.

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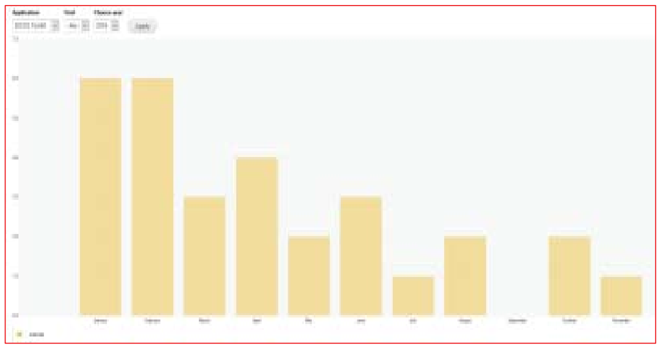
DICOS v02 New Users in 2016



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Stratovan DICOS v02A OS Support

- Microsoft Windows
  - Visual Studio
- Linux
  - Fedora
  - Scientific
  - OpenSuse
  - Ubuntu

✓ Both 32- and 64- bit versions of each OS.

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Stratovan DICOS v02A APIs

- API's allow for various levels of detail that toolkit users can choose from
  - **User Level API**
    - 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

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Stratovan DICOS v02A APIs

- **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

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DICOS Context and History

- TSA has open architecture project.
- DHS and then TSA funded NEMA to develop standards for encapsulating and transmitting data from TSA.
- Standard denoted as Digital Imaging and Communication for Security (DICOS).
- V01 released in early 2000s
- V02 needed for the following reasons:
  - Incorporate OEM recommendations from early DICOS use.
  - Incorporate additional functionalities and modalities.

- Stratovan funded to develop toolkit to implement DICOS
- v02A out for vote.
- V03 future directions.

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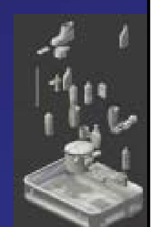
16.28 Taly Gilat Schmidt: Realistic Simulations of Baggage

Realistic simulations of baggage

Taly Gilat Schmidt, PhD
Associate Professor
Department of Biomedical Engineering
Marquette University & Medical College of Wisconsin
*Also consultant to Triple Ring Technologies

So What? Who Cares?

- Simulations can predict performance of explosive detection systems (EDS)
  - Reduced time to market and development costs
  - May obviate prototype development to predict performance
  - Applicable to x-ray CT, transmission, backscatter, diffraction, MMW
- Previous work demonstrated that simulated data can match the values, noise, scatter, artifacts of experimental CT data
- SBIR project is developing PRISM software for easy-to-use interface to existing simulation tools
- Two components to EDS simulations:
  - Accurate physics modeling → Solved
  - Modeling numerous, complex suitcases → Open problem
- Computer animation tools can solve problem of modeling numerous, complex suitcases configurations
- May be able to use simulated bag set to obviate qualification testing
- May be able to simulate explosives that are dangerous to synthesize and handle



Why now?

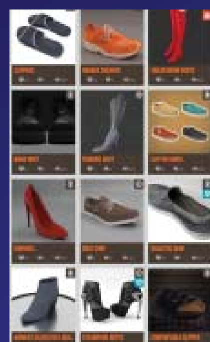
- Access to experimental test data is limited
- Validated simulation tools exist
- Computing power is readily available
- Challenge: Modeling realistic suitcases with threats in numerous configurations
  - Concealment, clutter
- Manual modeling of suitcase configurations is labor intensive
- Deterministic packing algorithm is challenging
- Software tools from the computer graphics industry can be used to simulate numerous suitcase configurations

Suitcase Packing Animation Overview

- Define mesh file objects to be packed
- Simulate dynamics of dropping objects into suitcase
  - Rigid body, elastic deformations, collisions
- Complex objects that are composites of multiple STL files can be assigned to move together
- Output STL object configurations after packing for use in EDS simulations
- Example animation software packages: Blender, Unity

Mesh Object Models

Grabcad results for a search of 'water bottle'

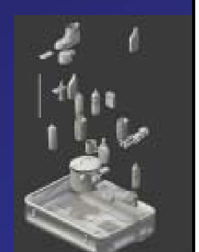


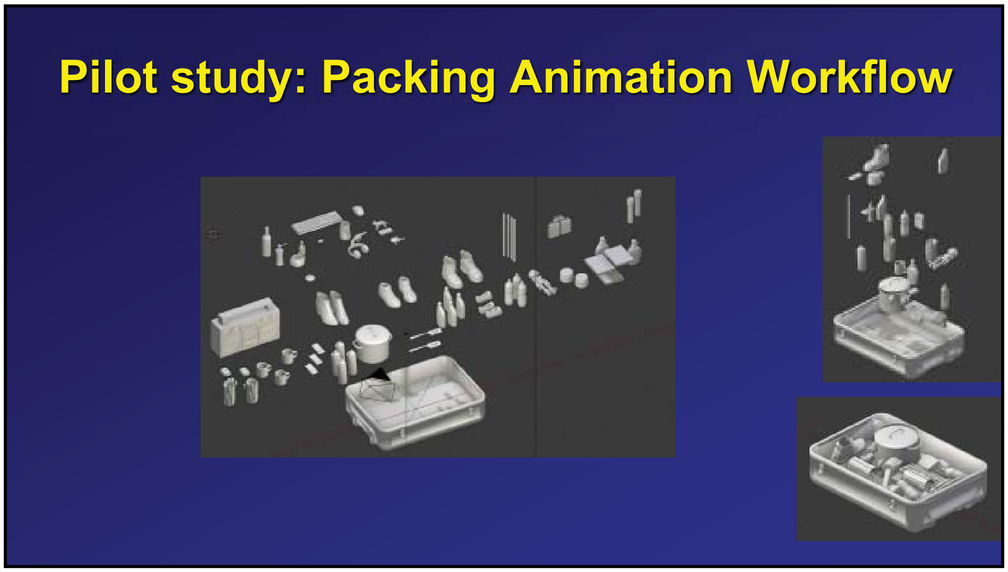
Blendswap results for a search of 'shoe'

CAD model of Raspberry Pi board available on GrabCad

Pilot study: Packing Animation Workflow

- Select suitcase container from predefined library
- Randomly pick from a library of objects
- Seed objects above suitcase with at random locations and orientations
- Assign mass to each object
- Run Blender animation engine (rigid body)
- Remove objects that fall outside of the suitcase
- Export STL files for each object at end of animation




Pilot study: Packing Animation Workflow


Suitcase Packing Animation

Pilot Study of Suitcase Packing Animation

- Developed python script to automate suitcase packing workflow in Blender
- Generated 15 suitcase models
  - 40 seconds per suitcase using 4 CPUs

PRISM x-ray simulation software

- Collection of STL files output by suitcase packing can be input to EDS simulation software
- Particle / Ray Interaction Simulation Manager (PRISM)
- Funded by DHS SBIR
- Unified user-interface wrapper for existing X-ray simulation tools
- Models ray tracing, scatter, detector effects

TRIPLE RING technologies

Next Steps for Packing Animation

- Model elastic objects that can fill voids between other objects (clothing, foam)
- Drop objects into suitcase individually using automated approach similar to humans
- Close suitcase
- Resolve issues that can occur when moving complex composite objects

So What? Who cares?

- Simulations can predict performance of explosive detection systems (EDS)
  - Reduced time to market and development costs
  - May obviate prototype development to predict performance
  - Applicable to x-ray CT, transmission, backscatter, diffraction, MMW
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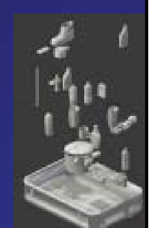


Acknowledgments

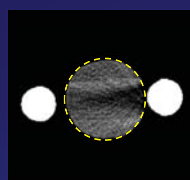
Triple Ring Technologies
- Tobias Funk
- Daniel Badali

Marquette University Visualization Lab (MARVL)
- Chris Larkee
- John LaDisa

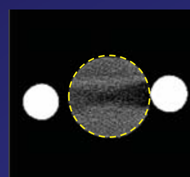
DHS SBIR D15PC00024, “X-Ray Simulation Platform for Explosive Detection Equipment”

EXTRA SLIDES

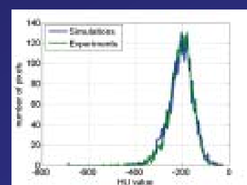
Streak Artifacts



Imatron



Simulated



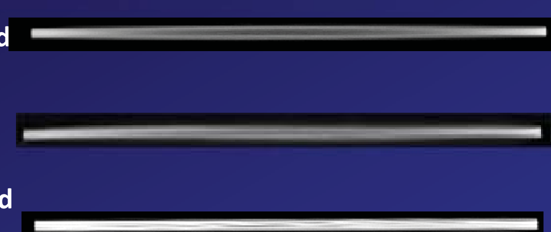
HU Histogram

PVC Sheet Object

Simulated

Imatron

Simulated without scatter

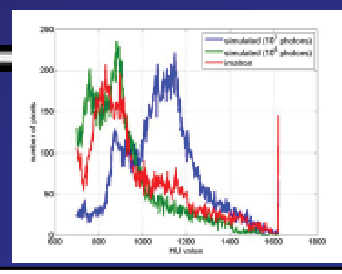


PVC Sheet Object

Simulated

Imatron

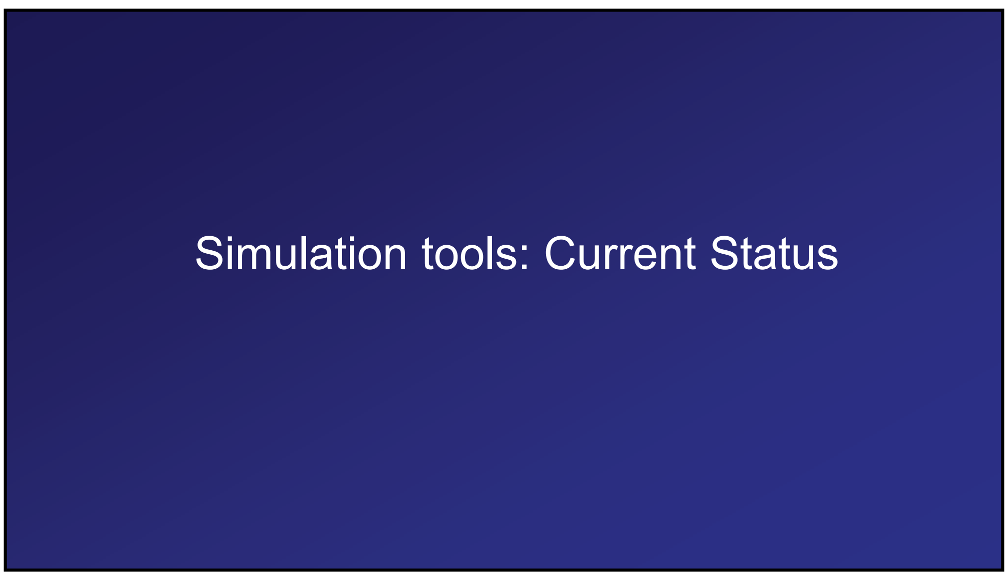
Simulated without scatter



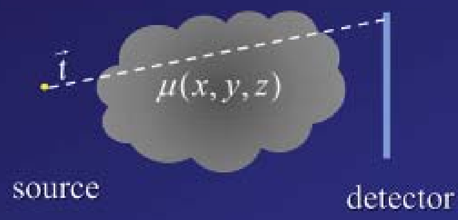
Challenges for EDS Simulations

- Many (infinite) materials / objects
- Severe metal, beam hardening, photon-starvation, and streak artifacts
- Artifacts cause object splitting, object merging, errors in estimated size
- Artifacts increase the feature space of threats / non-threats
- In order for simulations to be useful for security, must accurately model the artifacts, nonideal effects


Goals for Simulation Tools
• Model realistic scanner effects
– Validated
• Easy to use
– Expert User and Technician User*
• Flexible scanner configuration
– Flexibility to model a specific scanner very precisely*
• Speed
– "1000 bags per week"*
*DHS SBIR User Survey


Simulation tools: Current Status

Simple Simulation



$$\bar{N} = \int N_o(E)e^{\left(-\int \mu(x,y,z)d\vec{t}\right)}dE$$

How to calculate line integrals through objects?

Calculating Line Integrals

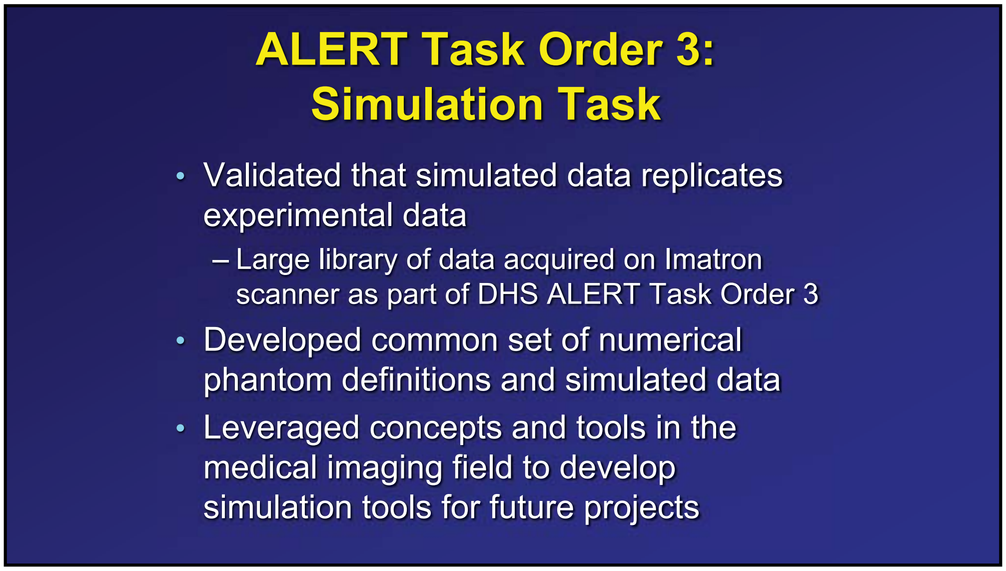
- Analytical calculation through combinations of primitive shapes
  - e.g., CATsim, g3d, CTsim,
- Ray tracing through voxelized objects
- Ray tracing through mesh objects

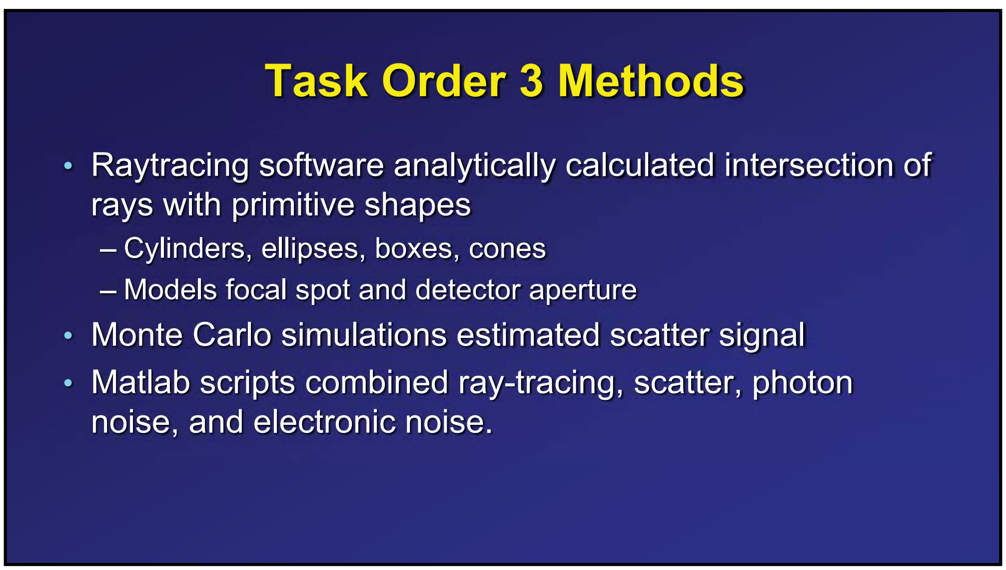
Nonideal Effects Can be Modeled

- Poisson noise
- Source aperture
- Detector aperture
- Detector crosstalk
- Afterglow
- HVPS drifts
- Geometric errors
- Electronic noise
- Sampling during rotation

Scatter Effects

- Generally requires Monte Carlo simulations
  - GEANT4, PENELOPE, MCNP, etc.
  - Used for backscatter simulations
- Computationally expensive
- Typically a combination of deterministic ray tracing and Monte Carlo simulations

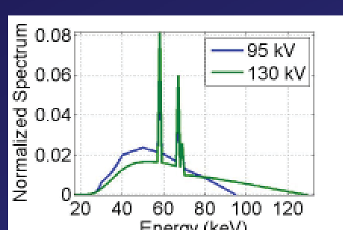

ALERT Task Order 3:
Simulation Task
• Validated that simulated data replicates experimental data
– Large library of data acquired on Imatron scanner as part of DHS ALERT Task Order 3
• Developed common set of numerical phantom definitions and simulated data
• Leveraged concepts and tools in the medical imaging field to develop simulation tools for future projects

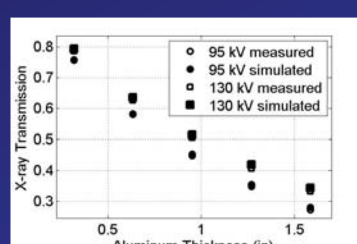

Task Order 3 Methods
• Raytracing software analytically calculated intersection of rays with primitive shapes
– Cylinders, ellipses, boxes, cones
– Models focal spot and detector aperture
• Monte Carlo simulations estimated scatter signal
• Matlab scripts combined ray-tracing, scatter, photon noise, and electronic noise.

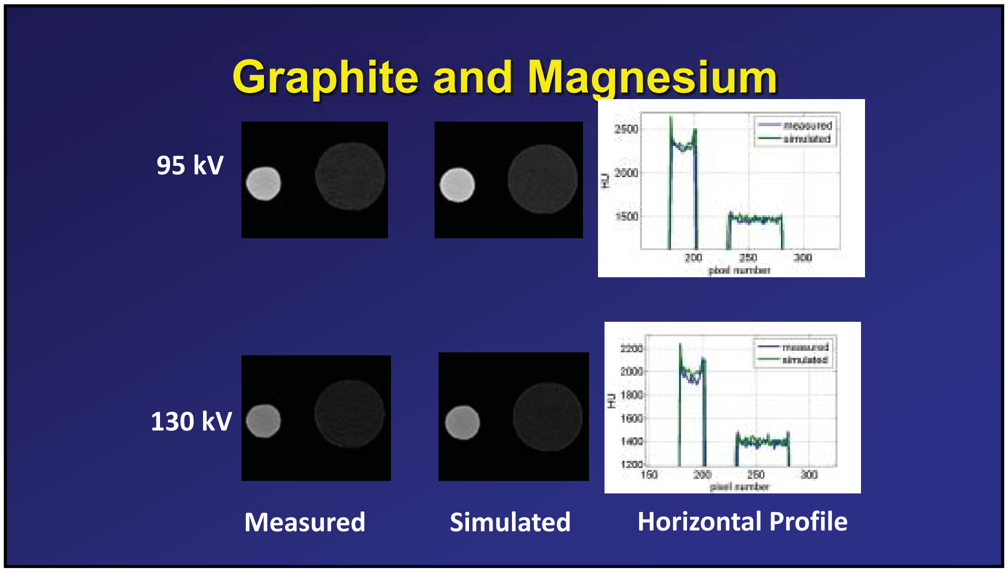
Validation

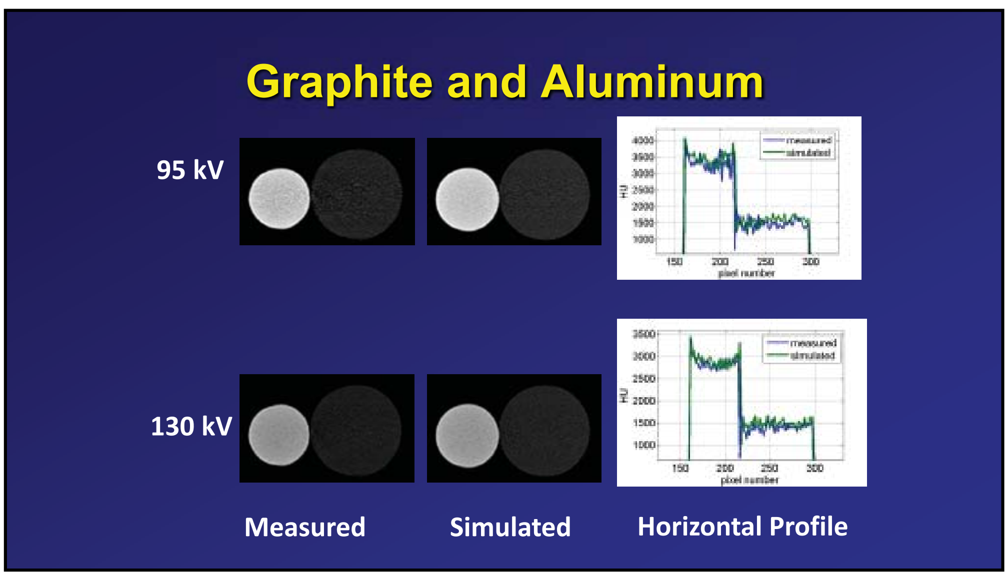
- Match the Imatron spectra
- Match the Imatron fluence
- Match the Imatron geometry
- Match the reconstructed HU mean and standard deviation
- Match the scatter level and artifacts

X-ray Spectra

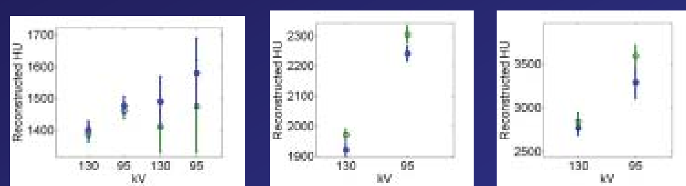




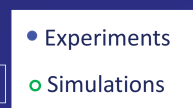

Graphite and Magnesium
95 kV
130 kV
measured
simulated
HU
pixel number
Measured
Simulated
Horizontal Profile


Graphite and Aluminum
95 kV
130 kV
measured
simulated
HU
pixel number
Measured
Simulated
Horizontal Profile

Reconstructed HU Values

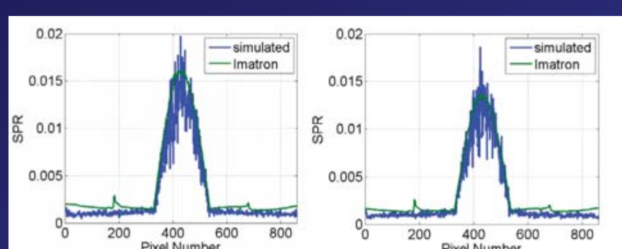


Graphite Magnesium Aluminum

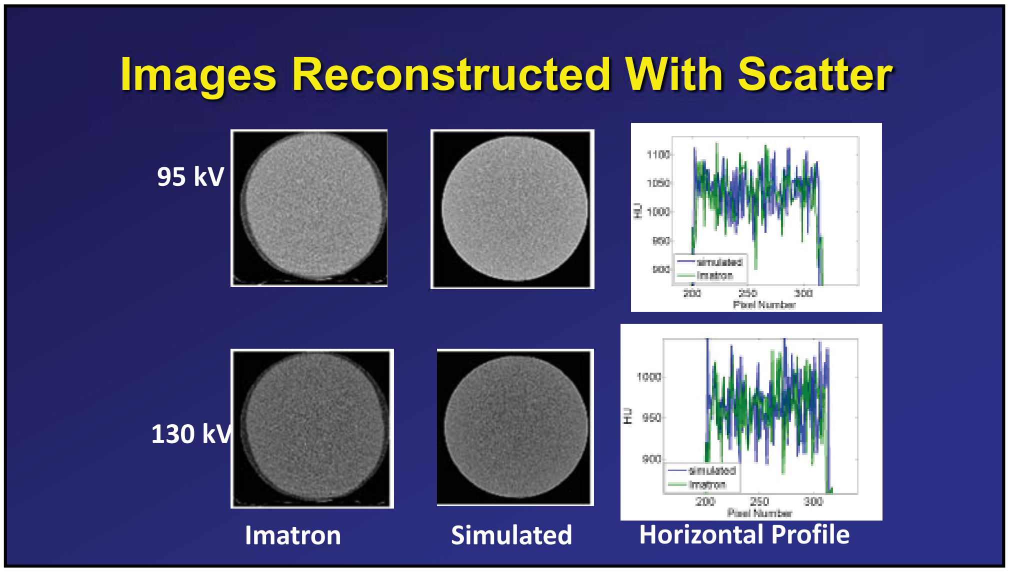


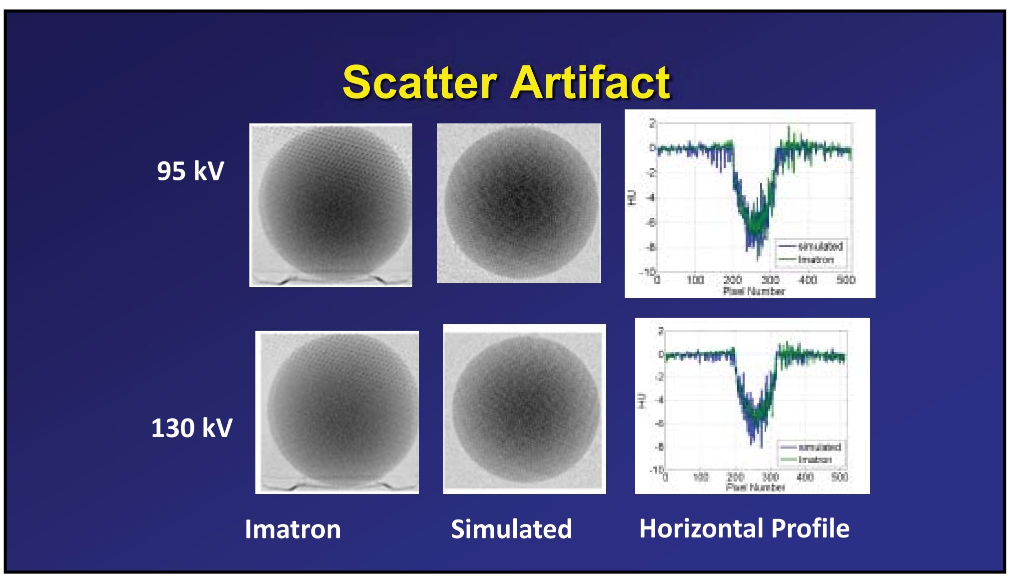
Good agreement between mean and std values

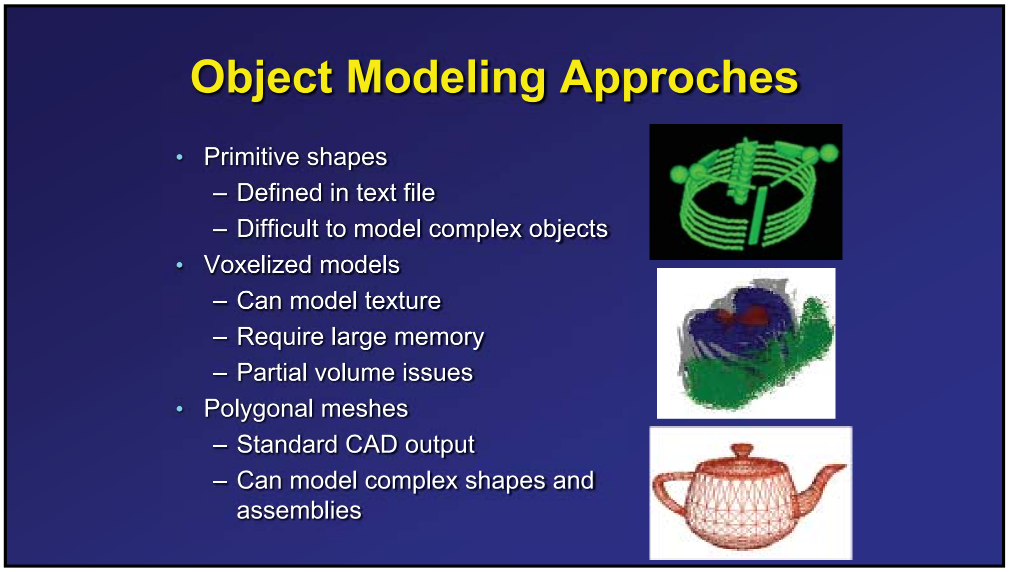
Scatter-to-primary ratio

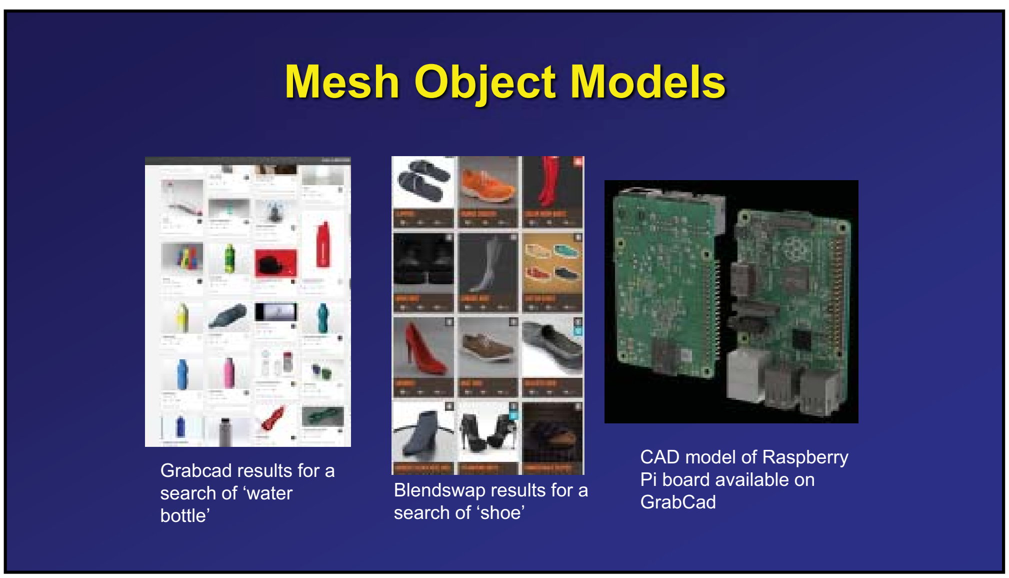


95 kV **130 kV**

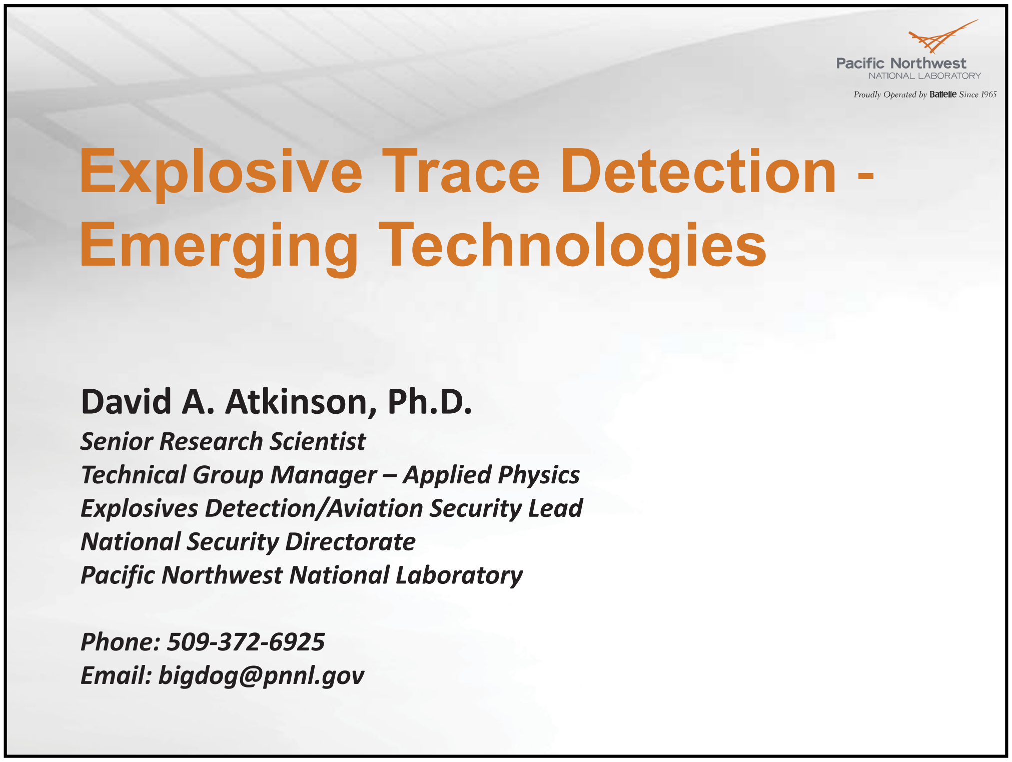

Images Reconstructed With Scatter
95 kV
130 kV
Imatron
Simulated
Horizontal Profile
simulated
Imatron
Pixel Number
HU

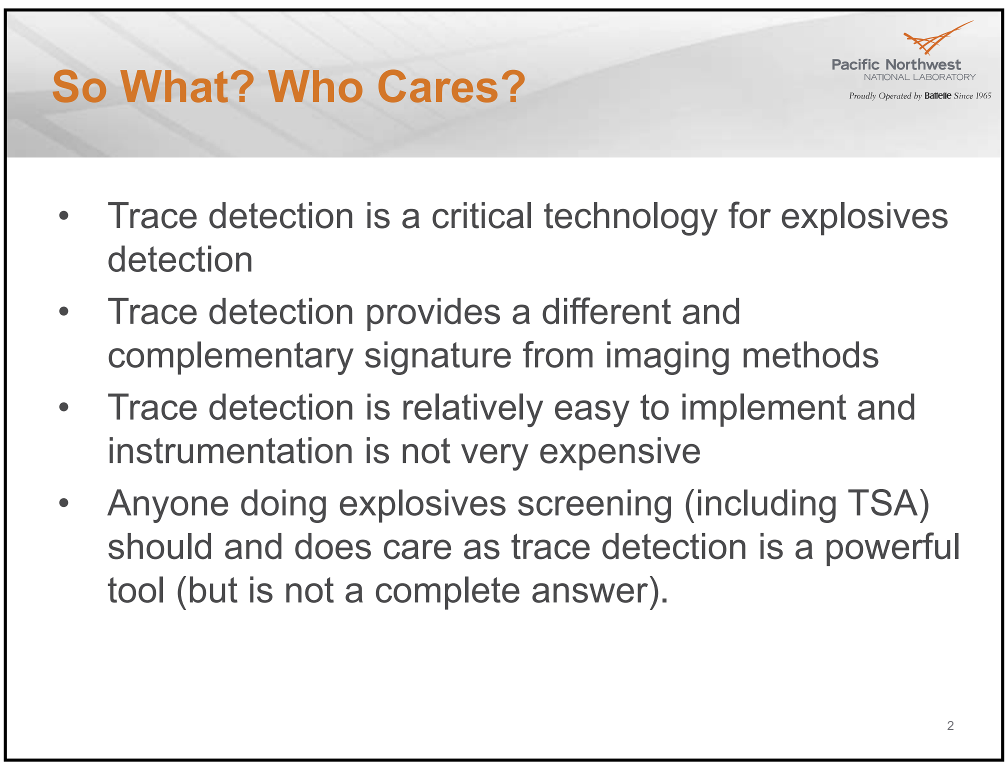

Scatter Artifact
95 kV
130 kV
Imatron
Simulated
Horizontal Profile
simulated
Imatron
Pixel Number
HU


Object Modeling Approches
• Primitive shapes
– Defined in text file
– Difficult to model complex objects
• Voxelized models
– Can model texture
– Require large memory
– Partial volume issues
• Polygonal meshes
– Standard CAD output
– Can model complex shapes and assemblies


Mesh Object Models
Grabcad results for a search of 'water bottle'
Blendswap results for a search of 'shoe'
CAD model of Raspberry Pi board available on GrabCad

16.29 David A. Atkinson: Explosive Trace Detection - Emerging Technologies





Trace Detection Considerations

Pacific Northwest NATIONAL LABORATORY
Proudly Operated by Battelle Since 1965

- Ion mobility spectrometry is the main deployed technology (with shallow development curve)
- CONOPS of current trace implementation is invasive, labor intensive, and subject to variability
- Trace is a secondary signature, an alarm does not mean a threat mass is present (nuisance alarm)
- Environmental backgrounds, false alarms, ion chemistry complications have to be considered
- Particle sampling can be challenging and highly variable.

June 19, 2017 3

Emerging Trace Technologies

Pacific Northwest NATIONAL LABORATORY
Proudly Operated by Battelle Since 1965

- Vapor detection
- Non-contact sampling (particles and vapor)
- Non-contact (standoff) detection
- Enhanced sampling (swipe) materials
- Adaptation to emerging threats (ion chemistry)
- New (and non-radioactive) ion sources
- Potential deployment of mass spectrometry
- Integration with physics based bulk methods

4

16.30 Carl Crawford, Suriyun Whitehead, Harry Martz: Summary and Next Steps

Summary and Next Steps

May 2-3, 2017

Carl Crawford, Csuptwo
Suriyun Whitehead, Booz Allen Hamilton
Harry Martz, LLNL

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Lawrence Livermore National Laboratory
Nondestructive Characterization Institute
LEDP

Was ADSA 16 Successful?

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NNSA

Was ADSA 16 Successful?

- Networking
- Holistic (macro) security
- New ideas; need for out of the box thinking; need for innovation.
- Benefits of privatize security (the ability to set your own requirements specifications)
  – Mall of America
  – Airlines

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What Did We Hear?

- **Dialogue about the relationship between Manufacturers and TSA**
- **Attendance continues to grow**. 35 people to 180 attendees -- 5x increase.
- **Silver Bullet**—May exist in emerging technologies
- **Benchmarking**--Need current technologies performance,
- **TSA panel**.
  – ADSA brings stakeholders together; it keeps getting better
  – ITF: Innovation Task Force ; ID gaps; DT&E to fill them
  – TSCAP: Trans. Security Capability Assessment Process; Enterprise view/challenges
  – What is the amount of risk is TSA willing to take
  – International markets for Global Aviation Security :Same Threats, Manufacturers…
  – Systems Engineering: Technology Development Process
- **Cyber Security:** Network and end points are secure
- **Predict Terrorists Targets—**Strong ldrs do not want to attack civilian targets?
- **Macro Security**—No new technologies; What do we do then?
  – We are the old team we need the new team
  – Release tools; public acceptance of unfamiliar approaches.

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What Did We Hear? continued

- **Requirement-Based Design**—We need leadership
- **Former insider look**
  - Inside
    - Lost track of the mission; only low risk development allowed
    - Diminishing return in more time doing lab testing; Have to get equipment early into the airport; until then you don't really know how well its going to work
  - Outside
    - OEMs massively invest; Remote connectivity; Data gathering & analysis. etc.; Increase risk
    - Run secondary software in the background for R&D then DT&E…get into the field early and often
    - Allow longer term R&D; Gov't should continue to fund third parties and let the market play out
    - Incentive to take some risk; need to get back into startup mode.
- **Manufacturers Panel**
  - In US, ITF is a great start; EU & Rest of World leading in innovation—replay test;
  - Need clearly defined requirements, focus on what you really need; improved gov't & vendor relationship; academic relationship -- streamline IP agreements (templates?).
  - Planning and funding are unpredictable
  - Testing
    - Number of shalls—tiered; Consensus standards; more agility; too long in testing
    - What can manufacturers do to address re-occurring issues encountered repeatedly in multiple testing cycles?
    - What can we do to ease the testing burden, and how and where should we test.
  - What should TSA do to ensure cost effective TSE to meet current and emerging needs
    - DoD acquisition lifecycle guarantees procurement pipeline, TSA's are not typically
    - Manufacturers should not expect the gov't be your Sugar Daddy

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What Did We Hear? continued

- **A Third Party**
  - Confusing, lucky guesses, painful, but it has been good; fail early and fail fast
  - Government wants us to succeed
- **Airline and Airport Perspectives Panel**
  - Passenger seamless experience; don't want to talk to anyone
    - Hassle-free experience, choices via kiosks, tag your own bags, etc.
    - Passengers like to do things themselves, at their own pace
  - Airlines want safe, secure, fast, smooth and simple
  - Airline employees are screened in collaboration with airports and local authorities
  - Disney was asked how to help with flow.
  - Communication. Responsibility of Government to explain policy changes.
  - Collaborate, demonstrate assess. Airport ecosystem. Lean six sigma metrics.
- **JetBlue Collection & Dissemination of Security-Related Information**
  - Incident command center; social media
  - Proactive never reactive... (interview…)
  - Track & trend customers, crew members, etc. not profiling
  - Respond to subpoenas only, otherwise no data sharing.

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What Did We Hear? continued

- **Cargo Update**
  - 2007 100% screening; Certified Cargo Screening Program
  - Certified shipper; Risk-Based Strategies;
  - R&D needs: Cheap, fast (20 skids/hr); low cost large aperture, heterogenous cargo
- **Aviation Security in Israel compared to US**
  - Israel: Screen cars entering airport; profiling; interrogation
  - You may miss your flight
- **Summary of Future X-ray Systems**
- **Specification of Jell-O—**Hard problem need academics to help
- **RORs, Transfer Functions, Simulants**
- **Mall of America Security**—Necessity of interviewing, behavior detection
  - Do a study to determine why successful here but not what TSA found out
  - See something, say something. What is out of the ordinary for your environment?
- **Screening/Security at Large Venues**—
  - Agent based modeling and simulation.

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What Did We Hear? continued

- **Weapons ATR**—eventually will need 100,000+++ images
- **Visual Analytics for Security Applications**
- **DE Decomposition**
  - Many possible spaces, what is best?
  - Need vendors to get involved.
- **Iterative Low-dose CT with DNN**
- **Realistic Simulations of Baggage**—use animation software platforms.
- **DICOS 2A and the TSL/DHS Database**
  - Need input and participation from manufacturers, researchers, etc.
  - Manufacturers participate to make sure we get it right and understand it, interoperability; need to deploy ASAP to DT&E, fix bugs, etc.
  - Opens up the market and will increase sales

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What we did not hear?

- Prohibited items at the check point is more than just guns and knives
- The role of lobbyist
- Who are the engineer leaders
- The B tour on private security
- How can you speed up deployment, checkpoint, etc.
- Not clear how out-of-the-box technologies apply
- How to handle 5%++ increase in passenger load
- Which is better educating or sorting passengers
- What does risk mean, how do we manage it, how do we communicate it?
- How does TSA learn from DoD, NIH, NSF, FDA, etc. What is appropriate for TSA?

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Next Steps

ADSA 17 is going to be systems engineering of security systems.

Oct. 17 & 18, 2017

LLNL-PRES-731343

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ALERT
AWARENESS AND LOCALIZATION
OF EXPLOSIVES-RELATED THREATS

Awareness and Localization of Explosives-Related Threats

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phone: 617.373.4673 — fax: 617.373.8627 — web: www.neu.edu/alert

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