Advanced Integrated Passenger and Baggage Screening Technologies

October 12, 2018

Fiscal Year 2018 Report to Congress

Homeland Security

Transportation Security Administration

Message from the Administrator

October 12, 2018

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 pursuant to the Joint Explanatory Statement accompanying the Fiscal Year (FY) 2018 Department of Homeland Security (DHS) Appropriations Act (P.L. 115-141). The report provides updates on the Department's efforts and resources devoted to developing more advanced integrated passenger and baggage screening technologies for the most effective security of passengers and baggage at the lowest possible operating and acquisition costs; how TSA is deploying its existing screener workforce in the most cost-effective manner; the labor savings of improved technologies for passenger and baggage screening; and how those savings are being used to offset security costs or are being reinvested to address security vulnerabilities.

The report also includes projected funding levels for the next 5 fiscal years, or until project completion, for each technology discussed, and summarizes the FYs 2017–2018 efforts made to improve and transform aviation security. This effort includes improving detection at the checkpoint, integrating behavior detection capabilities into the screening operations, suitably rightsizing and resourcing operations to address passenger growth, enhancing operational efficiency and passenger experience, and making necessary equipment investments to close vulnerabilities and improve system effectiveness.

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

The Honorable Kevin Yoder
Chairman, House Appropriations Subcommittee on Homeland Security

The Honorable Lucille Roybal-Allard
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.

Sincerely yours,

David P. Pekoske
Administrator

Executive Summary

The Joint Explanatory Statement accompanying the FY 2018 DHS Appropriations Act (P.L. 115-141) requires TSA to submit a detailed report to address the following:

- DHS efforts and resources that are devoted to developing more advanced integrated passenger and baggage screening technologies for the most effective security of passengers and baggage at the lowest possible operating and acquisition costs;
- TSA deployment of its existing passenger and baggage screener workforce in the most cost-effective manner; and
- Labor savings from the deployment of improved technologies for passenger and baggage screening, and how those savings are being used to offset security costs or are being reinvested to address security vulnerabilities.

The report also includes projected funding levels for the next 5 fiscal years, or until project completion, for each technology discussed.

Through FY 2017, TSA has continued to advance aviation security by enhancing existing technologies and acquiring and integrating new technologies to screen passengers and baggage more effectively and efficiently. TSA continues to operate year-round at 440 airports, and provided security for an average of 2.1 million passengers and 1.2 million checked bags on more than 25,000 flights per day in FY 2017. This represents 73,000 more passengers and 45,000 more checked bags per day, 3.6- and 3.8-percent increases respectively, than in 2016. On the basis of U.S. Department of Transportation passenger-volume forecasts combined with TSA historical and forecasted passenger-screening statistics, TSA anticipates that the number of passengers screened will grow by 3.5 percent in FY 2018.

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

TSA has undertaken a number of initiatives in FYs 2017–2018 to field mission capabilities that enhance the security of the aviation system. They include:

- Deployment of 141 automated screening lanes (ASL) across 14 airports;
- 42 Credential Authentication Technology units deployed to 13 airports for field development testing; and
- Deployment of Advanced Imaging Technology-2, Advanced Technology (AT) X-ray, and explosives trace detectors to meet increased need in the field and replace systems that were technically obsolete.

Additionally, TSA continues to enhance existing checkpoint and checked baggage screening technologies to increase security capabilities and operational efficiencies. TSA is working actively with government partners, industry, and other stakeholders to develop new technology, improve current technology and algorithms, and strive for an interoperable architecture to increase automation and integration. TSA also is investing in emerging technologies, such as:

- Computed tomography, which will offer an enhanced imaging platform at the checkpoint—as compared with the presently deployed AT X-ray systems—and can be upgraded to achieve a much higher detection standard; and
- Biometric Authentication Technology, which improves TSA's ability to verify passenger identity beyond the traditional credential authentication measures.

While enhancing existing technologies and acquiring new technologies, TSA continues to use a sophisticated staff allocation process to manage its security workforce efficiently. As new technology, emerging threats, passenger growth, and changes in TSA's operating procedures occur, TSA actively adjusts its staffing process to match resources more closely to mission demands. Considerations in this past fiscal year have included:

- Evaluation of TSA Pre✓® participation rates and the impact of ASLs;
- Integrating behavior detection capabilities into the screening workforce; and
- Accounting for the time needed to deliver the training to support the deployment of new technologies, changes to the threat and/or methods of concealment, and changes to operating procedures.

TSA also continues to install labor-saving, improved technology to support operational efficiencies. In FY 2017, TSA realized savings of 80 FTEs from in-line explosives detection systems for checked baggage screening, when compared to the staffing required for the standalone screening equipment configuration. TSA also was able to realize a savings of 1,002 FTEs by integrating behavior detection capabilities into the screening workforce. TSA was able to redirect these savings partially to address passenger volume increases and staffing needs across the checkpoint system. As TSA looks forward, enhanced screening capabilities to address emerging threats may require additional screening resources to ensure security effectiveness. TSA will continue to use its staffing methodologies to optimize screening.

In summary, TSA operates in a complex environment with dynamic, evolving threats to our Nation's aviation system, coupled with year-over-year increases in passenger volumes. TSA is committed to continue working closely with Congress to resource the organization appropriately to deliver required accuracy as efficiently as possible.

Advanced Integrated Passenger and Baggage Screening Technologies

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I. Legislative Language

This report is submitted pursuant to the Joint Explanatory Statement accompanying the Fiscal Year (FY) 2018 Department of Homeland Security (DHS) Appropriations Act (P.L. 115-141).

The Joint Explanatory Statement includes the following provision:

> TSA is directed to submit a detailed report on passenger and baggage screening, consistent with the reporting requirement in Public Law 114–113, not later than 90 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 the next five fiscal years for each technology identified in the report.

The reporting requirement in the FY 2016 DHS Appropriations Act (P.L. 114-113):

> *Provided further*, that not later than 90 days after the date of enactment of this Act, the Secretary of Homeland Security shall submit to the Committees on Appropriations of the Senate and the House of Representatives a detailed report on—
>
> (1) the Department of Homeland Security efforts and resources being devoted to develop more advanced integrated passenger screening technologies for the most effective security of passengers and baggage at the lowest possible operating and acquisition costs, including projected funding levels for each fiscal year for the next 5 years or until project completion, whichever is earlier;
>
> (2) how the Transportation Security Administration is deploying its existing passenger and baggage screener workforce in the most cost-effective manner; and
>
> (3) labor savings from the deployment of improved technologies for passenger and baggage screening, including high-speed baggage screening, and how those savings are being used to offset security costs or reinvested to address security vulnerabilities …

II. Introduction

The mission of the Transportation Security Administration (TSA) is to protect the Nation's transportation systems to ensure freedom of movement for people and commerce. TSA executes this mission by staying ahead of evolving terrorist threats while protecting privacy and civil liberties, and facilitating the flow of legitimate travel 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 risk substantially. Moreover, to remain ahead of those who seek to do us harm, TSA continues to evolve its security approach by constantly evaluating the procedures and technologies that TSA uses, training its workforce, and regularly assessing specific security procedures. In addition, TSA proactively invests in new technologies and enhancements to stay ahead of the consistent growth in passenger volume and shifting traveler demographics. The need to enhance the current security regimes constantly and to replace, update, and optimize detection systems still remains and must be prioritized.

TSA's current technology profile for aviation security includes approximately 14,000 total deployed units of transportation security equipment (TSE) at approximately 440 airports across the Nation. TSA identifies, tests, procures, deploys, and maintains equipment that is capable of detecting threats concealed on passengers and in their baggage. To fulfill its security responsibilities, TSA must be able to deploy technology to respond to changing threat information and have equipment ready to deploy when airport facilities are modified. In addition, TSA must have the flexibility to stand up operations in locations affected by natural disasters and other crises. These factors, among others, require that TSA have a steady inventory of technology available to deploy to continue to strengthen aviation security.

Coupled with ever-evolving threats, 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, integrate data to refine further how we deliver security to different passenger populations while ensuring the protection of privacy, and make certain that these capabilities can scale to handle the increasing number of travelers and goods traveling through an aviation network.

Background

TSA technology acquisition programs operate within complex environmental realities and considerations that influence not only the solutions that are procured, but how they are procured. Current influencing factors of the security technology environment include:

- ***Threat Landscape:*** TSA continues to face highly adaptive adversaries across the transportation security system. The use of improvised explosive devices (IED) continues to be an evolving and expanding threat that TSA must address. Improvised explosive threat materials include powders and liquids that must be identified effectively and efficiently and distinguished from the benign stream of commerce items carried by the traveling public. The detection of weapons and other prohibited items also remains a high priority for TSA.

Every checkpoint at every federalized airport is an entry point to the entire aviation system. As a result, each checkpoint needs to achieve the same baseline level of security capability as any other checkpoint, or there will be exploitable weak spots in the defensive system that is our network of checkpoints. For example, in September 2001, Mohammed Atta and a fellow terrorist drove from Boston to Portland, Maine, went through security at the relatively small Portland airport, boarded a plane back to Boston, and then boarded a large plane at the Boston airport to launch one of the 9/11 attacks. Also, in 2014, TSA had nearly 1,000 advanced imaging technology (AIT) units deployed to large and some medium-sized airports, but Al Qaeda in the Arabian Peninsula "Inspire" magazine (13^{th} edition) advised would-be jihadists to take their on-person IEDs to "local airports that do not have body scanning machines."

In addition, recent terrorist suicide bombing attacks[1] have demonstrated that international terror groups have widened their focus from attacking passenger aircraft to include attacks on airport terminals. Without constant innovation, TSA would have trouble seizing and maintaining the strategic advantage against a ruthlessly focused adversary that employs a wide range of asymmetric strategies and tactics. In 2006, the U.S. Government Accountability Office (GAO) report titled, "Aviation Security: Enhancements Made in Passenger and Checked Baggage Screening, but Challenges Remain," (GAO-06-371T) stated, "History has shown that terrorists will adapt their tactics and techniques in an attempt to bypass increased security procedures, and are capable of developing increasingly sophisticated measures in an attempt to avoid detection. This ever changing threat necessitates the need for continued R&D [research and development] of new technologies and the fielding of these technologies to strengthen aviation security."

- ***Evolving Cybersecurity Threats:*** In addition to the exploitation of physical vulnerabilities, TSA also must guard against cybersecurity vulnerabilities. Because the transportation and logistics sectors are integral to the world's economies, cyberattacks on them could have devastating effects. Through exploiting software and hardware vulnerabilities, cyberattacks can compromise data, disrupt system operations, and negatively affect the mission of TSA. TSA needs to be agile and rapid in its response to the evolving cyberthreat landscape. The protection of both TSE and the underlying network infrastructure against cybersecurity threats will be an integral part of acquisitions, capability, and enhancement upgrades that are implemented and that will remain a critical part of TSA's mission.

[1] In March 2016, two suicide bombers, carrying explosives in large suitcases, attacked a departure hall at Brussels Airport in Zaventem.

As TSA transitions standalone security screening equipment to a fully integrated networked security system, cybersecurity threats will be an increasingly important area that needs to be considered and addressed. The Security Technology Integrated Program (STIP) will provide the dynamic and 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 screening equipment. Additionally, prior to connectivity, TSA requires that devices 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 equipment to address issues and prevent failures.

- ***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 across all modes of transportation continues to change, the ways in which both TSA and our adversaries operate will be affected.

  TSA operates year-round across roughly 440 airports, and secured more than 2.1 million passengers and 1.2 million checked bags on more than 25,000 flights per day in FY 2017. This represents 73,000 more passengers and 45,000 more checked bags per day, 3.6- and 3.8-percent increases respectively, than in 2016. On the basis of U.S. Department of Transportation (DOT) passenger-volume forecasts, combined with TSA historical and forecasted passenger-screening statistics, TSA anticipates that the number of passengers screened will grow by 3.5 percent in FY 2018. In short, TSA and the aviation industry have seen a steady uptick in daily travelers, and this growth is projected to continue, barring economic downturns. 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 alter the transportation environment. Globalization has contributed to an increase in international travelers, illustrated by the 72-percent growth of international arrivals to the United States over the past 20 years.[2] This trend is projected to continue, contributing to the growth of the travel industry as well as driving new adversaries and threat areas across transportation modes. By 2045, an estimated 81 million Americans will be older than 65, necessitating more accommodating screening technology and procedures across transportation modes.[3]

[2] U.S. Department of Commerce, International Trade Administration, National Travel and Tourism Office from the Summary of International Travel to the United States (I-94) report.
[3] Population Reference Bureau report, "Aging in the United States" (January 2016).

- ***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 selectively 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 while also providing for improved operational efficiency (i.e., 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 stakeholders often have a variety of competing priorities that must be balanced in order to achieve maximum efficiency and effectiveness. 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:*** Because TSA does not own airport infrastructure, TSA must coordinate with airports and assess the impact of changes to integrate planned checkpoint and checked baggage technologies across varying physical layouts. Thus, when analyzing TSE for acquisition and deployment, TSA considers real estate footprint, existing infrastructure, and installation needs.

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

- ***User Adoption of Planned Technology:*** Technology must be suitable for integration in operational processes and must enable or enhance security protocols. Technology design and development involves extensive consideration of the end user and weighing the benefits of the technology solution against operator implications.

Overview

On the basis of the threat environment described above, TSA prepared the tables in Section III of this report, outlining FY 2018 TSE planned procurements to support checkpoint and checked baggage screening operations that were funded in P.L. 115-141. For planned procurements in FY 2019, this information is reflected in the FY 2019 President's Budget. FYs 2020–2023 data are based on the FY 2019 Future Years Homeland Security Program (FYHSP) report.

Actual purchase quantities are based on available funding and changing realities of the security environment. For example, because TSA expects continued annual passenger growth, TSA may look to purchase small quantities of currently qualified systems to respond to increased passenger throughput. TSA also may procure new commercial off-the-shelf TSE for demonstrations and developmental testing to assist in the development of future requirements.

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

- System Procurement Costs - costs of procuring TSE;
- System Detection Improvements and Enhancements - costs of development of planned, incremental enhancements in support of threat detection capabilities;
- Testing Costs - associated costs of testing TSE against requirements for the potential purchase or testing of system detection improvements and enhancements. Also, costs of factory and site acceptance testing for procured and deployed TSE;
- Deployment Costs - costs of deploying procured TSE or the cost of deploying any system detection improvements and enhancements; and
- Maintenance Costs - costs of sustaining all out-of-warranty TSE after deployment. Maintenance for in-warranty TSE is reflected in the system procurement costs.

III. Advancing Integrated Passenger and Baggage Screening Technologies

Threats to aviation security are persistent and evolving. As a result, passenger and checked baggage security screening must continue to adapt to meet evolving threats and changes within the aviation industry. This section of the report addresses passenger screening technologies, baggage screening technologies, and the programs and initiatives that TSA is undertaking to enhance and integrate these technologies for the most effective security of passenger and baggage screening.

A. Checkpoint Technologies

The checkpoint addresses emerging and evolving threats to aviation security carried out by terrorists acting as passengers. Although not every recent attack against aviation has transited a checkpoint to target an aircraft, this path has been and remains a primary option for terrorists. This is particularly true for attacks that require some manual preparation or activation once airborne. Threats such as metallic and nonmetallic weapons and explosive threats, either attached to a person’s body or within their carry-on baggage, are mitigated by enabling real-time decision-making and response capabilities with passenger and property scanning systems at the checkpoint.

Adversaries constantly innovate to try new explosive materials and concealments, additional threats beyond explosives, and new tactical and operational approaches. New concealment methods, and new explosive or nonexplosive threats, might not be recognized by older detection capabilities if TSA does not innovate and respond rapidly. Adversary tactical and operational innovations can bypass TSA’s best detection capabilities if those are not universally deployed, and could limit the effectiveness of TSA’s current identity and vetting status validation. Additionally, the continued proliferation of improvised explosive threats, increasing numbers of weapons found at checkpoints, and rising passenger throughput continually require TSA to seek to broaden automated threat detection capability while simultaneously streamlining security operations for increased throughput.

To address the security challenges at passenger screening checkpoints, TSA employs a flexible and robust multicapability approach to detecting an evolving range of threats. TSA is investing in initiatives such as technology automation and detection processes to improve effectiveness while reducing scanning and image-processing times as well as human error, and while rightsizing the number of personnel needed at the checkpoint. 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 security checkpoint. The implementation of threat detection algorithms on new and existing 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.

For technologies that require maturation before formal testing, TSA provides requirements to guide the DHS Science & Technology Directorate’s (S&T) investment in R&D activities.

TSA uses a competitive procurement process for its checkpoint technologies. TSA makes a best-value decision to acquire technology, which either meets or exceeds agency requirements. Full-rate production delivery orders can be awarded to one or multiple vendors depending on the program acquisition strategies implemented.

B. Existing Checkpoint Technologies and Upgrades

TSA identifies, tests, procures, deploys, upgrades, and maintains a variety of equipment to screen passengers and their carry-on baggage at airports nationwide. Current checkpoint technologies, which represent those technologies currently managed under a program of record, include:

- AIT;
- Advanced technology (AT) X-ray;
- Bottled liquid scanners (BLS);
- Boarding pass scanners (BPS);
- Credential authentication technology (CAT);
- Enhanced metal detectors (EMD); and
- Explosives trace detectors (ETD).

The following sections outline TSA's current and planned initiatives for these existing technologies. TSA continuously reevaluates equipment requirements on the basis of the latest operational needs and threats. Therefore, the following initiatives are subject to change as needed. Additionally, TSA monitors TSE detection capabilities and bases recapitalization and purchase decisions on the ability of fielded TSE to respond to changing threats and to adhere to new detection standards. TSA plans to replace many of the technologies above with the next generation (NextGen) equipment outlined below in order to meet new capability needs. TSA continues to recapitalize technologies as needed while new equipment is developed and acquired.

Advanced Imaging Technology
AIT detects metallic and nonmetallic anomalies concealed on passengers as they enter the screening checkpoint. AIT systems are used to screen passengers safely 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 machine and stands still, transmitters produce millimeter waves that either are absorbed, scattered, or reflected as they pass through clothing, bounce off of the person's skin and any potential threats, then return to the receivers. The AIT applies the necessary algorithms to the reflected millimeter wave signals to determine the location of possible anomalies on the body. If it detects an anomaly, a bounding box indicates its location on a generic human image. When the system identifies an anomaly, an operator is required to step in and 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 and are standardized with AIT Tier II detection capability. In FY 2014, TSA successfully deployed this technology and brought the AIT-1 equipment to functional equivalency with the AIT-2 equipment. The procurement of these additional AIT-2 systems has allowed TSA to deploy AIT equipment to many small airports that previously lacked advanced imaging capability because of space limitations. Deployment of AIT equipment to these smaller airports addresses the increased threat and potential for foreign terrorist organizations to use small airports as entry points to the aviation system.

AIT is undergoing development efforts to enhance detection capabilities through the use of more advanced threat detection algorithm software. Similar to the detection algorithm developed for AIT-1 systems in 2017, an enhanced detection algorithm for the AIT-2 systems currently is being assessed, which is anticipated to be deployed in the early FY 2019 timeframe.

TSA continues to explore new algorithm techniques and additional technological advances for its current AIT fleet. Some examples of potential enhancements include: the ability to apply detection algorithms on an individual passenger on the basis of risk or credible intelligence; and the use of wide bandwidth or enhanced image processing and associated detection algorithms that show promise for overall performance enhancements. Additionally, the next generation of AIT technology will have enhanced three-dimensional reconstruction algorithms to address threats concealed in obscured body locations.

Currently, TSA has 947 AITs deployed, which is 100 percent of full operational capability.

Table 1: AIT Planned Purchases as of September 2018[4,5]

($ in millions)

	Planned Requirements with:							
Advanced Imaging Technology	**All Available Carryover Funds**	**FY 2018 Funds**	**FY 2019 Funds**	**FY 2020 Funds**	**FY 2021 Funds**	**FY 2022 Funds**	**FY 2023 Funds**	**Total**
Units	*0*	*15*	*0*	*0*	*0*	*0*	*0*	***15***
System Procurement Costs	$0	$1.64	$0.00	$0.00	$0.00	$0.00	$0.00	**$1.64**
System Detection Improvements and Enhancements	$0	$10.93	$3.72	$4.89	$4.97	$5.05	$5.13	**$34.69**
Testing Costs	$0	$8.38	$7.54	$3.47	$3.53	$3.59	$3.65	**$30.16**
Deployment Costs	$0	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	**$0.00**
Maintenance Costs	$0	$16.20	$16.92	$18.78	$19.08	$19.38	$19.69	**$110.05**
Total Funding	**$0**	**$37.15**	**$28.18**	**$27.14**	**$27.58**	**$28.02**	**$28.47**	**$176.54**

[4] FY 2018 planned purchases are based on the FY 2018 DHS Appropriations Act (P.L. 115-141). FY 2019 is based on the FY 2019 President's Budget. FY 2020 is based on the most recent estimates. FY 2021–FY 2023 purchases are based on the FY 2019 FYHSP report.

[5] TSA is pursuing the option to procure additional AIT-2 machines in FY 2018. The additional AIT-2 machines are needed in support of airport expansions, increased passenger volumes, and safety stock.

Advanced Technology X-Rays (AT X-Rays)

TSA utilizes AT X-ray systems at the checkpoints to screen roughly 3 million carry-on bags for explosives and prohibited items each day. AT X-rays detect threats in carry-on baggage by providing enhanced detection capability, a higher resolution X-ray image, and a two-dimensional visual enhanced display that is clearer and more detailed than legacy X-ray. Within the X-ray image, different materials, including threat objects, will appear in a certain color to the operator to help identify threats. Threat object discrimination has continued to improve through R&D efforts, but comes at a cost of maintaining throughput efficiency and minimizing false alarm rates throughout the system.

As threats emerge and technical capabilities improve, enhancements to the AT X-ray 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 currently is assessing an enhanced Tier II algorithm for checkpoint X-ray image analysis. In addition to providing detection at a reduced threat mass and screening additional threat materials for overall improved system detection, this algorithm will provide a screener-assist function with frames or other markers around selected items. These frames will alert transportation security officers (TSO) to potential threats in carry-on bags, therefore increasing the TSO's efficiency and ability to find prohibited items while ensuring greater consistency of applying resolution protocols.

TSA also is studying the effects of current emerging threats, and currently is working with vendors to assess detection algorithms for each. Currently, such efforts are aimed at testing and ultimately deploying an enhanced algorithm. In addition, TSA currently is working with vendors to analyze the potential impacts of the new specific threats on their current algorithms while analyzing the AT detection/false alarm trade space to meet AT operational performance objectives. It is anticipated that both of these algorithms will be deployed in FY 2019.

Another work stream is focusing on future carry-on baggage screening systems in order to ensure that system capabilities meet TSA's Accessible Property Screening System (APSS) detection standard. The APSS detection standard is expected to advance checkpoint capability because it requires detection of a broader range of homemade explosives, reduced false alarm rates, automated detection for threats and prohibited items, remote image screening, detection of greatly reduced threat mass, and the potential ability for passengers to leave all accessible items in bags. TSA currently is pursuing algorithm development efforts with computed tomography (CT) technology for airport checkpoints, because CT systems offer an enhanced imaging platform compared to currently deployed AT X-ray systems and can be upgraded to potentially meet the APSS detection standard. TSA has purchased and is testing prototype CT systems in FY 2018. Additional information regarding CT is provided in Section III. C, "Emerging Checkpoint Technologies."

Currently, TSA has 2213 AT X-rays deployed, which is 100 percent of full operational capability.

Table 2: AT X-Ray Planned Purchases as of September 2018[6]

($ in millions)

Advanced Technology X-Ray	Planned Requirements with: All Available Carryover Funds	FY 2018 Funds	FY 2019 Funds	FY 2020 Funds	FY 2021 Funds	FY 2022 Funds	FY 2023 Funds	Total
Units	*0*	*0*	*0*	*0*	*0*	*0*	*0*	***0***
System Procurement Costs	$0	$0	$0	$0	$0	$0	$0	**$0**
System Detection Improvements and Enhancements	$0	$2.00	$2.00	$3.84	$3.92	$3.99	$4.07	**$19.82**
Testing Costs	$0	$0.02	$0.62	$0.55	$0.55	$0.55	$0.55	**$2.84**
Deployment Costs	$0	$2.00	$1.08	$1.80	$1.80	$0	$0	**$6.68**
Maintenance Costs	$0	$40.40	$55.41	$48.54	$49.51	$50.50	$51.51	**$295.87**
Total Funding	**$0**	**$44.42**	**$59.11**	**$54.73**	**$55.78**	**$55.04**	**$56.13**	**$325.21**

[6] FY 2018 planned purchases are based on the FY 2018 DHS Appropriations Act (P.L. 115-141). FY 2019 is based on the FY 2019 President's Budget. FY 2020 is based on the most recent estimates. FY 2021–FY 2023 purchases are based on the FY 2019 FYHSP report.

Bottled Liquid Scanners (BLS)

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 currently operate at the Tier I specification, which provides a primary resolution of liquids contained in clear or translucent bottles. BLS units are deployed fully to airport checkpoints, and, as such, no future purchases are planned. However, airport security screening equipment needs and capabilities are assessed on an ongoing basis, and equipment purchases may be made on the basis of a validated need. TSA is working with industry to develop capabilities that are able to detect a broader range of threats, enable the screening of opaque containers, and detect smaller quantities of liquid explosives.

Currently, TSA has 1,608 BLS deployed, which is 100 percent of full operational capability.

Table 3: BLS Planned Purchases as of September 2018[7]
($ in millions)

	Planned Requirements with:							
Bottled Liquid Scanner	**All Available Carryover Funds**	**FY 2018 Funds**	**FY 2019 Funds**	**FY 2020 Funds**	**FY 2021 Funds**	**FY 2022 Funds**	**FY 2023 Funds**	**Total**
Units	*0*	*0*	*0*	*0*	*0*	*0*	*0*	***0***
System Procurement Costs	$0	$0	$0	$0	$0	$0	$0	**$0**
System Detection Improvements and Enhancements	$0	$0	$0	$0	$0	$0	$0	**$0**
Testing Costs	$0	$0	$0	$0	$0	$0	$0	**$0**
Deployment Costs	$0	$0	$0	$0	$0	$0	$0	**$0**
Maintenance Costs	$0	$2.28	$2.33	$2.38	$2.48	$2.50	$2.56	**$14.53**
Total Funding	**$0**	**$2.28**	**$2.33**	**$2.38**	**$2.48**	**$2.50**	**$2.56**	**$14.53**

[7] FY 2018 planned purchases are based on the FY 2018 DHS Appropriations Act (P.L. 115-141). FY 2019 is based on the FY 2019 President's Budget. FY 2020 is based on the most recent estimates. FY 2021–FY 2023 purchases are based on the FY 2019 FYHSP report.

Boarding Pass Scanners (BPS)

A BPS is a device employed to read a passenger's boarding pass and to display the passenger's name, flight information, and risk status to the Travel Document Checker (TDC). With this information, the TDC is able to determine that a passenger should be admitted to, and routed through, the checkpoint to receive the appropriate level of security screening.

BPS systems reduce the need for manual verification of boarding passes and are currently the main tool for validating TSA Pre✓® passengers. The procurement of BPS allowed TSA to replace airline-owned systems and enabled TSA 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 boarding passes.

Currently, TSA has 2,490 BPS deployed, which is 100 percent of full operational capability. Future BPS purchases are planned to support airport expansions and growth. Airport security screening equipment needs and capabilities are assessed on an ongoing basis, and additional equipment purchases may be made on the basis of a validated need.

Table 4: BPS Planned Purchases as of September 2018[8,9]
($ in millions)

	Planned Requirements with:							
Boarding Pass Scanner	**All Available Carryover Funds**	**FY 2018 Funds**	**FY 2019 Funds**	**FY 2020 Funds**	**FY 2021 Funds**	**FY 2022 Funds**	**FY 2023 Funds**	**Total**
Units	*0*	*0*	*0*	*100*	*100*	*100*	*100*	***400***
System Procurement Costs	$0	$0	$0	$0.25	$0.25	$0.25	$0.26	**$1.01**
System Detection Improvements and Enhancements	$0	$0.02	$0.02	$0.02	$0.02	$0.02	$0.02	**$0.12**
Testing Costs	$0	$0.05	$0.05	$0.05	$0.05	$0.05	$0.05	**$0.30**
Deployment Costs	$0	$0	$0	$0	$0	$0	$0	**$0.00**
Maintenance Costs	$0	$0.13	$0.12	$0.12	$0.13	$0.14	$0.14	**$0.78**
Total Funding	**$0**	**$0.20**	**$0.19**	**$0.44**	**$0.45**	**$0.46**	**$0.47**	**$2.21**

[8] FY 2018 planned purchases are based on the FY 2018 DHS Appropriations Act (P.L. 115-141). FY 2019 is based on the FY 2019 President's Budget. FY 2020 is based on the most recent estimates. FY 2021–FY 2023 purchases are based on the FY 2019 FYHSP report.
[9] TSA is pursuing the option to procure additional BPSs in FY 2018. The additional BPSs are needed in support of airport expansions, increased passenger volumes, and safety stock.

Credential Authentication Technology (CAT)

CAT provides a primary means for authentication of passenger travel documents/identification (ID) that are presented to TSOs by passengers before entering the passenger screening checkpoint, and for determining the Secure Flight status for the passenger. CAT satisfies the mission need to verify passenger IDs effectively and rapidly, and to detect IDs that are fraudulent, expired, and/or show evidence of tampering. Additionally, CAT verifies a passenger's Secure Flight vetting status and validates a passenger's flight reservation status in near-real time, and informs the TDC of the results to ensure that only verified passengers proceed into the appropriate screening lane on the basis of risk.

The CAT system was created to provide a detailed scan of passenger-provided credentials and to validate the credentials for the proper authenticity 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 the human eye. 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 provided credential in order to provide the associated vetting status of the passenger (TSA Pre✓® Standard, or selectee). These two functions of the CAT system make it a very useful tool at the TDC, allowing TSOs to focus on the passenger and to continue to provide a "positive" traveling experience to the public.

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 be compliant with the TSA policy for remote connections. Additionally, the CAT equipment is compliant with DHS 4300A, "Sensitive Systems Policy Directive."

As of April 2018, 42 CAT units are deployed to 13 airports nationwide. CAT completed field development testing at the end of 2017, but continues to be operational for observation and throughput collection at the following airports:

- Washington Dulles International Airport (IAD)
- Ronald Reagan Washington National Airport (DCA)
- Chicago-O'Hare International Airport (ORD)
- Austin-Bergstrom International Airport (AUS)
- Hartsfield-Jackson Atlanta International Airport (ATL)
- Boston Logan International Airport (BOS)
- Charlotte/Douglas International Airport (CLT)
- Miami International Airport (MIA)
- Indianapolis International Airport (IND)
- Raleigh-Durham International Airport (RDU)
- Los Angeles International Airport (LAX)
- Seattle-Tacoma International Airport (SEA)
- Portland International Airport (PDX)

Six of the 13 sites were used for operational assessment, data collection, and formal initial operational testing and evaluation, which was completed in September 2018. TSA anticipates an acquisition decision event (ADE) approval in Q2 FY 2019. TSA then will begin procurement and deployment in Q2/Q3 of FY 2019.

TSA will have the ability to complete a combined procurement of CAT for both TSA Pre✓® and standard lane use. In order to expedite the deployment of CAT units to the field to meet existing and emerging threats and to enable TSA to utilize resources more effectively, TSA received DHS approval to conduct combined testing during FY 2018, as well as to seek a combined ADE to deploy to both types of lanes.

Additionally, in FY 2018 TSA completed site surveys for 84 of 450 airports to support the deployment of CAT systems in FY 2019. On the basis of these surveys, it was determined that site remediation will need to be conducted in FY 2019 to install or repair needed electrical outlets and data ports at the checkpoint to be able to support the use of CAT in operations. It is likely that there will be additional deployment costs in FY 2020, not currently reflected in Table 5, for site remediation at the remaining airports. These costs are unknown at this time because these costs will be based on site surveys completed in FY 2019 and an approved deployment methodology.

Full operation capacity for the CATs is planned at 1,473 units.

Table 5: CAT Planned Purchases as of September 2018[10]

($ in millions)

Credential Authentication Technology	Planned Requirements with:							Total
	All Available Carryover Funds	**FY 2018 Funds**	**FY 2019 Funds**	**FY 2020 Funds**	**FY 2021 Funds**	**FY 2022 Funds**	**FY 2023 Funds**	
Units	*0*	*0*	*294*	*405*	*552*	*222*	*0*	***1,473***
System Procurement Costs	$0	$0	$6.79	$9.36	$12.75	$5.13	$0	**$34.03**
System Detection Improvements and Enhancements	$0	$0.04	$1.44	$1.80	$1.83	$1.87	$1.91	**$8.89**
Testing Costs	$0	$3.36	$0.19	$0.28	$0.39	$0.16	$0	**$4.38**
Deployment Costs	$0	$3.87	$5.93	$0.11	$0.16	$0.06	$0	**$10.13**
Maintenance Costs (Including Cybersecurity)	$0	$1.65	$0.11	$3.03	$3.76	$4.53	$4.34	**$17.42**
Total Funding	**$0**	**$8.92**	**$14.46**	**$14.58**	**$18.89**	**$11.75**	**$6.25**	**$74.85**

[10] FY 2018 planned purchases are based on the FY 2018 DHS Appropriations Act (P.L. 115-141). FY 2019 is based on the FY 2019 President's Budget. FY 2020 is based on the most recent estimates. FY 2021–FY 2023 purchases are based on the FY 2019 FYHSP report.

Enhanced Metal Detectors (EMD)

Also referred to as walkthrough metal detectors, EMDs serve as a primary screening device of airline passengers 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, or processors, that provide an increased threat detection capability and extend the service life on existing walkthrough metal detectors. As the control heads fail, TSA replaces existing control heads rather than the entire unit. EMDs are deployed fully to airport checkpoints, and no future purchases are planned. However, airport security screening equipment needs and capabilities are assessed on an ongoing basis, and equipment purchases may be made on the basis of a validated need.

Currently, TSA has 1,360 EMD deployed, which is 100 percent of full operational capability.

Table 6: EMD Planned Purchases as of September 2018[11]

($ in millions)

	Planned Requirements with:							
Enhanced Metal Detector	**All Available Carryover Funds**	**FY 2018 Funds**	**FY 2019 Funds**	**FY 2020 Funds**	**FY 2021 Funds**	**FY 2022 Funds**	**FY 2023 Funds**	**Total**
Units	*0*	*0*	*0*	*0*	*0*	*0*	*0*	***0***
System Procurement Costs	$0	$0	$0	$0	$0	$0	$0	**$0**
System Detection Improvements and Enhancements	$0	$0	$0	$0	$0	$0	$0	**$0**
Testing Costs	$0	$0	$0	$0	$0	$0	$0	**$0**
Deployment Costs	$0	$0	$0	$0	$0	$0	$0	**$0**
Maintenance Costs	$0	$1.15	$1.15	$1.16	$1.17	$1.17	$1.18	**$6.98**
Total Funding	**$0**	**$1.15**	**$1.15**	**$1.16**	**$1.17**	**$1.17**	**$1.18**	**$6.98**

[11] FY 2018 planned purchases are based on the FY 2018 DHS Appropriations Act (P.L. 115-141). FY 2019 is based on the FY 2019 President's Budget. FY 2020 is based on the most recent estimates. FY 2021–FY 2023 purchases are based on the FY 2019 FYHSP report.

Explosives Trace Detectors (ETD)

ETDs are highly sensitive devices developed to detect various types of commercial and military explosives. ETD technology detects explosive compounds on airline passengers, their accessible property, and checked baggage. ETDs identify explosives by detecting the chemical attributes of microscopic residues of an explosive compound. ETD technology is highly sensitive, thereby enabling fast and accurate screening for trace explosive quantities on a variety of surfaces. Simple operation of these machines further enhances their effectiveness. They are designed to be used as standalone systems or in conjunction with other technologies, such as the ATs, to provide a comprehensive program to screen for explosives. Currently, TSA uses ETDs as the primary screening method at very small airports, and for alarm resolution at larger airports. In FY 2017, TSA completed the deployment of 1,353 ETDs for passenger screening in order to meet an increased need in the field and to replace technically obsolete ETD systems.

ETDs are undergoing development efforts to enhance detection capabilities 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 and sets smaller detection targets. In FY 2018, TSA began test and evaluation efforts for the new detection standard algorithm to increase security detection capabilities.

TSA checkpoint screening will have 3,222 ETDs deployed by Q3 FY 2019, which then will reach 100 percent of full operational capability.

Table 7: ETD Planned Purchases as of September 2018[12]
($ in millions)

Explosives Trace Detector	Planned Requirements with: All Available Carryover Funds	FY 2018 Funds	FY 2019 Funds	FY 2020 Funds	FY 2021 Funds	FY 2022 Funds	FY 2023 Funds	Total
Units	*0*	*175*[13]	*0*	*0*	*0*	*0*	*0*	***175***
System Procurement Costs	$0	$3.16	$0.00	$0	$0	$0	$0	**$3.16**
System Detection Improvements and Enhancements	$0	$0.82	$4.59	$1.37	$1.39	$6.30	$1.43	**$15.90**
Testing Costs	$0	$0.36	$3.32	$0.02	$0.02	$1.78	$0.02	**$5.52**
Deployment Costs	$0	$0.28	$0.00	$0	$0	$0	$0	**$0.28**
Maintenance Costs	$0	$16.21	$22.74	$24.45	$24.84	$25.24	$25.64	**$139.12**
Total Funding	**$0**	**$20.83**	**$30.65**	**$25.84**	**$26.25**	**$33.32**	**$27.09**	**$163.98**

[12] FY 2018 planned purchases are based on the FY 2018 DHS Appropriations Act (P.L. 115-141). FY 2019 is based on the FY 2019 President's Budget. FY 2020 is based most recent estimates.
[13] The planned purchase of ETD systems in FY 2019 was accelerated and purchased in FY 2018 to support recapitalization efforts, airport expansions, increased passenger volumes, and safety stock. As of September 2018, TSA does not anticipate purchasing additional ETDs in FY 2019 in support of the checkpoint.

C. Emerging Checkpoint Technologies

As threats advance, TSA continues to invest in emerging technologies to elevate checkpoint screening capabilities. As expanded and 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. These currently are not managed under a program of record and, as a result, are not reflected in the prior planned purchase tables.

Computed Tomography

The most impactful carry-on baggage screening technology available today is the CT system at airport checkpoints because it promises to automate much of the threat detection function while enhancing TSA security effectiveness. CT systems offer an enhanced imaging platform compared to deployed AT X-ray systems and can be upgraded to detect a broader range of threats automatically. Specifically, CT will detect a greatly reduced threat mass and broader range of homemade explosives and will provide the potential ability for passengers to leave liquids and laptops in their carry-on bags. CT will enhance screening for the current threat of interest and will provide an increase in overall checkpoint security effectiveness.

TSA is using an agile, innovative approach for the procurement and deployment of CT to address system integration, operational readiness, and system performance characteristics rapidly. This approach allows TSA to deploy specific capabilities as part of a larger solution—progressively expanding functionality until full capability is realized.

In FY 2017, TSA commenced procurement of eight CT prototypes and completed procurements and deployments to airports and testing facilities in FY 2018. These prototypes will be deployed in addition to the units currently in place at the demonstration sites of Phoenix Sky Harbor International Airport, Boston Logan International Airport, and John F. Kennedy International Airport. TSA will use these prototypes to demonstrate CT systems with capabilities that include enhanced visual interpretation, image manipulation, improved detection of homemade explosives, reduced false alarm rates, and reduced threat mass detection compared to current AT systems.

In FY 2018, TSA has continued testing efforts initiated in FY 2017. Current FY 2018 funding enabled the procurement and deployment of 10 CT units at airports to support operational testing in August 2018. In parallel, FY 2018 funding also allows for the procurement and deployment of up to 24 additional prototypes to support algorithm development efforts to meet the APSS detection standard. As stated previously, this standard will advance checkpoint imaging capability to address significantly reduced threat weights with a focus on highest risk threats while decreasing false alarm rates.

In FY 2019, a new acquisition program of record will be established to address the APSS capability. The APSS program will assume responsibilities for the qualification/Qualified Products List (QPL), testing, procurement, deployment, and maintenance of all TSA checkpoint CT systems. All requested CT funding then would be allocated as part of the APSS program. Also in FY 2019, TSA is planning for the procurement and the deployment of approximately 169 units at the AT-2 Tier II certification to airports under a risk-based deployment approach. The chart below outlines projected costs for CT deployment and sustainment at airport checkpoints as currently stated within P.L. 115-141, the FY 2019 President's Budget, the FY 2019 FYHSP report for FY 2020–FY 2023, and the most recent estimates for FY 2020. The number of units and system procurement costs provided in the table below are based on estimated costs and may change as TSA procurement and deployment costs become more accurate.

Table 8: CT Planned Purchases as of September 2018
($ in millions)

Computed Tomography	Planned Requirements with: All Available Carryover Funds	FY 2018 Funds	FY 2019 Funds	FY 2020 Funds	FY 2021 Funds	FY 2022 Funds	FY 2023 Funds	Total
Units	***10***	***24***	***169***	***114***	***114***	***114***	***114***	***659***
System Procurement Costs	$3.00	$7.20	$67.60	$45.60	$45.60	$45.60	$45.60	**$260.20**
System Detection Improvements and Enhancements	$0	$0.00	$1.19	$6.90	$7.01	$7.12	$7.23	**$29.45**
Testing Costs	$7.10	$5.92	$0.33	$6.80	$6.89	$7.06	$7.17	**$41.27**
Deployment Costs	$2.00	$38.60	$4.68	$22.58	$22.94	$23.30	$23.68	**$137.78**
Maintenance Costs	$0	$0	$0	$1.45	$11.85	$19.23	$26.90	**$59.43**
Total Funding	**$12.10**	**$51.72**	**$73.80**	**$83.33**	**$94.29**	**$102.31**	**$110.58**	**$528.13**

Initial CT deployments will require additional TSOs, then will reduce that requirement gradually over time. The initial staffing increase provides relief for:

- Initial training of current TSO workforce on CT;
- Additional need for Transportation Security Specialists-Explosives (TSS-E) for alarm resolution;
- The potential need to ensure positive baggage control, while automated baggage capabilities are being integrated with CT; and
- Refinement of concept of operations to optimize security effectiveness and efficiency.

Additionally, CT deployment has interdependencies with and will require the related investment of automated screening lanes (ASL), which is addressed below. Because of these interdependencies, TSA is looking at the possibility of placing both CT and ASL programs under an overarching APSS program in the future.

Automated Screening Lanes (ASL)

ASLs are a property handling system integrated into an existing AT X-ray or CT system. ASLs are necessary to mitigate checkpoint security vulnerabilities, reduce checkpoint passenger congestion, and reduce the number of misdirected bags. A modification of the existing carry-on baggage screening lanes incorporates the following to improve effectiveness and efficiency:

- ***Automated Tracking and Diverter:*** Removes the need to match the item onscreen with a physical item by providing a photo image of the bin in question with an ID tag, and automatically diverts bags that have been identified for alarm resolution;
- ***Managed System Queuing:*** Provides the necessary spacing between items, which improves the overall screening process efficiency and reduces the need to re-run items through the screening system;
- ***Parallel Divestiture:*** Removes the current first-in/first-out scenario; and
- ***Automated Bin Return:*** Removes the manual process of collecting and supplying empty bins.

In October 2016, TSA was approved to deploy up to 220 ASL systems by engaging in public-private partnerships to address an urgent operational need. The deployment of ASLs addressed a security gap and allowed private-sector partners (airlines and airport authorities) to procure and deploy the equipment, then gift or loan the ASLs to TSA.

As of August 2018, there are 143 ASLs deployed to 14 airports across the country. Additional demonstration deployments will be completed in FY 2018, with approximately 200 total systems deployed in the field.

During FY 2019, TSA intends to finalize requirements. TSA does not intend to establish ASL as a standalone program of record; instead, TSA will manage existing deployed ASLs as part of the AT-2 program. Future gifted, loaned, or purchased ASLs will be managed under the APSS acquisition program, with the intent to be configured and integrated with CT scanners. Deployment of CT with ASL capability is anticipated to begin in FY 2020. On the basis of the requirements and anticipated delivery of CT units, the projected CTs with ASL capability will be approximately 1,263 systems, including currently deployed systems.

Biometric Technologies

Specific and significant capability gaps have been identified that are associated with current manual identity verification methods at the TDC station. More specifically, methods of manually comparing the photograph on a passenger’s identity document to the passenger’s actual face, manually authenticating the identity document, and manually confirming the passenger’s vetting status have known gaps. To close these capability gaps and achieve TSA’s future-state goals associated with enhanced security, effectiveness, and passenger experience, TSA requires the ability to develop, procure, 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 an operational proof of concept (PoC) at two airports using both contact and contactless fingerprint-based Biometric Authentication Technology (BAT) devices. The purpose of the PoC was to explore methods for improving TSA’s ability to verify passenger identity beyond the traditional credential authentication measures. BAT PoC engaged TSA

Pre✓® Application Program passengers in the expedited screening lane to demonstrate the technical and operational feasibility of biometric identity verification, rather than verification through credentials and boarding passes.

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

In FY 2018, TSA partnered with U.S. Customs and Border Protection (CBP) on a phased series of facial-recognition based pilots in the airport operational environment. The pilots incrementally demonstrate increasing capability that leverage CBP's biometric Traveler Verification System (TVS).

- **Phase 1** (Completed in 2017) focused on data collection to determine the feasibility of using biometric facial recognition technology for identity verification of international outbound passengers over the course of 30 days at the TSA checkpoint in Terminal 7 at the John F. Kennedy International Airport (JFK). In parallel, TSA officers continued to manually inspect boarding passes and identity documents per the standard TDC procedure.

- **Phase 2** (August - October 2018) currently is being conducted at Los Angeles International Airport's (LAX) Thomas Bradley International Terminal and will stress-test the system at a larger checkpoint and explore the potential for TSA to leverage CBP's TVS in lieu of manual ID checks to perform identity verification for international outbound passengers. The pilot also will assess the impact of CBP officer staffing at the checkpoint for non-match resolution.

- **Phase 3** (Expected Summer/Fall 2019) will build upon Phase 2 and will incorporate passengers' Secure Flight vetting status into the TVS process. This will eliminate the need for boarding pass and physical ID checks to enable a secure, fully automated, seamless passenger experience as travelers enter the TSA checkpoint. Together, the joint TSA-CBP pilots may identify operational efficiencies enabling TSA to refocus some TSO labor toward higher order security tasks such as behavior and/or explosives detection.

This is a new technology, so the current FYHSP does not include funding to TSA for the development, procurement, or deployment of biometric technology. Many supporting capabilities and interconnections are required to ensure that there are sufficiently large populations of passengers who are able to utilize biometric solutions and associated processes efficiently. TSA is exploring ways to support the agency's biometrics capability development, but currently no dedicated funding will be available in FY 2019. TSA will continue to engage with industry on biometric solutions for trusted and standard passengers as well as with other populations (e.g., law enforcement officers, known crew members, aviation workers, airport concessionaires, etc.) and will pilot potential concepts of operation.

D. Checked Baggage Screening Technologies

In accordance with the Aviation and Transportation Security Act (ATSA) of 2001 (P.L. 107-71), TSA screens 100 percent of checked baggage with an explosives detection system (EDS) or a suitable alternative, such as an ETD. TSA accomplishes this mission by testing, acquiring, deploying, integrating, upgrading, and maintaining technology that screens checked baggage. Since achieving the ATSA mandate in 2003, TSA's checked baggage focus has expanded to ensure that airports' checked baggage screening zones use the most efficient and effective technologies. This effort requires the deployment of technology with improved performance and the integration of EDS equipment in line with airport baggage handling systems to improve the efficiency of checked baggage screening operations at many larger airports. In FY 2017, TSA screened approximately 475 million checked bags.

E. Existing Electronic Baggage Screening Technologies

Explosives Detection Systems

TSA uses EDSs as the primary screening method to achieve its 100-percent screening mandate. 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. TSA has deployed the advanced fleet of EDS checked baggage screening equipment 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 alarms can be resolved in quieter, dedicated spaces that are designed properly for the alarm resolution function. Also, in-line systems contribute to reduced injury rates.

The competitive procurement strategy to test and procure NextGen EDS has allowed TSA to deploy enhanced capabilities to the field successfully in support of its recapitalization efforts. To sustain recapitalization priorities and fulfill purchase requirements, TSA will continue to procure EDS models listed on the current EDS competitive procurement QPL. Although TSA closed the current EDS competitive procurement QPL to new entrants in February 2015, it plans to open a new qualification window with updated requirements in late 2018, supporting a shift of focus to the enhanced capabilities mission.

In addition, TSA continues to work with industry to apply spiral and incremental approaches to technology development. This allows TSA to upgrade existing machines as enhanced capabilities are available, instead of requiring complete system replacements. For example, TSA is pursuing enhanced explosive threat detection capabilities within checked baggage to detect an expanded set of threat materials with higher detection probabilities, lower false alarm rates, faster throughput rates, and at lower lifecycle costs, resulting in less impact to airport operations and the traveling public. TSA also is working toward the capability to connect EDSs to a cloud-based network to enable remote capability/reporting of EDS performance, maintenance, algorithm switching, and inventory management.

Where systems cannot be upgraded, TSA has implemented a robust plan for the recapitalization of EDS technologies reaching the end of useful life and the upgrade of selected airport screening zones to realize efficiencies. The prioritization of recapitalization projects is based on various factors, including lifecycle support maintenance records and threat detection capabilities.

Table 9: Explosives Detection Systems Planned Purchases as of September 2018[14]
($ in millions)

Explosives Detection Systems	Planned Requirements with:							**Total**
	All Available Carryover Funds	**FY 2018 Funds**	**FY 2019 Funds**	**FY 2020 Funds**	**FY 2021 Funds**	**FY 2022 Funds**	**FY 2023 Funds**	
Units	*63*	*73*	*79*	*52*	*39*	*36*	*16*	***358***
System Procurement Costs	$61.61	$65.56	$90.54	$57.98	$45.49	$37.63	$14.77	**$373.58**
System Detection Improvements and Enhancements	$35.03	$40.59	$17.47	$18.56	$14.16	$107.58	$98.02	**$331.41**
Testing Costs	$6.29	$7.29	$3.00	$1.32	$11.40	$11.38	$9.51	**$50.19**
Deployment Costs	$37.98	$44.00	$86.60	$37.07	$159.72	$74.10	$55.29	**$494.76**
Maintenance Costs	$67.53	$78.25	$138.01	$136.85	$152.85	$160.52	$165.82	**$899.83**
Total Funding	**$208.44**	**$235.69**	**$335.62**	**$251.78**	**$383.62**	**$391.21**	**$343.41**	**$2,149.77**

[14] FY 2018 planned purchases are based on the FY 2018 DHS Appropriations Act (P.L. 115-141). FY 2019 is based on the FY 2019 President's Budget. FY 2021–FY 2023 purchases are based on the FY 2019 FYHSP report. FY 2020 is based on the most recent estimates.

Explosives Trace Detectors

As referenced earlier in this report, TSA awarded a contract in September 2016 for the purchase and deployment of ETDs for the checkpoint, but also included in this award is the option to purchase an additional 1,898 ETDs for checked baggage screening. TSA exercised the option for the procurement of units and has begun deployment efforts.

Table 10: ETD Planned Purchases as of September 2018[15]
($ in millions)

Explosives Detection Systems	Planned Requirements with:							Total
	All Available Carryover Funds	**FY 2018 Funds**	**FY 2019 Funds**	**FY 2020 Funds**	**FY 2021 Funds**	**FY 2022 Funds**	**FY 2023 Funds**	
Units	*1,898*	*0*	*10*	*10*	*10*	*10*	*1,106*	***3,044***
System Procurement Costs	$34.28	$0.00	$0.17	$0.16	$0.16	$0.16	$52.16	**$87.09**
System Detection Improvements and Enhancements	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	**$0.00**
Testing Costs	$0.63	$0.00	$0.01	$0.01	$0.01	$0.01	$0.01	**$0.68**
Deployment Costs	$3.00	$0.00	$0.02	$0.02	$0.02	$0.02	$0.23	**$3.31**
Maintenance Costs	$0.00	$14.24	$12.75	$12.87	$19.09	$19.48	$19.92	**$98.35**
Total Funding	**$37.91**	**$14.24**	**$12.95**	**$13.06**	**$19.28**	**$19.67**	**$72.32**	**$189.43**

[15] FY 2018 planned purchases are based on the FY 2018 DHS Appropriations Act (P.L. 115-141). FY 2019 is based on the FY 2019 President's Budget. FY 2020 is based on the most recent estimates. FY 2021–FY 2023 purchases are based on the FY 2019 FYHSP report.

F. New Electronic Baggage Screening Technologies

TSA is working continuously to improve and expand on the aviation security screening capabilities that are deployed at the Nation's airports. Working in collaboration with DHS S&T and industry, TSA is pursuing new capabilities in the detection of explosive threats within checked baggage. Areas of R&D include: new means of data acquisition, data processing and management, detection algorithm development, and systems integration.

In the area of threat detection algorithm development, TSA expects new algorithms in the near term with the ability to detect homemade explosive formulations in checked baggage more reliably. The scientific and vendor communities are working on these challenges to deploy improved algorithms on both in-service EDSs and new systems currently in development.

Systems integration also is drawing much attention from TSA and the R&D community. Improvements in data communications, systems compatibility, open standards-based designs, human factors, and system reliability, maintainability, and availability all lead to improved checked baggage screening effectiveness and efficiency. TSA is developing a common elements architecture for airport security screening that will tie together the enabling technologies and processes to help meet future aviation security challenges.

G. TSA Technology Integration - Passenger and Baggage Screening

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

R&D Partnership with DHS Science & Technology

TSA constantly is seeking ways to improve security effectiveness, operational efficiency, passenger experience, and workforce capabilities. To achieve this, TSA maintains a broad awareness of technology developments and invests R&D funds into the transition of emerging technology for detecting, preventing, and mitigating terrorist threats into full operational capabilities. 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 mature cutting-edge technology and transition to the TSA operational environment to enhance mission-enabling capabilities. TSA's R&D initiatives are focused on the following strategic 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;

- Apply science and technology breakthroughs to advance security solutions; and
- Apply science and technology improvements to enhance the security of the intermodal transportation system.

Developing New Technology/Improving Current Technology

TSA works closely with academia, industry partners, interagency partners, and other DHS Components, such as CBP, to identify and integrate technology and process advancements into existing security systems to enhance security effectiveness and improve operational efficiency. In addition, TSA is continuing to identify emerging technologies that can improve security, passenger experience, and efficiency.

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. TSA continues to work with industry, academia, national laboratories, and interagency partners to develop advanced algorithms that can enhance performance of screening systems, such as AT X-ray, CT, AIT, EDSs, and other systems.

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

TSA is evaluating the utility 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 and system operational efficiency. For example, TSA is working to develop new algorithms that use machine learning approaches to discriminate between threats and benign objects, making the screening process more effective and efficient. Machine learning also offers a way to screen for all prohibited items (explosives, firearms, sharp objects, etc.) automatically. It is anticipated that machine learning algorithms not only will improve security effectiveness but also will support automation in future security systems, thereby enhancing operation efficiency and improving passenger experience through increased throughput and decreased false alarm rates. More broadly, machine learning algorithms can be applied to assess security performance and provide system-level improvements beyond performance enhancements realized at individual screening operations.

Enhancing Interoperability and Standardizing Systems

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. Specifically, TSA is striving for a more open, secure, and interoperable architecture that will increase automation and integration, driven by a digital transformation in how TSA leverages data to restructure how to deliver transportation security better and more effectively. This involves designing a true "systems of systems" approach, optimizing open technology platforms to encourage agile capability upgrades, and integrating 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. The ultimate long-term objective is to reengineer aviation security from top to bottom, with a continued focus on increasing security throughout the system.

Innovation Task Force (ITF)

The ITF supports TSA in diversifying the industrial base while responding to industry and stakeholder requests to increase access to operational data to mature solutions and to provide input on future transportation security capabilities. ITF establishes an integrated approach to address the imperatives for change, providing an environment and focused resources to collaborate on innovation efforts. Solutions may cover a breadth of concepts, from aesthetic solutions to new detection technologies, while supporting near-term and long-term progress toward the future TSA system architecture. ITF demonstrates selected innovative and systemic solutions to improve effectiveness, posture for future passenger growth, and evolve to deter and detect an adaptive enemy. The task force enables TSA and industry to refine potential emerging transportation security capabilities.

Since its standup in 2016, ITF launched its first operational demonstration and subsequently expanded ASLs to multiple airports around the country via an urgent operational need. This demonstrated ITF's ability to capture lessons learned to inform requirements. ITF also identified additional solutions for demonstration and expanded the pool of interested stakeholders. ITF continues to collaborate with industry partners as well, creating a shared commitment to aviation security among TSA and stakeholders.

Solution demonstrations for ITF include:

- CT demonstrations with multiple manufacturers;
- Checkpoint planning and staffing tools;
- ETD demonstrations;
- BLS demonstrations;
- BAT demonstrations;
- Passenger communication tools as TSA and airports identify tools and techniques for checkpoint enhancements;
- Enhanced AIT demonstrations; and
- Training enhancements for the frontline officers.

In addition to solution demonstrations, ITF also collaborates with partners (such as airlines, airports, and industry) to facilitate innovation through several projects, including:

- ***TDC Inspection*****:** demonstrates a different approach from the CAT for reviewing drivers' licenses in an effort to enhance identification inspection at the TDC position;
- ***Biometric Bag Drop*****:** pilot of a self-checked bag drop solution with biometric validation of identity by airlines; and
- ***TSS-E Alarm Resolution*****:** pilot of an alarm resolution technology for TSS-Es and small airports that do not have the necessary staff onsite.

IV. Cost-Effective Screener Workforce Development: Staffing Allocation Process

TSA employs staff at approximately 440 airports. Each airport is unique and requires its own technology and employee configuration. TSA determines the most cost-effective means of staffing through various methodologies, modeling, and optimization efforts to provide the greatest opportunity to maximize screening effectiveness while minimizing operational impacts due to passenger volume.

TSA utilizes a rigorous staff allocation process and Enhanced Staffing Model to allocate its security workforce effectively. The process considers each airport's flight schedule data, airport equipment, layout configuration, and unique operating characteristics to determine appropriate staffing. TSA refines and improves the tools for the staffing process and the Enhanced Staffing Model application on a continuous basis.

The model is centered on a proven, discrete-event simulation model with the following inputs:

- ***Airport Configurations*****:** Each airport's unique configuration is entered with details for operating hours, terminals, checkpoints, bag zones, screening equipment, and exit lanes. The configuration details are vetted with local airport scheduling operations officers.

- ***Passenger and Baggage Screening Work Demand*****:** TSA uses data provided directly from the airlines, the Bureau of Transportation Statistics, Federal Aviation Administration forecasts, and OAG Aviation[16] to project flight activity and subsequent passenger enplanements. This provides a means of accounting for planned growth in passenger loads, a variable that is monitored constantly and adjusted as needs mature. Each airport's unique flight schedules are loaded into TSA's simulation modeling software to reflect flight departure times, aircraft seat capacities, and other flight details.

- ***Processing Rates and Staffing Constants*****:** TSA uses data provided by the airlines and collected through time studies to determine appropriate staffing standards and expected processing rates. These rates and staffing standards are used for all airport staff modeling. In the case of airport deviation from these rates and standards, the reasoning for the deviation is documented.

The staffing requirements generated by the simulation model then are run through integrated schedule optimization software driven by a sophisticated mathematical problem-solving engine. In addition to the staffing demand generated by the simulation model, this schedule optimization engine considers several other variables that affect staffing requirements, including the requirements to utilize a mix of part- and full-time employees to cover the work demand and

[16] OAG is a private company (www.oag.com), providing access to flight schedule information from a database of more than 900 airlines and more than 4,000 airports, and is considered the most extensive flight status information database in the market.

minimize the number of start times for employees so that shift breaks can be scheduled effectively.

Following this step, TSA uses historical and projected requirements information to add funding for nonmodeled requirements, such as paid time off, overtime, and training. The result of all of these processes is an individual staffing goal for each airport, with a breakdown of the goal by screening type (baggage and passenger) and with recommended part- and full-time employee headcounts.

The staffing process has been used to establish airport staffing budgets since FY 2004. TSA has seen a decrease in staffing demand for checked baggage screening as in-line baggage screening systems have been installed. Conversely, there has been an even greater increase in staffing demand at checkpoints because of the increase in the number of passengers; the complications that arise from screening liquids, aerosols, gels, and powders; the increased number of electronics being screened individually; and the introduction of staffing-dependent technologies, such as AIT. Staffing resource requirements also have increased in recent years as a result of a substantial increase in passenger volume. Volume growth in FY 2017 was 3.6 percent and is expected to grow by 3.5 percent in 2018.[17]

The staffing process is adjusted periodically to account for new technology, emerging threats, and changes in TSA's operating procedures. TSA continues to strive for greater adaptability in its staffing process. TSA continually assesses potential adjustments to the existing model to match resources more closely to the demands of the screening environment. Considerations include:

- Updated modeling of TSA Pre✓® based on current participation rates;
- Integration of ASL systems;
- Integration of behavior detection capabilities into the screening workforce; and
- Accounting for the time needed to deliver the training to support the deployment of new technologies, changes to the threat and/or methods of concealment, and changes to operating procedures.

These changes allow for a holistic adaptable staffing approach (see Figure 1 below).

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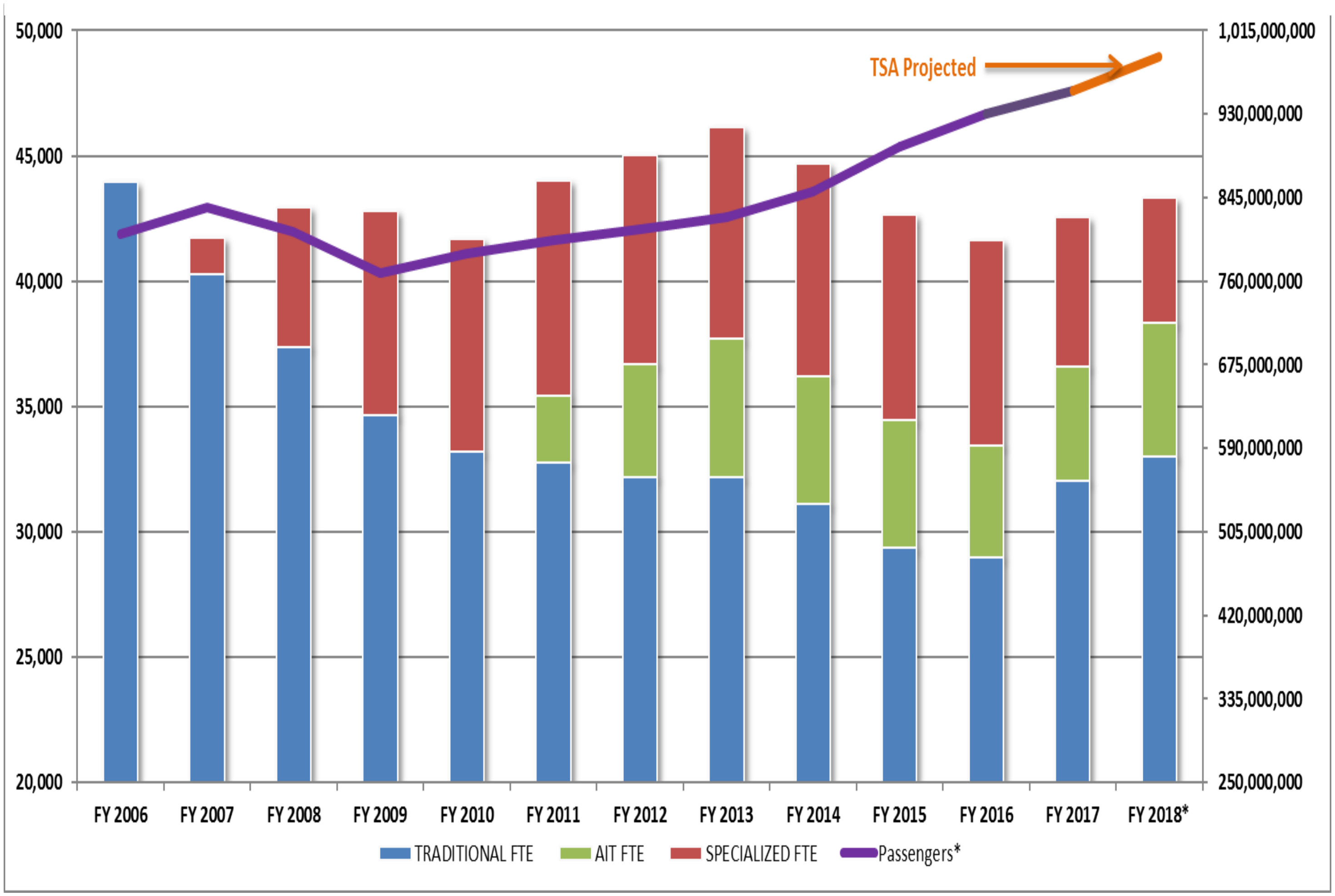
[17] The Bureau of Transportation Statistics has not published passenger enplanement data past January 2018; therefore, a final growth percentage for FY 2018 is not provided.

Figure 1: TSO Workforce FTE and Passenger Growth



* Passenger data are taken from the Bureau of Transportation Statistics T-100 market data. As of April 2018, the Bureau of Transportation Statistics has not published passenger enplanement data past January 2018; therefore, the FY 2018 projection is based on projected growth of 3.5 percent. Also note that passenger count ties to enplanements, not necessarily screening throughput.

** FY 2006–FY 2017 staffing levels have been adjusted to reflect the shift in Coordination Center staffing from the TSO workforce to the Federal Security Director staff that occurred in FY 2018.

V. Savings and Reinvestment from Improved Technology Deployment

TSA continues to look for efficiencies by installing labor-saving, improved technology for both passenger and baggage screening. When these efficiencies are found, TSA reinvests its resources in other essential security capabilities to support staffing needs at the checkpoint.

TSA realized savings of 80 FTEs from in-line EDS in FY 2017, when compared to the staffing required for the standalone screening equipment configuration. Because of the increase in passenger volume that TSA experienced in FY 2017, resulting savings were redirected to address passenger-volume increases across the system, with many of the larger airports experiencing double-digit increases in staffing requirements.

TSA has transitioned 1,002 FTEs from the dedicated Behavior Detection Program to traditional checkpoint screening activities that have been updated to include components of the Behavioral Detection security procedures. This transition has assisted in mitigating the additional work associated with increased passenger growth.

As TSA looks forward, enhanced screening capabilities to address emerging threats may require additional screening resources to ensure security effectiveness. For example, and as discussed previously, TSA anticipates that the deployment of CT initially will require additional screening workforce personnel to address the need for training, alarm resolution, and the refinement of concept of operations, then gradually will reduce the resource need over time as efficiencies are gained. With this expectation, as additional capabilities are deployed, TSA will continue to use its staffing methodologies to optimize screening efficiencies while minimizing operational impacts due to passenger volume increases.

VI. Conclusion

To address the ever-evolving threats to aviation security, TSA continues to enhance existing technologies, acquire and integrate new technologies, and use intelligence- and risk-based processes to screen passengers and their baggage more effectively and efficiently. TSA is committed to using its workforce productively, specifically by focusing on labor and cost savings to serve the public better and to secure the Nation's transportation system. As TSA moves forward with a renewed focus on security, revised alarm-resolution procedures, new investments in technology, and a retrained workforce, it is focused on enhanced security detection as it tests the system continuously to identify any capability gaps and to measure system readiness and performance.

By working closely with Congress to resource the organization appropriately, TSA will continue to address passenger growth, improve checkpoint performance, and mitigate vulnerabilities across the aviation system. The initiatives outlined in this report will allow TSA to address the dynamic threat to aviation security and partner with industry to provide the capabilities and solutions needed.

Appendix: Abbreviations

Abbreviation	Definition
ADE	Acquisition Decision Event
AIT	Advanced Imaging Technology
APSS	Accessible Property Screening System
ASL	Automated Screening Lane
AT	Advanced Technology
ATSA	Aviation and Transportation Security Act
BAT	Biometric Authentication Technology
BLS	Bottled Liquid Scanner
BPS	Boarding Pass Scanner
CAT	Credential Authentication Technology
CBP	U.S. Customs and Border Protection
CT	Computed Tomography
DHS	U.S. Department of Homeland Security
DOT	U.S. Department of Transportation
EDS	Explosives Detection System
EMD	Enhanced Metal Detector
ETD	Explosives Trace Detector
FTE	Full-Time Equivalent
FY	Fiscal Year
FYHSP	Future Years Homeland Security Program
GAO	U.S. Government Accountability Office
ID	Identification
IED	Improvised Explosive Device
IOT&E	Initial Operational Test and Evaluation
ITF	Innovation Task Force
NextGen	Next Generation
PoC	Proof of Concept
Q	Quarter
QPL	Qualified Products List
R&D	Research and Development
S&T	Science and Technology Directorate
TDC	Travel Document Checker
TSA	Transportation Security Administration
TSE	Transportation Security Equipment
TSO	Transportation Security Officer
TSS-E	Transportation Security Specialist-Explosives
TVS	Traveler Verification System