Advanced Integrated Passenger and Baggage Screening Technologies

January 14, 2020

Fiscal Year 2019 Report to Congress

Homeland Security

Transportation Security Administration

Message from the Acting Deputy Administrator

January 14, 2020

I am pleased to present the following report, "Advanced Integrated Passenger and Baggage Screening Technologies," prepared by the Transportation Security Administration (TSA).

This report was compiled in response to Senate Report 115-283 accompanying the Fiscal Year (FY) 2019 Department of Homeland Security Appropriations Act (P.L. 116-6). The report provides updates on the Department's efforts and resources devoted to developing more advanced integrated passenger and baggage screening technologies at the lowest possible costs.

The report also includes projected funding levels for the next 5 fiscal years, or until project completion, for each technology discussed and summarizes the efforts made in FYs 2019-2020 to improve and transform aviation security. This effort includes improving detection at the checkpoint, enhancing operational efficiency and passenger experience, and making necessary equipment investments to address vulnerabilities and improve system effectiveness.

Pursuant to congressional requirements, this report is being provided to the following Members of Congress:

The Honorable Lucille Roybal-Allard
Chairwoman, House Appropriations Subcommittee on Homeland Security

The Honorable Chuck Fleischmann
Ranking Member, House Appropriations Subcommittee on Homeland Security

The Honorable Shelley Moore Capito
Chairman, Senate Appropriations Subcommittee on Homeland Security

The Honorable Jon Tester
Ranking Member, Senate Appropriations Subcommittee on Homeland Security

If you have any questions, please do not hesitate to contact me at (571) 227-2801 or TSA's Legislative Affairs office at (571) 227-2717.

Sincerely,

Patricia F.S. Cogswell

Patricia F.S. Cogswell
Acting Deputy Administrator
for Administrator Pekoske

Executive Summary

Senate Report 115-283 accompanying P.L. 116-6 requires TSA to submit a detailed report to address passenger and baggage screening technologies. Specifically, the report should include a useful description of existing and emerging technologies capable of detecting threats concealed on passengers.

Through FYs 2018 and 2019, TSA has continued to advance aviation security by enhancing existing technologies and by acquiring and integrating new technologies to screen passengers and baggage more effectively and efficiently. During FY 2018, TSA screened approximately 804 million passengers, 1.8 billion carry-on items, and more than 521 million checked bags. This is an average increase of 112,329 passengers per day over the prior fiscal year. The International Air Transport Association 20-Year Air Passenger Forecast projects that the number of anticipated passengers screened in the United States will grow by 2.4 percent annually over the next 20 years, reaching a total of 1.4 billion by 2037.[1] In 2019, TSA projects that U.S. airports will see a 4.5-percent growth in enplanements, while industry projects that U.S. airline capacity is expected to grow between 3.5 percent and 4.7 percent.[2]

In short, TSA and the aviation industry have seen a steady increase in daily travelers, and this growth is projected to continue. TSA is committed to implementing appropriate technology and workforce efficiencies to process the record number of travelers and goods through our Nation's transportation system, within our passenger throughput goals, while maintaining our focus on effective security.

TSA has accomplished a number of initiatives in FYs 2018 and 2019 to enhance the security of the aviation system. Accomplishments include:

- Awarded a contract to procure and deploy 300 computed tomography (CT) units certified to the second-generation Advanced Technology Tier II detection level, beginning in FY 2020;
- Completed qualification and operational testing for credential authentication technology and completed site surveys for 335 airports, enabling TSA to complete its procurement of 505 systems in FY 2019 and to begin deployment in FY 2020;
- Deployed 184 automated screening lanes (ASL) integrated with AT-2 scanners in 16 airports; and
- Invested in numerous research and development activities to: improve explosives detection; expand automated detection to include prohibited items such as guns and knives; integrate eight checkpoint CT systems from four different CT manufacturers with eight ASLs from four different ASL manufacturers in six airports; and establish modular interfaces that will accelerate the adoption of future advances.

[1] International Air Transport Association report, "Passenger Forecast" (2017).
[2] Air Transport World, "Moody's: Airport enplanement growth will slow in 2019" (2018).

TSA continues to enhance existing checkpoint and checked baggage screening technologies to increase security capabilities and operational efficiencies. TSA is working with government partners, industry, and other stakeholders to improve current technology and algorithms, to develop new technology, and to build an interoperable architecture to increase automation and integration.

TSA is investing in emerging technologies, such as biometric technology, which improves TSA's ability to verify passenger identity beyond the traditional credential authentication measures. TSA has undertaken a number of pilot initiatives in collaboration with U.S. Customs and Border Protection in FYs 2018-2019 to test both technology and different operational models for use of biometrics.

In summary, TSA operates in a complex environment with evolving threats to our Nation's aviation system and yearly increases in passenger volumes. TSA is committed to continue working closely with Congress to make sure that the organization has the resources that it needs to deliver security as efficiently as possible.

Advanced Integrated Passenger and Baggage Screening Technologies

Table of Contents

I. Legislative Language

This report is submitted pursuant to language in Senate Report 115-283, which accompanies the Fiscal Year (FY) 2019 Department of Homeland Security (DHS) Appropriations Act (P.L. 116-6).

Senate Report 115-283 includes the following provision:

> TSA is directed to submit a detailed report on passenger and baggage screening technologies not later than 180 days after the date of enactment of this act. The report shall include a useful description of existing and emerging technologies capable of detecting threats concealed on passengers and in baggage, as well as projected funding levels for each technology identified in the report for the next five fiscal years.

II. Introduction

The Transportation Security Administration's (TSA) mission is to protect the Nation's transportation systems to ensure freedom of movement for people and commerce. TSA continually adapts security screening to meet evolving security threats and changes within the aviation industry. TSA assesses risk and identifies and prioritizes capability deficiencies at various levels across the agency to inform both strategic and tactical decisions.

TSA's security measures involve a range of capabilities designed to mitigate substantial risk to the transportation system. Moreover, to remain ahead of our adversaries, TSA constantly evaluates its security approach by reviewing its procedures, technologies, and workforce training. TSA proactively invests in new technologies and enhancements to scale with consistent growth in passenger volume and shifting traveler demographics.

TSA has approximately 14,200 transportation security equipment (TSE) units deployed at approximately 440 airports across the Nation. TSA identifies, tests, procures, deploys, and maintains TSE that is capable of detecting threats concealed on passengers and in their baggage. To fulfill its security responsibilities, TSA must have a steady inventory of TSE available to allow TSA to respond to changing threat information and modification of airport facilities. In addition, TSA must have the flexibility to stand up operations in locations affected by natural disasters and other crises.

The goal for TSA is clear when it comes to technology investment: identify, implement, and enhance capabilities that can detect increasingly complex threats; secure those capabilities against cyber intrusions; and integrate data to refine further how we deliver security to different passenger populations. TSA is committed to making certain that these capabilities can scale to handle the increasing number of travelers and goods traveling through the aviation network. Equally important is the commitment to protect traveler privacy, while delivering exceptional security.

A. Background

TSA technology acquisition programs operate within complex environments that influence not only the solutions that are procured, but how they are procured. Factors that influence the security technology environment include:

- ***Threat Landscape:*** The checkpoint system addresses emerging and evolving threats to aviation security by terrorists onboard commercial aircraft. Although recent attacks on aviation have targeted multiple aspects of the aviation environment, terrorists continue to have a strong interest in defeating checkpoint security measures to bring threat materials, such as metallic and nonmetallic weapons and explosives, onto an aircraft; the materials either are attached to a person's body or are within carry-on baggage. TSA actively seeks new technologies or enhancements to current TSE, such as machine-learning for automated threat detection and enhanced threat detection provided by computed tomography (CT), to defeat the evolving threat.

TSA must deploy its best detection capabilities broadly to prevent adversaries from being able to transport weapons, explosives, or other threat materials onto planes. To address the continued spread of new explosive threats, greater numbers of weapons, and other threat materials identified at checkpoints, TSA must improve automated threat detection and alarm resolution capabilities through innovation and rapid response. TSA also seeks to become more efficient to meet expanding passenger throughput, which can be served by improving capabilities. One such example is the recent deployment of CT systems, which offer better imaging compared to legacy (second-generation Advanced Technology, or AT-2) scanners and can detect a broader range of threats automatically.

The threat environment for checked baggage includes military, commercial, and homemade explosives (HME). TSA continues to screen 100 percent of checked baggage, as required by the Aviation and Transportation Security Act. Over the past several years, multiple plots on checked baggage involving HMEs have been identified, making proactive detection one of TSA's top priority requirements. Vulnerabilities within the checked baggage environment are mitigated through the use of explosives detection systems (EDS), which use CT technology to screen checked baggage dropped off at the check-in counter before it is loaded onto commercial aircraft, and explosives trace detection units, which have enhanced explosives detection sensitivity and can detect a wider range of explosive threats.

- ***Evolving Cybersecurity Threats:*** TSA also must identify and work with aviation partners to close cybersecurity vulnerabilities. Because the transportation and logistics sectors are vital to the world's economies, cyber-attacks on them could have devastating effects. Through exploiting software and hardware vulnerabilities, cyber-attacks can compromise data and disrupt system operations. TSA needs to respond rapidly to the evolving cyber threat landscape. Protecting both TSE and the underlying network infrastructure against cyber threats is an integral part of acquisitions, capability, and enhancement upgrades that TSA implements and will remain a critical part of its mission.

  As TSA transitions standalone TSE to a fully integrated networked security system, addressing cybersecurity threats will become an increasingly important task. The Security Technology Integrated Program (STIP) will provide the adaptable communications infrastructure to facilitate the transfer of information to and from this equipment once it is connected to the TSA Network. STIP is piloting a solution to isolate, monitor, and protect this information by segmenting the traffic from TSE. Additionally, prior to connectivity, TSA requires that TSE be modified to implement cybersecurity requirements, including patching, hardening, and personal identity verification compatibility. Once connected, STIP can provide enhanced security features such as remotely pushing software and other configuration changes to respond to emerging threats as well as remotely monitoring, diagnosing, troubleshooting, and managing TSE.

- ***Passenger Volume and Traveler Demographic Shifts:*** Since inception, TSA's security capabilities have scaled to keep pace with increases in the global commercial aviation industry. However, as the landscape of travelers continues to change, the ways in which both TSA and our adversaries operate will be affected.

  TSA operates year-round in approximately 440 airports, and each one is an entry point into the entire aviation system. During FY 2018, TSA screened approximately 804 million passengers, 1.8 billion carry-on items, and more than 521 million checked bags. This average increase of 112,329 passengers per day over the prior fiscal year is projected to continue to grow. The International Air Transport Association 20-Year Air Passenger Forecast projects that the number of anticipated passengers screened in the United States will grow by 2.4 percent annually over the next 20 years, reaching a total of 1.4 billion by 2037.[3] In 2019, TSA projects that U.S. airports will see a 4.5-percent growth in enplanements, while industry projects that U.S. airline capacity is expected to grow between 3.5 percent and 4.7 percent.[4] TSA's security capabilities must scale to keep pace with these increased demands.

  Furthermore, the demographic profile of the traveling public continues to change, requiring innovative and inclusive solutions from TSA. In particular, globalization, an aging population, and a growing emphasis on customer experience will change the transportation environment. Globalization contributes to an increase in overseas travel, with 81.3 million international travelers visiting the United States in 2018 alone, a 6-percent increase from the previous year.[5] This trend is projected to continue, driving new adversaries and threat areas across transportation modes. In addition, the percentage of the population ages 65 and older in the United States is expected to increase from 15 percent in 2018 to 22 percent in 2050, requiring more inclusive screening technology and procedures.[6] Finally, to ensure that TSA continues to lead transportation security during this age of digital connectivity, it must use emerging technologies to streamline and individualize the customer experience.

- ***Security Effectiveness:*** Security effectiveness is a measure of integrated, real-world performance in security screening according to a defined set of criteria designed to identify and mitigate threats within a protected area. TSA continues to pursue updated detection standards based on emerging intelligence-based threat streams and actual terrorist events, while also requiring a reduction in false alarm rates. TSA needs to ensure that the technology that it identifies, tests, procures, and ultimately deploys meets (or can be upgraded to meet) these requirements and, therefore, provides improved security effectiveness and operational efficiency (that is, throughput).

- ***Coordination with Stakeholders:*** TSA interacts with various stakeholders as partners in aviation security and recognizes the impact that TSA decisions can have on them. These

[3] International Air Transport Association report, "Passenger Forecast" (2017).
[4] Air Transport World, "Moody's: Airport enplanement growth will slow in 2019" (2018).
[5] U.S. Travel, "U.S. Travel's Research Trends. December 2018: Economic Overview" (2018).
[6] Population Reference Bureau report, "2018 World Population Data Sheet" (2018), https://stage.prb.org/wp-content/uploads/2018/08/2018_WPDS.pdf.

stakeholders often have competing priorities that they must balance to achieve maximum efficiency. Stakeholders include:

  - ***Passengers:*** Checkpoint technology affects the overall passenger experience and is often the primary factor that influences the level of public cooperation and contribution to aviation security.

  - ***Airports:*** When analyzing TSE for acquisition and deployment, TSA considers the real estate footprint, existing infrastructure, and installation needs. TSA must coordinate with airports that own and operate the infrastructure to assess the impact of integrating checkpoint and checked baggage technologies across different physical layouts.

  - ***Airline and Air Cargo Carriers:*** TSA's actions affect air carrier operations and the flow of people and goods through an aviation transportation system.

- ***User Adoption of Planned Technology:*** TSA must be able to integrate technology into its operational processes, and the technology must enable or enhance security protocols. Human systems integration should be included as an integral part of a total system approach. The goal is to consider equally the human factors (transportation security officer (TSO) and passenger) to optimize system performance and to minimize ownership costs.

B. Overview

TSA prepared the tables in Section III of this report outlining FY 2019 TSE planned procurements to support checkpoint and checked baggage screening operations. The procurements were funded in P.L. 116-6. FY 2020–FY 2024 funding data are based on the FY 2020 Congressional Justification (CJ) from the DHS Future Years Homeland Security Program (FYHSP) database as of May 1, 2019.

FY 2019 purchase quantities are based on available funding balances, and FY 2020 equipment purchase quantities are based on the FY 2020 President's Budget. FY 2021–FY 2023 projected purchase quantities are based on the agency's evaluation of projected available funding. However, changing realities of the security environment often result in changes from budgeted quantities. For example, because TSA expects continued annual passenger growth, TSA may look to purchase small quantities of qualified systems to respond to increased passenger throughput. TSA also may buy new commercial off-the-shelf TSE for demonstrations and testing to help develop future requirements.

In addition to planned checkpoint and checked baggage TSE purchases, the subsequent tables also provide funding information for each fiscal year using these definitions:

- System Procurement Cost: Cost of purchasing TSE, related peripherals, and shipping and supporting equipment;

- System Detection Improvements and Enhancements: Cost of developing incremental enhancements to threat detection capabilities;
- Testing Costs: Cost of testing TSE against requirements for the potential purchase or testing of system detection improvements and enhancements, and cost of factory and site acceptance testing for TSE in use;
- Deployment Cost: Cost of deploying procured TSE and any system detection improvements and enhancements, and cost of changes to airport infrastructure or facilities driven by TSE;
- Maintenance Cost: Cost of sustaining TSE after deployment; and
- Program Support Cost: Cost for program management, monitoring, and overhead functions.

III. Advancing Integrated Passenger and Baggage Screening Technologies

Threats to aviation security are changing constantly. As a result, passenger and checked baggage security screening must continue to adapt to meet evolving threats to aviation. This section of the report addresses current and emerging screening technologies, and highlights the initiatives that TSA is undertaking to ensure that these technologies provide for the most effective screening.

A. Checkpoint Technologies

Adversaries constantly are developing new methods of concealment and explosive materials, threats beyond explosives, and new tactical and operational approaches to seek to defeat our security measures. Older detection capabilities may not be able to recognize new concealment methods and new explosive or nonexplosive threats if TSA cannot develop and deploy new capabilities rapidly.

To address the security challenges at airport security screening checkpoints, TSA is investing in initiatives such as technology automation and detection processes. Threat detection algorithm software is designed to detect automatically threats or other anomalies concealed on passengers and in their carry-on baggage as they pass through the airport security screening checkpoint. The implementation of threat detection algorithms on TSE is expected to improve TSA's ability to detect threats, increase throughput at the checkpoint, decrease the probability of false alarms, bring consistency into the screening process, and reduce physical inspections.

TSA uses a competitive procurement process to select new checkpoint technology based on the best value to the government, ensuring that technology either meets or exceeds agency requirements. Full-rate production delivery orders can be awarded to one or many vendors depending on the program acquisition and procurement strategies.

B. Existing Checkpoint Technologies

TSA identifies, tests, procures, deploys, upgrades, and maintains a variety of TSE to screen passengers and their carry-on baggage at airports nationwide. Funding tables for TSE technologies are aligned with FYHSP investments. All airport security screening checkpoint technologies historically have been grouped into a single Passenger Screening Program (PSP) FYHSP investment and acquisition program.

TSA began to divide the single PSP FYHSP investment into the new individual investments beginning with the FY 2020 budget development process. These amounts and quantities are subject to change on the basis of final contract awards. Current checkpoint technologies and associated FYHSP investment, which represent those technologies managed under an acquisition program of record, include:

- Advanced Imaging Technology (AIT) – AIT FYHSP Investment;
- AT-2 – Advanced Technology (AT) FYHSP Investment;
- CT – AT-CT and AT FYHSP Investment;
- Credential Authentication Technology (CAT) – CAT FYHSP Investment;
- Explosives Trace Detector (ETD) – ETD FYHSP Investment; and
- PSP Legacy Technology to include Bottled Liquid Scanner (BLS), Boarding Pass Scanner (BPS), and Enhanced Metal Detector (EMD) – PSP legacy FYHSP Investment.

TSA continuously reevaluates TSE requirements on the basis of the latest operational needs and security threats. Therefore, the following initiatives are subject to change. Although TSA plans to replace many of its technologies with next generation (NextGen) capabilities, it continues to upgrade existing technologies as needed while new equipment is developed and acquired.

Advanced Imaging Technology

AIT systems detect metallic and nonmetallic concealed items on passengers as they pass through the airport security screening checkpoint. AIT systems are used to screen passengers for weapons, explosives, and other objects concealed under layers of clothing, without physical contact, thus reducing the need for patdown searches.

As the passenger steps into the AIT system, transmitters produce millimeter waves that either are absorbed, scattered, or reflected as they pass through clothing, bounce off the person's skin and any concealed items, and then return to the receivers. The AIT system applies the necessary detection algorithms on the reflected signals to determine the location of possible concealed items on the body. If the AIT system detects an item, the system presents a bounding box indicating the item's location on a display monitor. The bounding box is shown to the operator using a generic human image. When the system identifies a concealed item, an operator must resolve the alarm with a patdown. The total processing time for this system, from the start of the scan to the automated decision, is less than 6 seconds.

The AIT fleet includes both the first generation AIT-1 and second generation AIT-2 systems. The AIT-2 units have a smaller physical footprint at the checkpoint, but both systems are standardized with AIT Tier II detection capability. The benefit of AIT-2 systems is that they allow TSA to deploy AIT equipment to many small airports that previously lacked advanced imaging capability because of space limitations. Deployment of AIT systems to these smaller airports mitigates the increased threat and potential for foreign terrorist organizations to use small airports as entry points to the aviation system.

In 2018, TSA conducted an analysis on the capability needs within the person screening capability and the associated capability gaps. This analysis resulted in the DHS validated Capability Analysis Report for Screening Traveler's/Nontraveling Individual's Person. The report established the need for improvements and need for development of technology.

AIT will continue to be a key component of passenger screening, and its algorithm software is being enhanced to allow for detection of more advanced threats. To address these specific threats, AIT-1 and -2 enhancement packages have been developed and are in the testing phase of the acquisition lifecycle. These enhancement packages are scheduled for deployment in the first quarter of FY 2020. The capabilities in these packages provide a more focused threat detection capability while giving the operator tools to maintain throughput levels. Some of these capabilities include improved detection for physically sensitive areas of the body, the ability to resolve alarms while maintaining screening of passengers, and the ability to adjust detection algorithms for appropriate threats.

In addition, the Innovation Task Force (ITF) recently has completed operational demonstrations of the enhanced AIT system at Denver International Airport and Los Angeles International Airport (LAX). The enhanced AIT is a dual, flat-panel millimeter wave imaging system that offers simplified passenger stance requirements, corrective feedback on improper positioning, and multiple secondary screening stations for alarm resolution. Additional operational demonstrations of the enhanced AIT are anticipated to be conducted over the next several months.

TSA is piloting connecting AIT systems to the STIP network. Connecting to STIP will provide a way to obtain metrics from the AIT system without TSOs and others in the field having to record data manually. STIP connectivity also will result in faster and less costly deployment of software configuration changes. Should the agency decide to connect AITs, proper IT and cybersecurity controls, managed through the authority-to-operate process, will be in place to ensure that information is managed securely.

In accordance with a DHS-validated process, TSA has identified capability gaps in on-person screening and is pursuing their closure in multiple ways. TSA has continued exploring algorithm integration and wideband development to advance the detection standard in the current and future fleet of AIT systems by possibly reaching Tier III+ detection levels. A recent achievement in this area was TSA's open competition for an AIT detection algorithm via Kaggle, a Google-owned, online community hosting machine-learning competitions. TSA provided prize money to top performers and now owns several detection algorithms, which provide the ability for TSA to enhance algorithms without reliance on the original equipment manufacturer. The next generation of passenger screening technology will offer enhanced image resolution by using a wider frequency bandwidth that supports more advanced algorithms for automated threat detection. TSA also is exploring adaptable/machine-learning algorithms, alternative millimeter wave frequency bands, passenger screening during continuous movement through the checkpoint, and the use of advanced imaging antennas to improve image processing and to identify a wider variety of threats. Adaptable algorithms and an open architecture allow TSA to continue to enhance threat detection capabilities without replacing an entire machine.

As indicated above, DHS has validated TSA's need to invest in new technology related to checkpoint on-person screening (via the Capability Analysis Report for Screening Traveler's/Nontraveling Individual's Person). TSA currently is working to establish a targeted broad agency announcement (BAA) to be executed in FY 2020. Funding has been identified for this effort through a program decision option (PDO) with $5 million per year going to development activities. Additionally, future capability development will focus on three-dimensional reconstruction algorithms to address threats concealed in obscured body locations, the ability to discern materials/objects detected, and improved detection. In part, those development efforts will be through a targeted BAA, for which $5 million of research and development (R&D) funds was proposed for FY 2020. Subsequently, TSA plans to assess NextGen units in FY 2021.

As of May 2019, TSA has 945 AITs deployed to airports. Table 1 outlines projected costs for AIT maintenance and enhancement at airport checkpoints.

Table 1: AIT Planned Purchases as of May 2019[7] *($ in millions)*

Advanced Imaging Technology – FY 2020-FY 2024 – CJ 2020 FYHSP					
	FY 2020	FY 2021	FY 2022	FY 2023	FY 2024
Total O&S	**$30.50**	**$28.68**	**$28.60**	**$29.37**	**$28.57**
Investment Maintenance	$29.76	$27.94	$27.86	$28.63	$27.83
Salaries	$0.74	$0.74	$0.74	$0.74	$0.74
Total	**$30.50**	**$28.68**	**$28.60**	**$29.37**	**$28.57**

*TSA began to divide the single PSP FYHSP investment into the new individual investments beginning with the FY 2020 budget development process. The total FY 2019 PSP budget was $241.48 million.

Advanced Technology X-rays

Checkpoint AT-2 systems are an x-ray-based scanner used to detect threats concealed in passengers' carry-on items at the airport security screening checkpoint. TSA uses AT-2 systems to screen roughly 3 million carry-on bags for explosives and prohibited items each day. AT-2 systems detect threats in carry-on baggage by providing automated detection capability and a two-dimensional view. Within the x-ray image, different materials, including threat objects, will appear in a certain color to help the operator to identify threats. Threat object discrimination has continued to improve through R&D efforts but can affect throughput efficiency and increase false alarm rates throughout the system.

As threats emerge and technical capabilities improve, enhancements to the AT-2 systems at airports may include both software upgrades and procedural changes. TSA continues to work with vendors to develop and deploy enhanced detection capabilities. For example, TSA intends to deploy an enhanced Tier II algorithm in FY 2019. In addition to providing overall improved system detection, this algorithm will provide a screener-assist function with frames or other markers around selected items. These frames will alert TSOs to potential threats in carry-on bags, increasing the TSO's efficiency and ability to find prohibited items while ensuring greater consistency in resolving issues.

TSA also is studying the effects of specific emerging threats and is working with vendors to assess detection algorithms for each. These efforts are aimed at testing and ultimately deploying

[7] FY 2020 planned purchases are based on the FY 2020 President's Budget. FY 2021-FY 2024 purchases are based on the FY 2020 CJ FYHSP report.

an enhanced algorithm. In addition, TSA is working with vendors to analyze the potential impacts of the new specific threats on their current algorithms while analyzing AT-2 system detection/false alarms to meet AT-2 operational performance objectives. Enhanced threat algorithms will be tested and will begin deployment in FY 2019.

Over the coming fiscal years, AT-2 systems will be replaced where possible with newly procured CT systems; however, TSA currently cannot replace all AT-2s with CT systems because of airport infrastructure constraints. As a result, TSA will continue to utilize AT-2s in a small number of locations until a reduced-size CT capability or other solution exists.

Automated screening lanes (ASL) are a property handling system integrated into an AT-2 (and soon-to-be CT) system to mitigate checkpoint security vulnerabilities, to improve checkpoint efficiency and throughput, and to reduce the number of misdirected bags identified for additional screening. In October 2016, TSA was approved to deploy up to 220 ASL systems through public-private partnerships to address a DHS-validated, urgent operational need. The deployment of ASLs addressed a security gap and allowed private-sector partners (airlines and airport authorities) to purchase the equipment, and then to donate or bail it to TSA.

TSA does not intend to establish ASL as a standalone program of record. Instead, it will continue to manage existing and any future deployed ASLs as part of the AT-2 program. ASL capability will be integrated with CT technology as part of the Checkpoint Property Screening System (CPSS) Program.

As of May 2019, TSA has 2,221 AT-2 systems and 172 ASLs deployed to 16 airports across the country. By the end of FY 2019, approximately 200 ASLs will be in use in the field. AT-2 planned purchases are included in Table 2.

Computed Tomography

CT systems offer enhanced images compared to AT-2 systems and can be upgraded to detect a broader range of threats automatically. They also provide the potential for passengers to leave liquids and laptops in their carry-on bags. CT will enhance screening for the current threats of interest and will increase checkpoint security effectiveness.

In 2017, TSA conducted an analysis on the capability needs within the carry-on screening capability and the associated capability gaps. This analysis resulted in the DHS-validated Capability Analysis Report for Accessible Property Screening. The report established the need for improvements and need for development of technology, such as CT. FY 2018 funding enabled the purchase and deployment of CT systems at airports to support operational testing, which was completed in September 2018. FY 2018 funding also allowed for the purchase and deployment of prototypes to support requirement and algorithm development efforts to meet the Accessible Property Screening System (APSS) detection standard.

TSA is pursuing sustained technology investments to meet emerging threats related to aviation transportation effectively. TSA is using an innovative approach to procure and deploy CT in the checkpoint to address rapid system integration, operational readiness, and system performance characteristics. This approach allows TSA to deploy specific capabilities as part of a larger solution, incrementally expanding functionality until full capability is realized. To support this approach, TSA uses CT systems as prototypes for data collection efforts, which will help to inform requirements and to support algorithm development efforts to meet the APSS detection requirements. These requirements advance checkpoint imaging capability, focusing on the highest risk threats while decreasing false alarm rates.

In March 2019, TSA originally awarded a contract for the procurement and the deployment of 300 CT systems (certified at AT-2 Tier II detection level) to airports under a risk-based deployment approach. Because of a protest of the award, TSA only now is finalizing the deployment schedule but anticipates starting in FY 2020. The deployment of 300 units is intended to be a bridge strategy to address current threats of interest and to increase checkpoint security effectiveness. TSA also is focused on algorithm development efforts to enhance CT capability to meet the APSS detection requirements.

Also in FY 2019, a new acquisition program of record, the CPSS Program, was established to address the APSS capability. The CPSS assumed responsibilities for the qualification, testing, procurement, deployment, and maintenance of all TSA checkpoint CT systems. All requested CT funding would be allocated to this program.

The program is collaborating with industry to define future CT enhancements and deployments to include updated threat detection requirements, network connectivity, and integrated automated conveyance systems to improve efficiency in locations that can accommodate their size. CT systems also are envisioned to use network connectivity to push out algorithms and to conduct potential remote screening and review of images. CT systems also will rely on TSA future-state investments to develop more effective and rapidly deployable threat-detection algorithms.

Table 2 outlines projected costs for CT deployment and maintenance at airport checkpoints as stated within P.L. 115-141, the FY 2019 President's Budget, the FY 2019 FYHSP report for FY 2020–FY 2024, and the most recent estimates for FY 2020.

The number of units and system procurement costs provided in this table are based on estimated costs and may change as TSA procurement and deployment costs become more accurate. Based on requirements and anticipated delivery of CT units, the projected CTs will be approximately 2,218 systems, including systems already in use.

Table 2: AT-2 and CT Planned Purchases as of May 2019[8] *($ in millions)*

AT-2 and CT – FY 2020 – FY 2024 – CJ 2020 FYHSP					
	FY 2020	FY 2021	FY 2022	FY 2023	FY 2024
CT Procurement Quantities	237	82	82	82	82
Total PC&I	**$148.60**	**$109.80**	**$180.00**	**$295.00**	**$300.00**
Investment Planning	$148.60	$109.80	$180.00	$295.00	$300.00
Total O&S	**$93.14**	**$115.46**	**$120.69**	**$129.62**	**$132.92**
Investment Maintenance	$90.26	$110.65	$115.88	$124.81	$128.11
Salaries	$2.88	$4.81	$4.81	$4.81	$4.81
Total	**$241.74**	**$225.26**	**$300.69**	**$424.62**	**$432.92**

*TSA began to divide the single PSP FYHSP investment into the new individual investments beginning with the FY 2020 budget development process. The total FY 2019 PSP budget was $241.48 million.

Credential Authentication Technology

CAT enables TSA to detect IDs that are fraudulent, expired, or show evidence of tampering. Additionally, CAT verifies a passenger's Secure Flight vetting status, validates a passenger's flight reservation status in near-real time, and informs the Travel Document Checker (TDC) of the results to ensure that only verified passengers proceed into the appropriate risk-based screening lane.

Identity verification is important to sterile area security. It ensures that passengers traveling into and within the United States are not attempting to avoid identification. CAT provides a detailed scan of passenger-provided credentials and allows TSOs to validate credentials consistently and efficiently. CAT is a tool developed with the understanding that ID documentation is becoming very difficult to validate as "real" merely by using visual inspection. The CAT system examines the credential, scanning it using infrared, ultraviolet, and visible white light to verify the proper security enhancements for the provided credential. An additional benefit is the system's ability to extract data elements from the credential to provide the associated vetting status of the passenger (TSA Pre✓®, standard, or selectee).

CAT will play a critical role in ensuring that passengers receive the screening procedures appropriate to their risk level, supporting the congressional mandate that requires TSA to segment passengers. To ensure that only identified non-Pre✓®, low-risk passengers receive the new modified screening procedures, the modified lane will use CAT units to validate travelers' identities and to verify vetting status.

[8] FY 2020 planned purchases are based on the FY 2020 President's Budget. FY 2021-FY 2024 purchases are based on the FY 2020 CJ FYHSP report. Future-year funding is subject to change on the basis of annual budget reviews.

In 2018, TSA conducted an analysis on the capability needs within the identity verification capability and the associated capability gaps. This analysis resulted in the DHS-validated Capability Analysis Report for Identity Verification. The report established the need for improvements and for development of technology, such as biometrics, but also established the importance of continuing to leverage the CAT for identification verification.

With the implementation of the REAL ID Act, the document library will require updating to add the ability to authenticate newly designed and issued REAL ID-compliant identifications. Software enhancements also will be required to alert the TDC if a passenger presents a noncompliant state-issued identification. Additionally, as mobile drivers' licenses (a digital version of an individual's driver's license stored on a smart phone) continue to develop, hardware and software enhancements to CAT will be developed to enable it to authenticate mobile drivers' licenses.

In addition to improved credential validation of passenger vetting status, CAT is interdependent with TSA's STIP. STIP focuses on the automated exchange of information between TSE across the TSA network, to draw passenger vetting statuses from Secure Flight. Passenger data are pulled from Secure Flight to STIP to CAT. These vetting statuses allow the checkpoint to receive and act on additional passenger risk segmentation. Without STIP, CAT is able only to validate a passenger's ID, not to verify his or her vetting status. CAT is the first technology built to use network connectivity for necessary functionality. To address cybersecurity vulnerabilities, the CAT system has implemented STIP client agents and software patches to monitor and update the posture of the CAT system. The CAT system has been hardened to comply with the TSA policy for remote connections. Additionally, the CAT equipment complies with DHS Sensitive Systems Policy Directive 4300A.

In February 2019, TSA received a successful acquisition decision event from the DHS Under Secretary of Management to begin procuring CAT units for TSA Pre✓® and standard lanes. As a result of this approval, TSA was able to:

- Achieve initial operating capability;
- Delegate decision authority to the TSA Chief Acquisition Executive for final procurement and deployment of the CAT system, updated with Windows 10; and
- Award a contract for 505 CAT systems.

As of May 2019, 45 CAT units are in 14 airports nationwide. Operational assessment, data collection, and formal initial testing and evaluation were completed in September 2018 at six of these airports. Although CAT completed operational testing, it continues to be operational only for observation and throughput collection.

TSA completed site surveys for 335 of 435 airports to support the deployment of CAT systems in FY 2020. On the basis of these surveys, TSA found that electrical outlets and data ports at the checkpoint need to be installed or repaired to be able to support the use of CAT. TSA also is working to test Windows 10 on CAT and, upon successful completion, will deploy CAT, in early FY 2020.

Full operational capability for the CAT systems is planned at 1,520 units. Table 3 outlines projected costs for CAT procurement, maintenance, and enhancement at airport checkpoints. Since site remediation is ongoing, deployment costs in FY 2020 and FY 2021 for site remediation at the remaining airports are not reflected in Table 3.

Table 3: CAT Planned Purchases as of May 2019[9] *($ in millions)*

Credential Authentication Technology – FY 2020 – FY 2024 – CJ 2020 FYHSP					
	FY 2020	FY 2021	FY 2022	FY 2023	FY 2024
Quantities	294	552	152	0	0
Total O&S	**$14.84**	**$17.66**	**$11.08**	**$6.12**	**$5.53**
Investment Maintenance	$13.95	$16.77	$10.19	$5.23	$4.64
Salaries	$0.89	$0.89	$0.89	$0.89	$0.89
Total	**$14.84**	**$17.66**	**$11.08**	**$6.12**	**$5.53**

*TSA began to divide the single PSP FYHSP investment into the new individual investments beginning with the FY 2020 budget development process. The total FY 2019 PSP budget was $241.48 million.

Explosives Trace Detection

The most commonly used alarm resolution capability is the ETD. ETDs are highly sensitive devices developed to detect various types of commercial and military explosives. They detect the chemical attributes of microscopic residues of an explosive compound, thereby enabling fast and accurate screening for trace explosive quantities on a variety of surfaces. ETDs are used to detect trace amounts of explosive materials on passengers and their accessible property at the screening checkpoint. These machines are simple to use and can be used as standalone systems or with other technologies, such as the AT-2s, to provide a comprehensive program to screen for explosives. TSA uses ETDs as the primary screening method at very small airports and for alarm resolution at larger airports.

The detection capabilities of ETDs are being improved through the use of more advanced threat detection algorithm software. Specifically, TSA began development efforts with industry for an algorithm that meets Detection Standard 6.2. This detection standard increases the number of threats of interest, sets smaller detection targets, and is critical to TSA's effort to align detection standards with key international partners. In FY 2018, TSA began testing and evaluating the new 6.2 detection standard algorithm. TSA deployed Detection Standard 6.2 in 2019.

TSOs need to be able to resolve alarms from the primary screening device (for example, AIT, AT-2, etc.). As a result, TSA must pursue enhancements to develop NextGen technology that can close this capability gap. Two primary areas that will benefit from enhancement are: new

[9] FY 2020 planned purchases are based on the FY 2020 President's Budget. FY 2021-FY 2024 purchases are based on the FY 2020 CJ FYHSP report.

updated detection standards on all fielded units and the identification of next-generation solutions through the Alarm Resolution Program (ARP).

In 2018, TSA conducted an analysis on the capability needs within the alarm resolution screening capability and the associated capability gaps. This analysis resulted in the DHS-validated Capability Analysis Report for Checkpoint Alarm Resolution. The report established the need for improvements and for development of technology. Specifically, there is a need for technology to be developed in order to provide complementary detection performance across the security screening space.

ARP solutions will improve upon current ETD capabilities, increase the types of substances that can be detected, enhance detection sensitivity, and incorporate new cybersecurity requirements. Beginning in FY 2021, these enhancements will be incorporated into a full recapitalization of the current fleet, including additional ETDs to address airport expansions.

Beyond the ARP's impact on ETDs, the program also will enable future alarm resolution capability to detect and identify suspect materials in containers or concealments that do not allow access or sampling. TSA currently is working to establish a targeted BAA to be executed in FY 2020. Funding has been identified for this effort through a PDO with $3 million per year going to development activities.

As of May 2019, TSA has 3,227 ETDs deployed to airport checkpoints. Table 4 outlines projected costs for ETD maintenance and enhancement at airport checkpoints.

Table 4: Checkpoint ETD Planned Purchases as of May 2019[10] *($ in millions)*

Explosive Trace Detection – FY 2020 – FY 2024– CJ 2020 FYHSP					
	FY 2020	FY 2021	FY 2022	FY 2023	FY 2024
Total O&S	**$23.81**	**$21.84**	**$26.90**	**$22.59**	**$21.72**
Investment Maintenance	$22.78	$20.81	$25.87	$21.56	$20.69
Salaries	$1.03	$1.03	$1.03	$1.03	$1.03
ETD Total	**$23.81**	**$21.84**	**$26.90**	**$22.59**	**$21.72**

* TSA began to divide the single PSP FYHSP investment into the new individual investments beginning with the FY 2020 budget development process. The total FY 2019 PSP budget was $241.48 million.

Passenger Screening Program Legacy

Bottled Liquid Scanners

[10] FY 2020 planned purchases are based on the FY 2020 President's Budget. FY 2021-FY 2024 purchases are based on the FY 2020 CJ FYHSP report.

BLS units are used to differentiate explosive or flammable liquids from common, benign liquids carried by passengers. BLS units analyze substances within a container, measuring particular characteristics of a container's contents. The device can analyze substances within a container in seconds without having to open the container and also can be used to screen medically exempt liquids.

Deployed BLS units operate at the Tier I specification, which is the primary means of identifying liquids contained in translucent bottles. BLS units are deployed fully to airport checkpoints, and no future purchases are planned unless a need arises. Currently, the DHS-validated Checkpoint Alarm Resolution Capability Analysis Report demonstrated TSA's need to develop and evaluate alarm resolution systems capable of detecting and identifying suspect materials in containers or concealments that do not allow access or sampling. Through the ARP, TSA is working with industry to develop capabilities to: detect a broader range of threats, enable the screening of opaque containers, and detect smaller quantities of liquid explosives.

As of May 2019, TSA has 1,627 BLS units deployed, which is considered full operational capability.

Enhanced Metal Detectors

Also referred to as walkthrough metal detectors (WTMD), EMDs serve as a primary screening device of airline passengers. They screen for prohibited metallic objects at fixed checkpoints at the Nation's airports. EMDs are co-located with AIT in standard lanes and are the primary passenger screening capability used in TSA Pre✓® lanes.

TSA, through the Engineering Change Proposal process, approved new EMD control heads that provide an increased threat detection capability and extend the service life on existing WTMDs. As the control heads fail, TSA replaces that component, rather than the entire unit. EMDs are deployed fully to airport checkpoints, and no future purchases are planned unless a need arises.

As of May 2019, TSA has 1,367 EMDs deployed, which is considered full operational capability.

Boarding Pass Scanners

A Boarding Pass Scanner (BPS) is a device that reads a passenger's boarding pass and displays the passenger's name, flight information, and risk status to the TDC. With this information, the TDC can determine whether a passenger should be admitted to, and routed through, the checkpoint to receive the appropriate level of security screening.

BPS systems reduce the need to verify boarding passes manually and are the main tool for validating TSA Pre✓® passengers. However, with the deployment of CAT, they will become a secondary tool for verification. The purchase of BPS systems allowed TSA to replace airline-owned systems and to control the configuration of all deployed BPS systems at airport security checkpoints nationwide. As more airlines use TSA Pre✓® and mobile boarding passes, the BPS firmware is updated to accept these new types of boarding passes.

TSA has 2,490 BPSs deployed. Future BPS purchases are planned to support airport expansions and growth.

Table 5 outlines projected costs for PSP legacy procurement, maintenance, and enhancement at airport checkpoints.

Table 5: PSP Legacy Planned Purchases as of May 2019[11] *($ in millions)*

PSP Legacy Technologies – FY 2020 – FY2024 – CJ 2020 FYHSP						
		FY 2020	FY 2021	FY 2022	FY 2023	FY 2024
Quantities	BPS	100	100	100	100	0
	WTMD	743	743	0	0	0
Total O&S		**$16.02**	**$12.75**	**$12.72**	**$12.29**	**$6.83**
Investment Maintenance		$14.40	$11.13	$11.10	$10.67	$5.21
Salaries		$1.62	$1.62	$1.62	$1.62	$1.62
Total		**$16.02**	**$12.75**	**$12.72**	**$12.29**	**$6.83**

* TSA began to divide the single PSP FYHSP investment into the new individual investments beginning with the FY 2020 budget development process. The total FY 2019 PSP budget was $241.48 million.

C. Emerging Checkpoint Screening Technologies

As threats advance, TSA continues to invest in emerging technologies to elevate checkpoint screening capabilities. As enhanced screening capabilities are introduced at the checkpoint, new independent programs will be implemented. TSA is exploring the following capabilities as potential independent programs in the future. Because they are not managed under a program of record, they are not reflected in the planned purchase tables.

Biometric Technologies

In 2018, through a formal DHS-validated process, TSA conducted an analysis of the current identity verification capability and determined that it needs to improve the ability to verify the identity and to obtain the risk level of every traveler/nontraveling individual. To close these capability gaps, the Identify Verification Capability Analysis Report recommended a course of action to investigate a new matériel solution, because current capabilities do not allow TSA to verify the identity confidently and to obtain the risk level of 100 percent of travelers/nontraveling individuals. The Capability Analysis Report also stated that biometric technology could enable a

[11] FY 2020 planned purchases are based on the FY 2020 President's Budget. FY 2021-FY 2024 purchases are based on the FY 2020 CJ FYHSP report.

more effective and efficient passenger identity and vetting status verification than the current manual procedures.

There are capability gaps in the method of manually verifying identities at the TDC station. TSA analyzed and documented a mission need for improved identity verification. Specifically, known gaps exist in the methods of visually comparing the photograph on a passenger's identity document to the passenger's face, manually authenticating the identity document, and manually confirming the passenger's vetting status. To close these gaps and to achieve TSA's future-state goals associated with enhanced security, effectiveness, and passenger experience, TSA must develop and deploy a capability to enable biometric (e.g., fingerprint, facial, or iris recognition) verification of passenger identity and real-time confirmation of passenger vetting status.

In FY 2017, TSA conducted a test at two airports using both contact and contactless fingerprint-based biometric authentication technology devices. The purpose of the test was to explore methods for improving TSA's ability to verify passenger identity beyond the traditional credential authentication measures. The test engaged TSA Pre✓® Application Program passengers in the expedited screening lane to show the feasibility of biometric identity verification, rather than verification through credentials and boarding passes.

The test allowed TSA to assess critical operational and technological components of biometric authentication technology and to capture specific metrics to influence future requirements for improving the identity verification process. It showed that using biometric-based identity verification potentially can enhance TSA's security mission and the traveler experience when supported with appropriate solution architecture and privacy safeguards.

In April 2018, U.S. Customs and Border Protection (CBP) and TSA signed *The Joint TSA-CBP Policy on Use of Biometrics*, providing direction on the continued development and implementation of biometric technology at airports. Additionally, TSA published the *TSA Biometrics Roadmap for Aviation Security & the Passenger Experience* in October 2018, which states that "TSA will seek to achieve a vision for biometrics technology that will fundamentally transform security operations and the passenger experience across the Nation's commercial aviation ecosystem."[12] To support this vision, the roadmap outlines four strategic goals that TSA will pursue to deploy biometrics technology in the field:

- Partner with CBP on biometrics for international travelers;
- Operationalize biometrics for TSA Pre✓® travelers;
- Expand biometrics to additional domestic travelers; and
- Develop supporting infrastructure for biometric solutions.

To foster cooperation and develop a holistic strategy, the TSA Biometrics Roadmap incorporated feedback gathered during more than 40 engagements with aviation security leaders from airlines, airports, and solution providers. Airlines and airports have expressed a strong interest in streamlining and modernizing the passenger experience and using biometrics technology in their own business processes. The roadmap provides a collaborative biometric vision for TSA and its

[12] https://www.tsa.gov/sites/default/files/tsa_biometrics_roadmap.pdf

aviation security partners. It highlights facial recognition technology as the primary method of choice but also acknowledges that multiple approaches may increase further the accuracy, security, and scalability of TSA biometric operations over time.

TSA collaborated with CBP at John F. Kennedy International Airport in 2017 to begin testing CBP's facial recognition and matching technology to verify identities at the TSA checkpoint. TSA and CBP tested facial recognition technology again at LAX in August 2018 to assess the feasibility of co-locating TSOs and CBP officers at the checkpoint. In November 2018, TSA and CBP, with Delta Air Lines, began testing the viability of noncheckpoint biometrics in the aviation passenger journey at Hartsfield-Jackson Atlanta International Airport (ATL). A CBP/TSA pilot is underway at ATL to test CBP's Traveler Verification Service, which matches a traveler's presented biometrics to data on that traveler. To enable future pilots and a long-term biometric solution, TSA is analyzing capabilities and development efforts to support deployment of this technology to the field and to ensure the security, integrity, and availability of biometrics data.

Additionally, TSA is working with interagency and industry partners to assess privacy and performance error issues, specifically the potential for bias, associated with biometrics technology, in compliance with the FAA Reauthorization Act of 2018. Finally, TSA is working to build consistent, testable requirements and to develop procurement and acquisition strategies for future use of this technology. These activities will enable the development of a biometric solution that is viable for the aviation sector, focusing initially on international and TSA Pre✓® passengers.

Because biometric technology is an emerging capability, the FYHSP does not include funding to TSA for the development, purchase, or deployment of biometric technology. Many supporting capabilities and interconnections are required to ensure that sufficiently large populations of passengers will be able to use biometric solutions and associated processes efficiently. TSA is exploring ways to support the agency's biometrics capability development, but no dedicated funding was available in FY 2019.

TSA is using the Innovation Technology Demonstration (ITD) process of the TSA Systems Acquisition Manual to demonstrate mature biometric technologies, to gather requirements, and to present performance results to multiple committees that are responsible for determining the technology's suitability to transition to the Acquisition Lifecycle Framework. To support the ITD process, TSA has developed a capability development plan to establish technology-maturing and analysis activities needed to understand the biometric technology space better. These activities will allow TSA to demonstrate biometric technology in the field and to evaluate performance against the consolidated operational requirements document, which describes how the technology must perform to meet the mission need within the envisioned operating concept. The results of these demonstrations will inform and support TSA's exploration of biometric technology.

Lastly, TSA is writing a capability development plan to guide future biometric R&D investments. Those investments will be oriented to assess more rapidly the maturity of particular biometric technologies for performance in the demanding TSA operational environment, while remaining compliant with legal and regulatory frameworks and protecting the privacy of the traveling public.

D. Checked Baggage Screening Technologies

In compliance with the Aviation and Transportation Security Act of 2001 (P.L. 107-71), TSA screens 100 percent of checked baggage with an EDS or a suitable alternative, such as an ETD. TSA accomplishes this mission by identifying, testing, acquiring, deploying, integrating, upgrading, and maintaining technology that screens checked baggage.

Since achieving the mandate in 2003, TSA's checked baggage focus has expanded to ensure that airports' checked baggage screening zones use the most effective technologies. This effort requires the deployment of technology with improved performance and the integration of EDS equipment with airport baggage handling systems. In FY 2018, TSA screened approximately 521 million checked bags.

E. Existing Electronic Baggage Screening Technologies

EDSs and ETDs are TSA's electronic baggage screening technologies. Both technologies are funded from the Electronic Baggage Screening Program FYHSP investment and are reported in Table 6.

Explosives Detection Systems

TSA uses EDSs as the primary screening method to achieve its 100-percent screening mandate. TSA provides ETD screening in locations where an airport does not screen the minimum requirement for TSA to deem the EDSs as being cost-effective. TSA has provided advanced EDS equipment for checked baggage screening to meet the security needs of the Nation's aviation network.

EDS equipment can exist in two configurations:

- Standalone systems typically are found in lobby screening for small airports or in larger airports with terminals that have low baggage volumes.

- In-line configurations integrate the EDS equipment into the baggage handling system that is customized for each airport. This type of automation improves working conditions for TSOs because they can resolve alarms in quieter, dedicated spaces that are designed properly for alarm resolution. Also, in-line systems contribute to reduced injury rates.

The competitive procurement strategy to test and purchase NextGen EDS has allowed TSA to bring enhanced screening capabilities to the field in support of its recapitalization efforts. To meet recapitalization priorities and purchase requirements, TSA will continue to purchase EDS models listed on the EDS competitive procurement qualified products list. TSA closed the current EDS list to new entrants in February 2015. However, it opened a new qualification window with updated requirements in mid-FY 2019, supporting a shift of focus to enhancing our current capabilities.

TSA continues to work with industry to apply incremental approaches to technology development. This allows TSA to upgrade existing machines as enhancements become available instead of replacing complete systems. These enhancements include the ability to detect more threat materials with higher detection probabilities, lower false alarm rates, and faster throughput rates at lower costs.

TSA has an effective plan for recapitalizing EDS technologies that have reached the end of their useful life and for upgrading selected airport screening zones to gain efficiencies. TSA prioritizes recapitalization projects based on various factors, including lifecycle support maintenance records and threat detection capabilities. TSA has 1,689 EDSs deployed. EDS planned purchases are included in Table 6.

Explosives Trace Detection

In locations where an airport does not screen the minimum requirement for TSA to deem the EDSs as being cost-effective, ETD screening is provided. As of May 2019, TSA has 2,453 ETDs deployed to checked baggage areas.

Table 6: Electronic Baggage Screening Program, EDS, and ETD Planned Purchases as of May 2019[13] *($ in millions)*

EBSP – Explosives Detection Systems – FY 2020 – FY 2024 – CJ 2020 FYHSP					
	FY 2020	FY 2021	FY 2022	FY 2023	FY 2024
EDS Procurement Quantities	73	78	16	15	3
Total PC&I	**$264.02**	**$268.52**	**$268.15**	**$267.20**	**$267.20**
Aviation Security Capital Fund[14]	$250.00	$250.00	$250.00	$250.00	$250.00
Investment Planning	$14.02	$18.52	$18.15	$17.20	$17.20
Total O&S	**$195.49**	**$197.53**	**$200.08**	**$200.08**	**$194.57**
Investment Maintenance	$182.37	$184.41	$186.96	$186.96	$181.45
Salaries	$13.12	$13.12	$13.12	$13.12	$13.12
Total	**$459.51**	**$466.05**	**$468.23**	**$467.28**	**$461.77**

F. Emerging Electronic Baggage Screening Enhancements

TSA continues to develop the necessary technical advances under EBSP to address threat vulnerabilities across hundreds of federalized airports. Planned technology enhancements include the following:

- Development and deployment of EDS algorithms that improve security effectiveness by detecting more threat materials, detecting a reduced threat mass, and reducing the false alarm rate;
- Image format standardization and use of machine-learning technology;
- On-screen alarm resolution in the checked baggage resolution area to gain efficiencies in the screening process;
- Common graphical user interface on EDS machines, which improves operator performance; and
- Recapitalization of technically obsolete EDS machines.

TSA is currently in the process of conducting a capability need and gap analysis on checked baggage screening. When completed, this analysis will be documented in a capability analysis report and submitted to DHS for validation. Because there is also a need to improve detection performance, TSA will continue to pursue improvements in detection.

Working with the DHS Science and Technology Directorate (S&T) and industry, TSA is pursuing new capabilities in detecting explosive threats in checked baggage. Areas of R&D

[13] FY 2020 planned purchases are based on the FY 2020 President's Budget. FY 2021-FY 2024 purchases are based on the FY 2020 CJ FYHSP report.

[14] Funding includes $250 million from the Aviation Security Capital Fund.

include: new means of data acquisition, data processing and management, detection algorithm development, and systems integration.

TSA expects new threat detection algorithms in the near term. These algorithms will make detection of HME formulations in checked baggage more reliable. The scientific and vendor communities are working to deploy improved algorithms on in-service EDSs and new systems in development.

Human systems integration is drawing much attention from TSA and the R&D community. The umbrella of human systems integration includes human factors engineering, performance and training, manpower and personnel, and system safety, which will improve screening effectiveness and efficiency. TSA is developing a common elements architecture for airport security screening that will tie together the enabling technologies and processes and people to help meet future aviation security challenges.

G. TSA Technology Integration - Passenger and Baggage Screening

TSA is working with DHS S&T, interagency partners, industry, and other stakeholders on a number of initiatives to standardize and integrate equipment further at the checkpoint and baggage screening areas.

R&D Partnership with DHS Science & Technology

TSA works with DHS S&T and its network of federally funded research and development centers, national laboratories, academic institutions, and industry partners to make R&D investments that rapidly develop cutting-edge technology and transition it to the TSA operational environment. TSA's R&D initiatives are focused on the following areas:

- Enhance detection performance of security screening systems;
- Improve passenger experience in transportation security through increased integration and automation of security screening processes;
- Develop enhanced technologies and capabilities to enable risk-based and intelligence-driven screening processes;
- Increase the capability to respond to emerging threats through development of flexible security solutions; and
- Apply science and technology breakthroughs to advance security solutions and to enhance the security of the intermodal transportation system.

Enhancing Algorithms/Signature Characterization

TSA partners with external stakeholders to develop reliable, cost-effective system components (both hardware and algorithms) that meet strategic security system goals.

When TSA screens a passenger or baggage, the officers look for prohibited items and improvised threat signatures from HMEs. HMEs present a challenge for screening because, unlike commercial and military explosives, they are not manufactured with strict quality controls. As a result, they can have highly variable properties. To screen for these explosives more effectively, TSA needs to develop more capabilities that discriminate between harmless objects and potential threats. Broad-based detection of improvised explosives will benefit from enhanced material discrimination, sufficient independent discriminating measurements, and enhanced resolution processes.

TSA is evaluating the use of advanced screening systems that use nontraditional measurement processes such as differential phase contrast x-ray, x-ray diffraction, walkthrough AIT systems, and application of machine-learning approaches to improving detection capabilities. For example, TSA is working to develop new algorithms that use machine-learning approaches to discriminate between threats and harmless objects, making the screening process more effective. Machine-learning also offers a way to screen for all prohibited items (explosives, firearms, sharp objects, etc.) automatically. Machine-learning algorithms are expected not only to improve security effectiveness but also to support automation in future security systems that will improve passenger experience through increased throughput and decreased false alarm rates. In addition, machine-learning algorithms can be used to assess security performance and to provide systemwide improvements.

Enhancing Interoperability and Standardizing Systems

In accordance with its Security Technology Diversification Strategy and Administrator's Intent, TSA will pursue the development and acquisition of modular systems with interfaces that are accessible to a more diverse vendor base, enabling easier maintenance, training, and quicker upgrades when new innovations become available in the marketplace. Since 2016, TSA has partnered with Sandia National Labs and a variety of technology vendors to develop an "Open Threat Assessment Platform." This work successfully has opened interfaces to x-ray and body-scanner machines using the Digital Imaging and Communications in Security standard. TSA will continue development work to transition this technology to operational use, incorporating processes that enable innovators in the artificial intelligence and machine-learning industry to produce, qualify, and deploy easily state-of-the-art algorithms onto TSA detection platforms.

Rather than focusing on security at particular points at the airport, TSA is distributing security from the time that a passenger makes a reservation to the time that the passenger disembarks at his or her destination. TSA is striving for a more open, secure, and interoperable system architecture that will increase automation and integration. This architecture will be driven by a digital transformation in how TSA uses data to restructure and deliver even better transportation security. This involves designing a "system of systems" that is more modular and amenable to incorporating innovations from a broad array of providers, including small companies. This will promote quick capability upgrades and integrate real-time risk information and data-sharing. Such an architecture will allow TSA to realign capabilities continually to maximize effectiveness across the entire aviation security spectrum.

In FY 2018, TSA invested \$1.4 million in R&D for an open threat assessment platform, followed by an added \$3.6 million in FY 2019. Led by Sandia National Labs under the special authorization afforded by 6 USC § 189, this investment will result in an operational pilot of a system that enables TSA to take advantage of the latest developments in machine-learning and artificial intelligence, while avoiding the vendor-lock that makes upgrades to existing systems so costly and lengthy. The first function to be automated under this effort is detecting prohibited items in accessible property, a process that currently relies on the expensive visual review of every x-ray image by a TSO. These capabilities will be implemented using nonproprietary data interfaces that are accessible to many security technology vendors, enabling further iterative capability improvements by multiple technology providers.

Innovation Task Force

ITF was established in 2016 as a component within the TSA Requirements and Capabilities Analysis office. Among its first actions, ITF launched operational demonstrations of ASLs, which led to their expanded use at multiple airports around the country to meet an urgent operational need. This achievement demonstrated ITF's ability to capture lessons learned quickly and to influence security screening requirements for the agency. Since 2016, ITF has created and refined processes to identify, select, and demonstrate rapidly emerging solutions in a live operational environment.

As a method to identify impactful solutions for demonstration, ITF has completed three BAA solicitations. Industry submits solution proposals to the ITF BAA for consideration. ITF then implements a robust selection process to develop and identify its portfolio of emerging solutions, leveraging TSA subject matter experts for review and selection.

The ITF supports TSA in its efforts to mature the capabilities of the aviation security ecosystem, which includes vendors, academia, and other governmental agencies, by facilitating an increase for TSE manufacturers to obtain access to operational data and by providing insight on the needs of future transportation security capabilities. ITF establishes an integrated approach to address the need for change, providing an environment and focused resources to collaborate on innovation efforts. Solutions may cover a variety of capability needs, from aesthetic solutions to new detection technologies, while supporting progress toward the future TSA system architecture. ITF demonstrates selected emerging solutions in an effort to improve security effectiveness, to improve the posture for future passenger growth and the passenger experience, and to evolve capabilities to deter and detect an adaptive enemy. ITF enables TSA and industry partners to refine potential emerging transportation security capabilities by evaluating the future TSE landscape against capability needs.

ITF has demonstrated the following solutions:

- ASLs integrated with multiple x-ray manufacturers;
- CT demonstrations with multiple manufacturers;
- Checkpoint planning and staffing tools;
- ETD demonstrations;
- BLS demonstrations;
- Biometrics for identity management;
- Customer movement analytics demonstrations;
- Passenger communication tools;
- On-person detection-at-range solutions;

- Passenger vetting indicator solutions for small checkpoints;
- Enhanced AIT demonstrations; and
- Training tools for frontline officers.

In addition to solution demonstrations, ITF continues to collaborate with industry partners to create a shared commitment to aviation security. Looking to the future, ITF will expand its stakeholder relationships and demonstrations to ensure continuous innovation in operations and solution identification. ITF has identified a checkpoint that will allow it to demonstrate a multiplatform system of systems in a single operational environment. ITF will use this checkpoint to identify screening requirements and to address capability gaps for the agency and the security screening system as a whole. This environment will allow ITF to highlight how TSA seeks to expand the organization's collaborative and operational practices in the short and long terms.

Through ITF's work, TSA is positioned better to identify NextGen requirements, to deliver enhancements to processes and training, to refine long-term investment strategies, and to develop future requirements with a system of systems approach to protect the traveling public.

IV. Conclusion

To address the ever-evolving threats to aviation security, TSA continues to enhance existing technologies, to acquire and integrate new technologies, and to use intelligence- and risk-based processes to screen passengers and their baggage more effectively. TSA is moving forward with a renewed focus on security, revised alarm resolution procedures, new investments in technology, and a retrained workforce. As always, this renewed focus emphasizes enhanced security detection, identification of capability gaps, and testing to measure system readiness and performance.

By working closely with Congress to secure appropriate funding for the organization, TSA will continue to address passenger growth, to improve checkpoint performance, and to mitigate vulnerabilities across the aviation system. The initiatives outlined in this report also will allow TSA to partner with industry to address the changing threats to aviation security.

Appendix: Abbreviations

Abbreviation	Definition
AIT	Advanced Imaging Technology
APSS	Accessible Property Screening System
ARP	Alarm Resolution Program
ASL	Automated Screening Lane
AT	Advanced Technology
AT-2	Second-Generation Advanced Technology
ATL	Hartsfield-Jackson Atlanta International Airport
BAA	Broad Agency Announcement
BLS	Bottled Liquid Scanner
BPS	Boarding Pass Scanner
CAT	Credential Authentication Technology
CBP	U.S. Customs and Border Protection
CJ	Congressional Justification
CPSS	Checkpoint Property Screening System
CT	Computed Tomography
DHS	U.S. Department of Homeland Security
EBSP	Electronic Baggage Screening Program
EDS	Explosives Detection System
EMD	Enhanced Metal Detector
ETD	Explosives Trace Detector
FY	Fiscal Year
FYHSP	Future Years Homeland Security Program
HME	Homemade Explosive
ITD	Innovation Technology Demonstration
ITF	Innovation Task Force
LAX	Los Angeles International Airport
NextGen	Next Generation
PDO	Program Decision Option
PSP	Passenger Screening Program
R&D	Research and Development
S&T	Science and Technology Directorate
STIP	Security Technology Integrated Program
TDC	Travel Document Checker
TSA	Transportation Security Administration
TSE	Transportation Security Equipment
TSO	Transportation Security Officer
WTMD	Walkthrough Metal Detector