Aviation Security Views on Aircraft Fire Safety – a Research and Development Perspective

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Topics

- U.S. Department of Homeland Security (DHS)/Science & Technology (S&T) Directorate
  - Explosives Division
  - Transportation Security Laboratory (TSL)
  - Aviation Security Approach
- Aircraft Protection Technologies
  - Commercial transport vulnerability to MANPADS
    - Counter-MANPADS Programs
  - Transport aircraft survivability
    - Requirements & Objectives
    - Vulnerability R&D
    - Mitigation R&D
    - Fuel Tank/Systems Survivability Issues
- Summary

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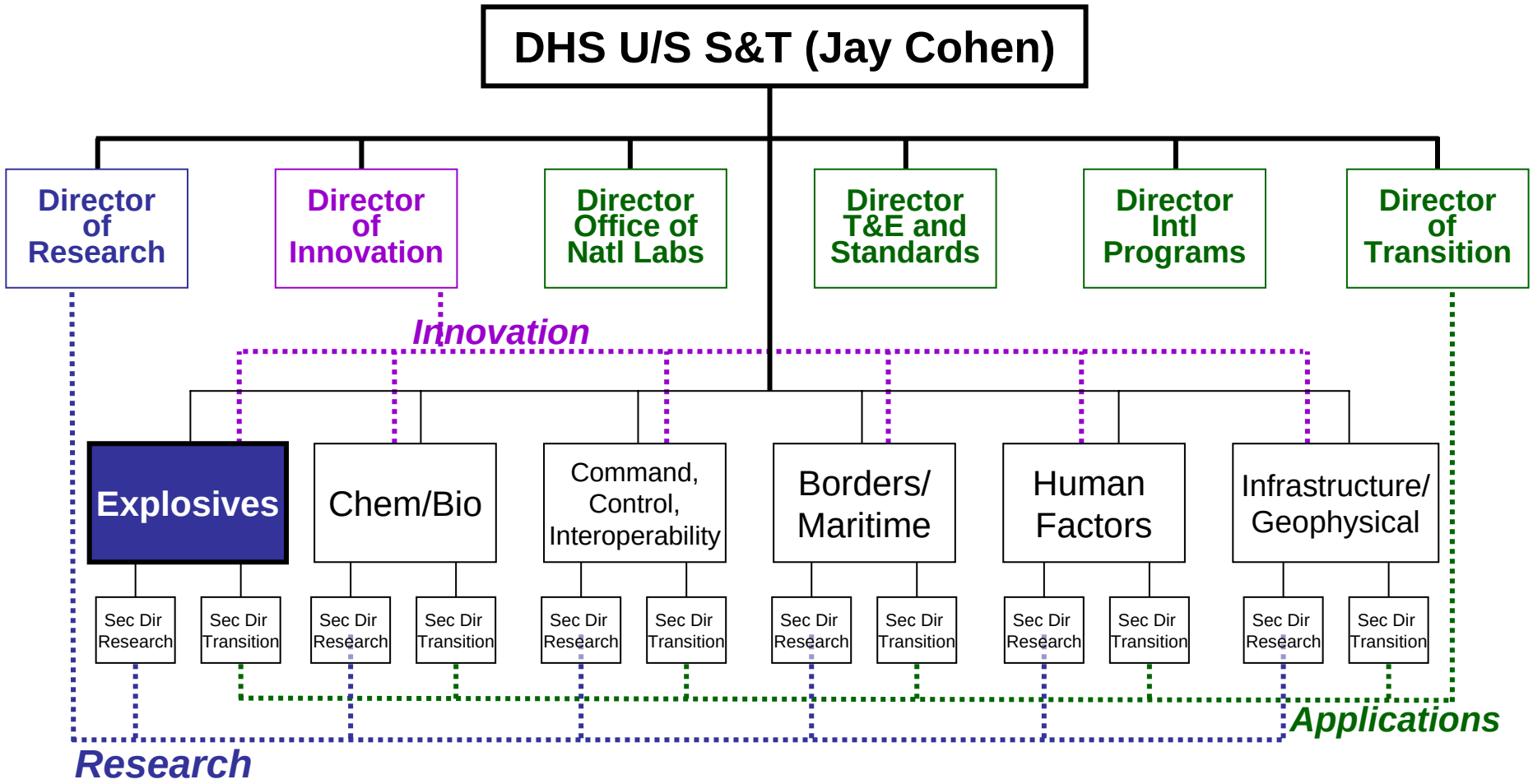

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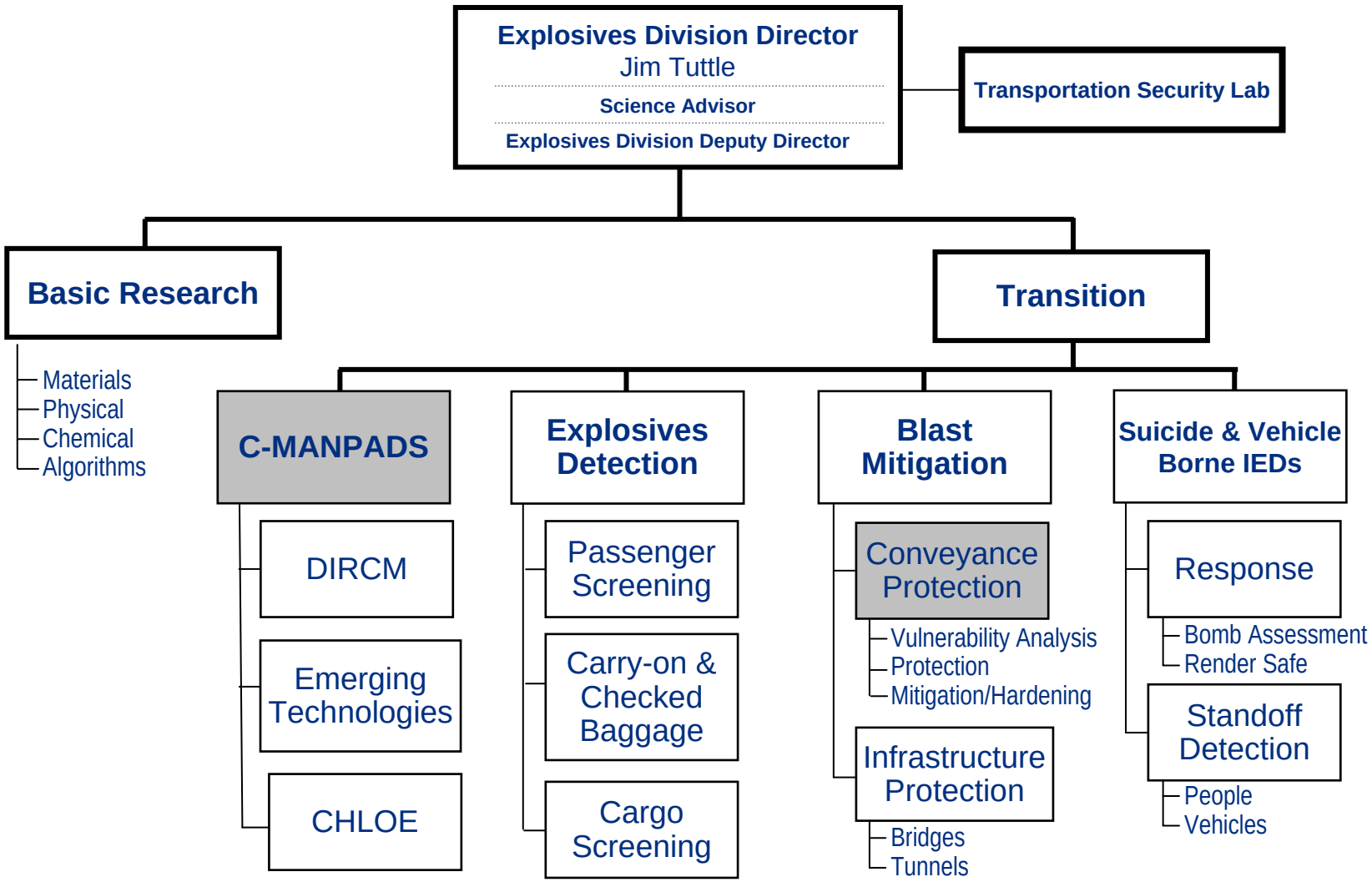
DHS S&T Explosives Division



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Explosives Division

- Mission: To develop, demonstrate and deliver to customers mature technology to prevent, render safe or mitigate the effects of explosives or other energetic materials used by terrorists against people or physical property.
  - Threats –
    - Suicide bombers
    - Conventional and home made explosives (HME)
    - Vehicle borne improvised explosives devices (IED)
    - Guided and ballistic missiles
    - Others
  - Targets –
    - VIPs, congregations of people and first responders
    - Conveyances - air, land, and sea vehicles
    - Property – structures, bridges, tunnels, and others

Transportation Security Laboratory

- "Migration" from FAA (Aviation Security Lab) to Transportation Security Administration (2002) to S&T Directorate (2005) – "are we there yet?"
- Located Outside of Atlantic City, New Jersey
- Responsible for Research, Development, Engineering, Test & Evaluation Activities, and Technology Deployments
- Staff is Composed of Scientists, Mathematicians, Engineers, and Technical Specialists
- Major Product Areas include Checked Baggage, Checkpoint, Cargo, Conveyance and Infrastructure
- Enabling Technologies include Bulk Sensors, Trace Sensors, Communications & RFID, Access Control, Modeling & Simulation, Human Factors, Explosives Effects & Survivability

Aviation Security Technology History

- 1970's – Hijacking
  - Metal Detectors
- Early 1980's – Explosives
  - Thermal Neutron Activation (TNA)
- 1988 – Pan Am 103
  - U.S. Aviation Security Improvement Act (Public Law 101-604) Mandated Current Laboratory
  - Explosives Detection Systems (EDS) & Trace EDE
- 1996 – TWA 800
  - Created Security Equipment Integrated Product Team (SEIPT)
- 2001 – 9/11
  - U.S. Aviation and Transportation Security Act (Public Law 107-71)
  - Today's Efforts & Focus

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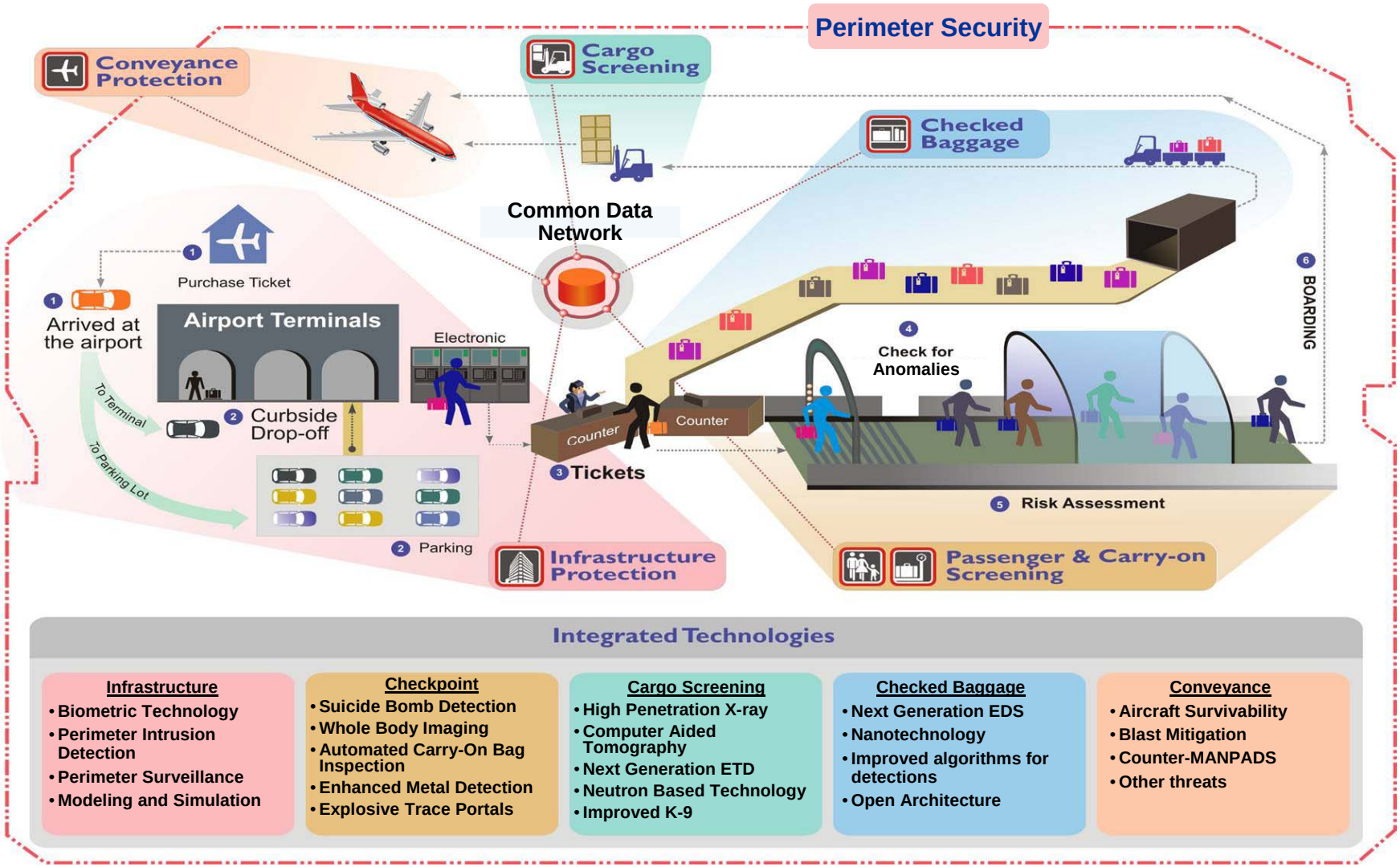
Aviation Security System-of-Systems



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Aircraft Protection Program Requirements

- Requirements Drawn from U.S. Legislation, Presidential Commissions, and Advisory Committees including:
  - 1990 Presidential Commission on Aviation Security and Terrorism
  - Aviation Security Improvement Act of 1990
  - 1996 Aviation Security Advisory Committee Domestic Security Baseline Final Report
  - 1997 White House Commission on Aviation Safety & Security
  - Aviation and Transportation Security Act of 2001 (PL 107-71)

- PL 107-71 States “The TSA [now S&T] shall Accelerate Research, Development, Testing and Evaluation of Aircraft Hardening Materials and Techniques to Reduce the Vulnerability of Aircraft to Terrorist Attack”

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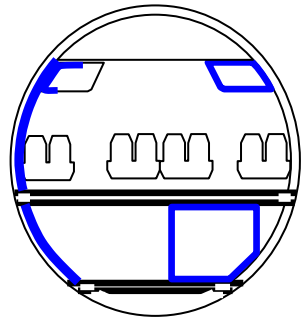
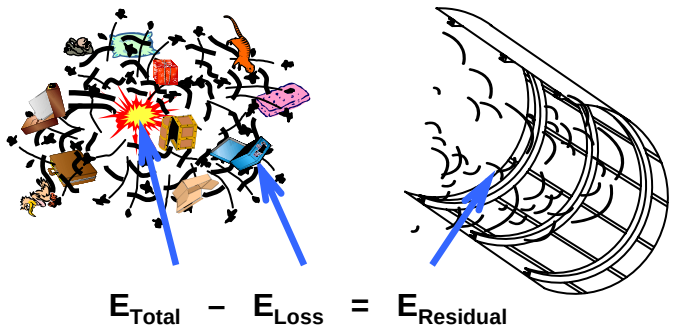
Aircraft Protection Program

CONOPS and Technologies to Protect Against Terrorist Threats Directed at Civil Aircraft

- Understand Threats and Vulnerabilities
- Develop Deployable Technologies to…



  - Protect Aircraft
  - Reduce Vulnerability & Susceptibility ⇨Increase Survivability
  - Mitigate Effects on Passengers and Crew



$E_{Total} - E_{Loss} = E_{Residual}$

DHS MANPADS* Threat Summary

- MANPADS are readily available worldwide and capable of destroying aircraft
- Civilian aircraft are easy targets: slow and predictable, with large signatures

Russian SA-18

- Aircraft are most susceptible near airfields and when traveling below 15,000 – 20,000 feet
- Danger zone of MANPADS attack is large
  - Largely outside airport boundaries (greater than 60 nm)
  - Attack corridor may be up to 8 nm wide

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*Man-Portable Air Defense Systems

National Strategy: A Multi-Layered Approach

- U.S. Department of State – Non-Proliferation
  - Global weapons stockpile
  - Global export controls
  - MANPADS destruction program
- DHS/TSA – Tactical Operations
  - Airport vulnerability assessments and mitigation plans
  - Guidelines for identifying and reporting threats
  - Elevated alert guidelines
- DHS/S&T – Technical Countermeasures
  - Assess commercial transport vulnerability
  - Adapt military DIRCM systems for commercial transports
  - Assess MANPADS emerging countermeasure technology
  - Demonstrate innovative concepts - CHLOE

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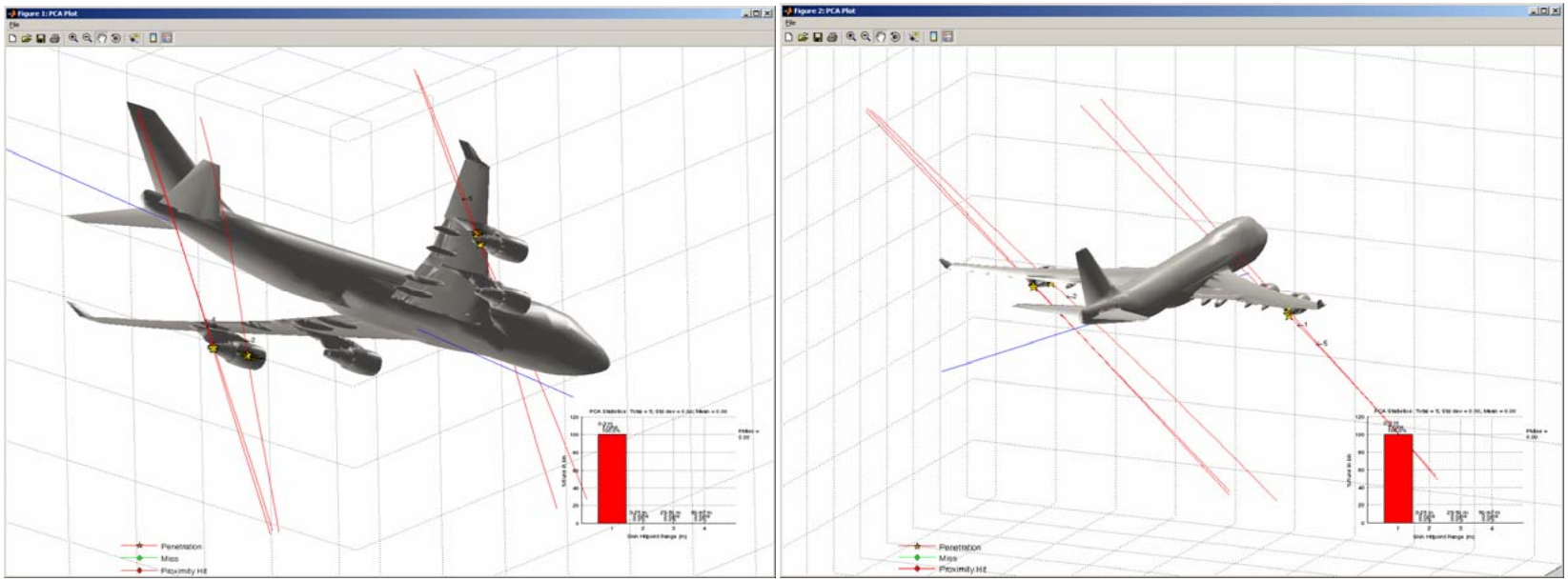
Commercial Transport Vulnerability Analysis

- MANPADS Hit-Point Analysis

example data product



- Simulated missiles (6,000) fired at B-747 IR model
  - Using USAF Guided Weapons Evaluation Facility (GWEF)
  - Multiple generation MANPADS, ranges, azimuths, and atmospheric conditions
- Determine statistically where missiles hit the aircraft
- Manufacturer estimated likely damage
- B-737 and B-757 IR models available

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Counter-MANPADS DIRCM Program

- Phase I - Jan - July 2004 - 6 months
  - Feasibility and preliminary design - three contracts
    - BAE Systems Team - distributed DIRCM
    - Northrop Grumman Corp Team - DIRCM pod
    - United Team - decoy flares
- Phase II - Aug 2004 - Mar 2006 - 18 months
  - Adapted DoD technology for commercial transport protection
    - Evaluated performance through simulations and flight tests
  - Obtained FAA Supplemental Type Certification (STC)
    - B-767 with BAE system
    - B-747, MD-11 and MD-10 with NGC system
  - Developed operations, maintenance and supply procedures
  - Performed initial manufacturing/installation rate assessment
  - Completed preliminary ownership and life-cycle cost analysis
- Phase III - Mar 2006 - Mar 2009 - 3 years
  - Conducting in-service evaluations with cargo airlines
  - Plan to start passenger in-service evaluations late 2007 or early 2008
  - Improving system performance and reliability
  - Live fire tests at White Sands Missile Range Fall 2007
  - Goal to certify performance of both systems

DIRCM Counter-MANPADS Summary

- Program on schedule – to be completed early 2009
- Systems can protect commercial transports
  - Live fire test demonstrations Fall 2007
- Four different FAA-certified prototype installations
- Phase III designed to reduce risk and cost of ownership
- DHS results also improving DoD systems' reliability and performance
- No decision to deploy

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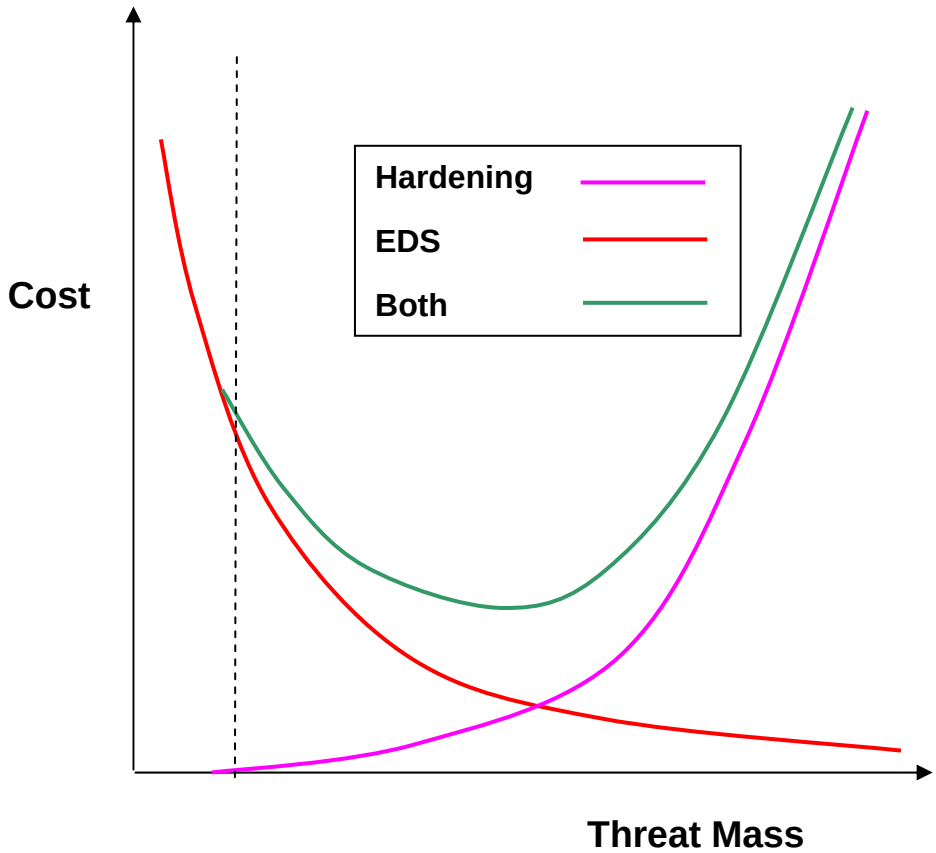
Aircraft Vulnerability/Hardening

- Commercial air transport vulnerability to interior detonated explosives
  - Type, amount, location, surroundings, etc.
  - Assess other Threats (e.g., MANPADs)
- Explosives Detection Systems (EDS) screening
  - Checked, carry-on bags & cargo
  - ***Costs increase as threat mass decreases***
- Aircraft hardening/mitigation
  - Overhead bins, passenger cabin liners, cargo containers, cargo compartment liners, etc.
  - ***Costs increase as threat mass increases***
- Is there a best combination of screening and hardening?



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Aircraft Vulnerability – Research Overview

- Over 140 explosive vulnerability tests conducted on commercial aircraft structures since 1990
  - 98 Tests on Narrow-Body Aircraft (B707, B727, B737, DC9, MD80)
    - 45 in passenger cabin (9 Pressurized)
    - 53 in cargo hold (1 Pressurized)
  - 42 Tests on Wide-Body Aircraft (A300, B747, DC10, L1011)
    - 32 in passenger cabin (4 pressurized)
    - 10 in cargo hold (5 pressurized)

- Over 200 Supporting Data Tests
  - Includes determining suppressive properties of passenger luggage and air cargo contents on explosive effects

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Aircraft Hardening – Mitigation Overview

- 104 tests conducted on various explosive mitigation concepts since 1990

- Investigating a number of explosive mitigation concepts including:
  - Passenger cabin blast resistant liners
  - Hardened overhead baggage storage bins
  - Cargo compartment liners
  - Hardened Unit Load Devices (HULD) for Wide-Body Aircraft
  - Validation of least risk bomb location (LRBL) procedures
  - Threat Containment Unit (TCU) for airport terminal deployment

Optimized Telair International HULD Design

- Reduced Aluminum Frame (6061-T6) Extrusion
- Kevlar 129 body panels (3-8 ply)
- Replaced SS Connecting Hardware w/Titanium
- Revised Door Handles and Frames
- Enhanced Operability
- Tare weight: 265 lbs.
- FAA Airworthiness Certification Pending (TSO-C90c)
- Cost: $15K (<100 units prod.)

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On-Board Weapons Effects

- Identify Adverse Effects of Weapons Discharge on the Flight Deck or Passenger Cabin
  - Joint U.S. Transportation Security/Federal Aviation Administration Project Evaluating the Risk of Catastrophic Failure due to Accidental FFDO (Armed Pilot) Weapon Discharge
  - Performed “Quick Look” Report on Practicality of Electric Stunning Pistols on the Flight Deck (with much Input from FAA)
- Future Efforts in this Area likely to Require Similar Cooperation
- Clear Link between Aviation Safety & Security

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Threats and Potential Consequences

- Threats include Internal (Explosive Devices, Firearms, EMI) and External or Stand-off (MANPADS, RPGs, Small Arms Fire, Directed Energy)

- Potential Structural Modifications to Increase Aircraft Survivability after an Event include:
  - Cargo Hold and Passenger Cabin Liners, Hardened Overhead Bins
  - Protection of Fuel Tank & Systems from the Possibility of Secondary Fire/Explosion from Internal Threat
  - Protection of Fuel Tank & Systems from External Attack
  - Survivability of Fire Suppression Systems Exposed to an Explosion (i.e., will the System still be effective?)

Threats and Potential Consequences (continued)

- Damage Mechanisms Primarily are Fuel Tank Fires, Fuel Tank Explosions, and Hydrodynamic Ram

- Fires and Explosions can Cascade from the Original Source; Fires can Propagate and Lead to Explosion, etc.
  - Potential Solutions include Fuel Tank Inerting and Suppressive Agents, both “Active” (such as Foams or Meshes) and “Reactive” (release triggered by a sensor alarm)

- Hydrodynamic Ram Typically caused by Projectiles Entering Fuel Tank; Stand-off Attack is Greatest cause for Concern (Wing Tanks), but also Potential Exists for an Internal Device to Fragment
  - Shockwave in Fuel, likely to Cause Structural Damage, Particularly in Wing Structures
  - Active Suppressive Agents the most Likely Solutions

Threats and Potential Consequences (continued)

- Fire Suppression Systems in the Cargo Hold must be Robust enough to Still be Effective
- Security Solutions must Consider the Capability of Fire Suppression to Contain Explosion-Induced Fires
- Example – Will the Fire Suppression System still Function after Detonation of a Bomb in a Hardened Container?
  - Fully Functioning System in a Retired DC-10-40 Aircraft Evaluated in December 2003 – Fire Suppression Performed Nominally
- Similar Activity Planned for FY08 for Evaluation of Cargo Hold Liners

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Thoughts

- Solutions to Many Safety Problems, Particularly in the Fuel Systems Area, also have Benefit to Security Concerns
  - With Tight Resources, Leveraging of Efforts Provides Maximum Return to all Parties
- Commercial Aircraft Survivability Solutions must Strive to Satisfy Security Goals with Minimal Penalty for Weight and Cost
  - Compliance with Current Airworthiness Requirements is also Essential
- Security Enhancements must be Balanced against Safety Requirements and Customer Service (Operational Considerations)
- Holistic Approach to the Aircraft Survivability Discipline would Synergistically Consider both Safety & Security Threats
- What are the Win-Win areas to Pursue?

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Summary

- Program is Generally Testing-Centered with Security-Critical Mission
- Survivability Work allows for Identification of Measures/Criteria for Prevention (Screening) and Mitigation (Vulnerability Reduction)
- Mitigation Products Serve to Provide Layered Protection to Secure against Breach/Avoidance of Screening Initiatives
- Program Initiatives Evolving to Address Sophistication of Terrorist Threat

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