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ADVANCES IN PASSENGER SCREENING CHECKPOINT TECHNOLOGY

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Airport security is a paramount concern in the modern world. The need to protect travelers from security threats while ensuring the efficient flow of passengers through airports is a constant challenge. In recent years, significant investments have been made in the development and deployment of innovative systems aimed at improving airport security operations. These new systems offer a host of advantages over the legacy systems used for the last few decades.

This whitepaper explores the advances in today's airport security screening, from the identification verification equipment used during first contact with the traveler to the advanced screening lanes being installed in airports all over the world. With a focus on enhancing passenger experience while maintaining stringent security standards, new passenger checkpoint technology represents an evolution in airport traveler security screening capabilities. We delve into the current legacy equipment screening process and discuss how the technological advancements, operational efficiencies, and other benefits provided by this new generation of passenger screening equipment can help mitigate the screening challenges airports are experiencing with legacy systems.

FIRST CONTACT

FIGURE 1. CAT-2 WITH CAMERA (PHOTO COURTESY OF TSA.GOV)

When a traveler purchases a ticket, the first layer of screening occurs through the Secure Flight program. Passenger information is matched against a watch list to the No Fly and Selected portions of the Terrorist Screening Database (TSDB), which uses Known Traveler information to identify trusted travelers enrolled in TSA PreCheck. Risk is assessed based on factors related to the passenger and a given flight, which helps to determine the level of screening required for that trip. The first on-site interaction a passenger has after obtaining a boarding pass begins with ID verification at the start of the checkpoint area by a Transportation Security Officer (TSO) Travel Document Checker (TDC). The REAL ID Act of 2005 is an Act of Congress that establishes requirements for driver's licenses and identification cards issued by U.S. states and territories that must be satisfied to be accepted for accessing federal government facilities, nuclear power plants and boarding airline flights in the United States. Many states have or are in the process of incorporating these requirements into their state identification documents. Earlier processes required passengers to present a boarding pass and an approved government document to validate their request to enter the screening area, but Credential Authentication Technology (CAT) systems have simplified the identification verification process for the TSO, creating a faster validation process. Linked electronically to the Secure Flight database, CAT scans the driver's licenses and identification documents to verify passengers' identity when they present themselves to the TSO for access to the screening checkpoint. CAT quickly confirms travelers' flight details, secures flight pre-screening status, and ensures that travelers are ticketed to travel on that day. TSA requires two TDC/CAT stations be installed per lane with flush mount power/data outlets supporting them. While it does not replace airline boarding pass requirements, CAT is an effective tool for TSA officers and provides fast, enhanced fraudulent ID detection that can bypass the requirement for passengers to scan a boarding pass for checkpoint entry and help reduce queue wait times.

Biometric Identification is currently being tested and integrated into passenger verification processing by TSA to expedite ID authentication without the need to present a physical driver's license, ID card, or other type of government-issued document. The TSA PreCheck Touchless Identity Solution program, in operation at select airports with participating airlines, uses a second-generation CAT station (CAT-2) that incorporates a camera and a facial recognition system as an option for passengers who prefer a faster, touchless solution to the screening process **(Figure 1)**. Digital programs, such as mobile driver's licenses (mDL) and select airline digital ID apps for cell phones, are also currently being accepted for limited testing and evaluation purposes in pilot programs at select airports.

IDENTIFICATION SECURITY CONCERNS

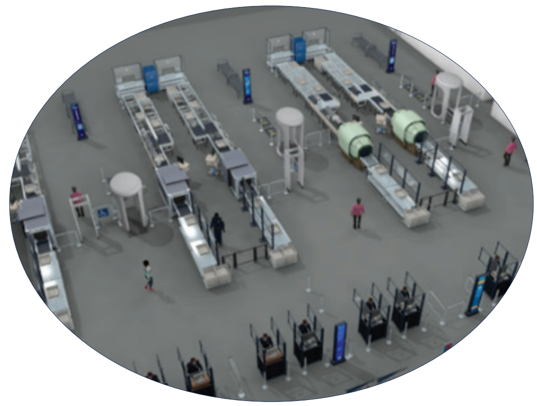


FIGURE 2. STANDARD CHECKPOINT LAYOUT SHOWING SINGLE AND DOUBLE LANES (TSA CHECKPOINT REQUIREMENTS PLANNING GUIDE 2023)

The COVID-19 pandemic has pushed forward an interest in touchless technology across many platforms, which may eventually be adopted by retail stores, restaurants, hotels, and more. Currently, users remain concerned about how their identification information is stored and used by government agencies. TSA states that they will be able to receive a passenger's digital identification information only at TSA checkpoints with a passenger's consent when they voluntarily opt into their Touchless ID program; this system uses the U.S. Customs and Border Protection (CBP) Traveler Verification Service (TVS). Generally, TSA does not copy or store the digital ID, except in a limited testing environment for evaluation of the effectiveness of the pilot program. In that instance, TSA will inform the passenger through privacy impact assessments (PIAs), signage, and other means for this procedural deviation. TSA is committed to protecting passenger privacy and securing all personal data collected as part of its biometric data collection and processing. In addition to cybersecurity measures that ensure all data is protected while in transit and while at rest, biometric technology used by TSA transforms passenger photos into templates that cannot be reverse engineered to recreate the original image, and all capabilities of TSA tests adhere to Department of Homeland Security (DHS) and TSA cybersecurity requirements. Overcoming the initial hesitancy by the public will take concerted effort and trust, but the eventual adaptation of this technology will improve the first step in security screening.

FIGURE 3. AIT (COURTESY OF FLYITHICA.COM)

Once a passenger's ID is verified, the passenger is allowed to approach the checkpoint screening lanes. Layout for these lanes can vary based on the size of the airport and the space provided for the system. The lanes can be grouped in either a set of one-lane or two-lane configurations **(Figure 2)**. The area between the lanes where the passengers flow through is called the "infield." This area contains barriers, gates, Advanced Imaging Technology (AIT) body scanners developed in the 1990s, and a Walk-Through Metal Detector (WTMD) to screen passengers and allow them to pass from the public side of the checkpoint to the sterile side **(Figure 3)**. If this scan triggers the requirement for a secondary search of a passenger, the passenger is moved to an area off to the side where a TSO can perform a pat down or, if necessary, use a private search room for a more extensive search.

LEGACY-GENERATION BAGGAGE SCREENING SYSTEMS

Current screening lane technology, which we will refer to as legacy-generation screening systems, typically requires a series of manual processes that are time-consuming and labor-intensive for both passengers and TSOs. Passengers are required to remove shoes, belts, and outerwear, empty pockets, remove laptops and the 3-1-1 liquid containers from bags, and place all carry-on items in separate bins for x-ray screening. TSOs stationed at the divest area provide direction for these actions, along with performing “bin management” by collecting and transporting them from the end of the lane back to its beginning using carts. During peak periods, these processes often lead to long queues, passenger frustration, and potential security bottlenecks.

A basic legacy lane is approximately 60 feet long and consists of a divest area, an x-ray scanner, a manual diverter roller (MDR), recomposure rollers, secondary screening rollers, and a secondary screening station. The divest area, which can be from four to twelve feet long, is where passengers place their bags, shoes, coats, belts, and other personal belongings into bins moved along by the passengers on non powered roller tables to the Advanced Technology (AT) scanner for x-ray screening. Once a passenger’s bin is at the x-ray scanner, the passenger is sent through the AIT or the WTMD to be scanned for potential threats concealed underneath the passenger’s clothing while the scanned bag’s image is reviewed by a TSO at the x-ray machine. The TSO will determine whether the bag is cleared and sent down the re-composure extension rollers for reclamation by the passenger or diverted for a manual search by a TSO in the secondary screening area at the end of the lane. There the TSO performs a manual bag inspection and has Explosive Trace Detection (ETD) and/or Bottled Liquids Scanner (BLS) testing equipment for chemical analysis screening of the bag. Legacy lanes usually use x-ray units like the Smiths HI SCAN 6040aTiX or Rapiscan 620DV 2D for baggage screening and can clear up to 150 passengers an hour per lane in this configuration. TSA no longer deploys nor accepts these legacy systems as a donation in either renovation or new construction projects, so replacing this older equipment with an Advanced Screening Lane (ASL) system can help an airport conform to TSA’s newest requirements, improve its checkpoint throughput performance, and increase customer satisfaction metrics.

ADVANCED SCREENING LANES: THE NEXT GENERATION

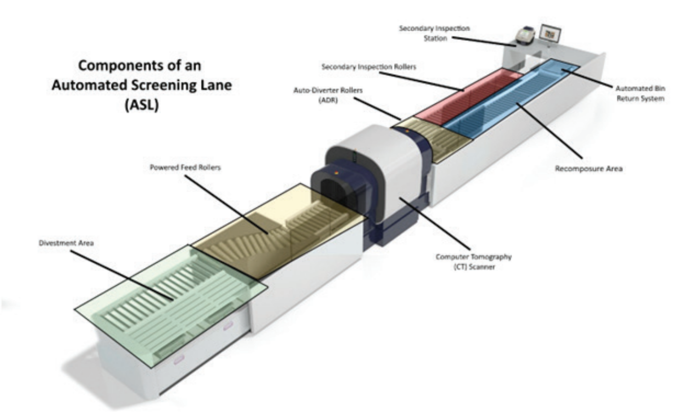


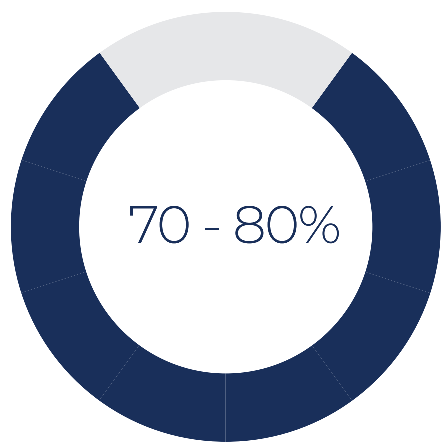
FIGURE 4. BASIC ASL COMPONENTS (COURTESY OF LEIDOS.COM)

Advanced screening lanes represent a transformative development in airport security. These systems leverage cutting-edge technology and streamline processes which can increase passenger screening rates to 300 passengers an hour per lane, doubling the capacity of the legacy systems. The initial cost of installing advanced screening lanes can be a significant capital expenditure for airports with limited budgets, but in the long term this would be offset by reduced operational expenses. The basic components of an ASL consist of a divestment area, a CT scanner, either manual diverter rollers (MDR) or auto diverter rollers (ADR), secondary inspection rollers, re-composure rollers, and a secondary inspection station **(Figure 4)**.

TSA has qualified Security Screening Check Point (SSCP) systems that can be sized into a base-, mid-, and full-size configuration from approximately fifty-seven to seventy-five feet in length (full-size lanes incorporate additional divest and re-composure sections along with an automated bin return system in their design) to support any size airport (and its budget). The base unit has an MDR while the mid- and full-size configurations use an ADR, a high-threat containment unit, and incorporates Radio Frequency Identification (RFID) tags in the bins along with RFID scanners for bin tracking, which provides additional accountability for carry-on bag processing. This equipment can enhance both security and passenger experience and incorporates several technological advancements that set them apart from legacy systems.

State-of-the-art imaging technology, such as CT scanners, enables TSOs to detect potential threats with greater accuracy and efficiency. CT has been adapted from the medical field to provide a 3D cross-section of a bag and its contents by using several x-ray generators to scan an object from multiple angles and process the image. These are the most expensive of the scanner units and have a slower throughput but allow for quicker decision-making by the TSO when evaluating the scanned object. The 3D images of carry-on items allow security personnel to virtually rotate and separate layers of an image to identify threats more easily without requiring passengers to remove items from their bags. Passengers benefit from a more streamlined screening process, as they no longer need to remove laptops, liquids, or other items from their bags, minimizing the number of bins a passenger needs to use and a TSO needs to scan. This significantly reduces the hassle, time, and stress associated with removing items from the bags at the beginning of the scanning process and then reclaiming them at the end as is required for legacy-equipped security checkpoints. If a bag requires secondary inspection, the ADR diverts it from the clear rollers to the secondary inspection rollers, allowing bags trailing it to pass by if they are deemed cleared. This station is equipped with an Alternate Viewing Station (AVS) that recalls the alarmed bag's scanned image for reference while the manual search is performed along with ETD and/or BLS tests.

The decision of whether the scanned item is considered clear or suspect is performed by a TSO. This is the bottleneck in both the legacy and ASL screening processes. Currently, low-risk passengers utilizing the TSA PreCheck or CLEAR programs pass through a WTMD only to wait at the re-composure section for their items to be scanned, read, and cleared by the TSO at the operator workstation, slowing the flow of traffic through the lane. Normal-risk passengers screened through the AIT have a similar experience when their bags are scanned. Image analysis AI algorithms are currently employed with CT scanners for checked baggage to analyze x-ray images and detect explosives, clearing about 70–80% of bags without TSO action. Yet they are not yet advanced enough to perform the same function at passenger screening checkpoints. A TSO must view every image to evaluate whether a prohibited item, which could have been disassembled or broken up into separate bags, is hidden in the carry-on. TSA is working towards an auto-detect "Image on Alarm Only" operational capability, which would show an image only when a bag has a suspect item, such as an explosive threat or prohibited item like a firearm, firearm component, or a knife. The continuing work by scanner manufacturers to develop and eventually deploy



AI algorithms are currently employed with CT scanners for checked baggage to analyze x-ray images and detect explosives, clearing about 70–80% of bags without TSO action more accurate detection algorithms in this area will reduce the reliance on human screeners and the chances of human error, and could increase the throughput of the checkpoint with just a software upgrade (depending on the age of the x-ray machine).

OPERATIONAL EFFICIENCIES FOR IMPROVED PASSENGER DIVESTMENT AREA AND THROUGHPUT RATES

One of the key benefits of advanced screening lanes is the reduced need for passengers to divest themselves of personal items. Allowing passengers to keep liquids, electronics, and other items in their baggage significantly accelerates the screening process, reduces wait times, and enhances the overall passenger experience. While the base- and mid-size systems still use bin carts handled by TSOs to transport bins from the re-composure area back to the divesture end, mid- and full-size systems can have three or four divest stations fed by an automated bin return system that runs along the bottom of the lane.

Advanced screening lanes are designed for higher throughput, which means more passengers can be processed per hour compared with legacy systems. Sensors in the divestment area allow empty bins, embedded with RFID tags, to feed three divestment stations as passengers load their items into them and onto powered rollers that move the filled bins to the scanner. Passengers and TSOs no longer need to collect the bins and place them into carts after belongings are retrieved; an optical scanner at the end of the re-composure lane checks to see if the bin is empty, then allows it to enter a stacker/de-stacker compartment which collects and sends it back to the front of the lane, eliminating the need for a TSO to manually relocate it. Automating processes like this is crucial in busy airports where congestion is a constant challenge and allows TSOs to focus on performing screening activities instead of manual activities.

Another significant advancement incorporated into advanced screening lanes is the integration of remote screening capability. This feature is a game-changer in airport security, offering numerous benefits for both passengers and security personnel. Remote screening capability involves the use of technology to separate the screening process from the physical location of the passenger and allows for a more efficient, streamlined security experience, freeing TSOs in the checkpoint to monitor passengers instead of being distracted by processing activities.

Remote screening capability provides the ability to analyze the scanned images of bags from any ASL away from the ASL and the public space. The CT-scanned image is sent to a centralized screening room where TSOs, referred to as Primary Viewing Station (PVS) operators, review the images generated by the scanning equipment. In the future, this analysis could occur at a location far away from airport property in a centralized facility. Images from the x-ray scanners are continuously displayed on monitors in the screening room and are cleared or flagged for secondary searches. ADRs at the end of the CT machine sort the bins based on the decisions made by the PVS operators. The operators can review scans from any lane (this is known as cross-lane imaging), which reduces the number of TSOs in the lanes needed to watch a monitor at the machine. Checkpoints with three or more lanes qualify for remote screening capability. While this feature is still in the pilot test stage at select airports, all new checkpoint designs will be required to provide a space to support this future capability. The COVID-19 pandemic has underscored the importance of social distancing and hygiene in public spaces. Remote screening reduces the need for close contact between passengers and security personnel, contributing to a safer and more hygienic airport environment for airport workers and the traveling public.

With remote screening, the screening process becomes more efficient and can handle a higher volume of images from all checkpoint lanes, reducing wait times and congestion at security checkpoints. While the initial investment in remote screening technology can be substantial, the long-term cost savings in terms of reduced labor and increased operational efficiency can make it a cost-effective solution for airports. Installing ASL equipment in place of legacy systems increases the throughput of passengers within the same square footage, delaying the need to install additional lanes to handle expected traffic growth.

ADOPTION CONSIDERATIONS

Airports must invest in the necessary infrastructure upgrades to build or renovate their passenger screening checkpoints as part of their master plans and operational budget planning. Power requirements differ between legacy and newer CT systems, so floor outlets and power drops require early coordination based on standard machine power cord lengths. To ensure the smooth operation of this technology, the transition to advanced screening lanes necessitates regular training for security personnel to effectively operate the equipment and new servicing contracts to maintain and repair these systems. To maintain security in the event of technical failures or emergencies, airports must have robust redundancy and contingency plans in place that are reviewed and updated on a regular basis.

TSA could utilize AI image analysis of the queue space to support predictive analytics that optimize the allocation of resources so security personnel could be stationed where and when they are most needed. This resource management tool could be used by the checkpoint supervisor to more efficiently utilize TSO staffing by opening or closing screening lanes according to the trending flow of passengers, helping to proactively reduce wait times and increase security effectiveness.

SECURITY SCREENING IN THE FUTURE: SCREENING AT SPEED PROGRAM

Future ASL designs currently under development and testing with TSA are moving towards a more “self-checkout” style of checkpoint design. The DHS Science and Technology Directorate (S&T) has developed a Screening at Speed program that is performing research and development on new technologies, techniques, and processes that will increase security effectiveness while improving the passenger experience. The goal is to raise passenger throughput, lower costs, and maintain the highly secure screening standards that meet TSA’s requirements by augmenting and enhancing current screening systems. Working with the TSA’s Office of Requirements and Capabilities Analysis, the program leverages state-of-the-art technologies to develop, test, and certify systems, processes, and techniques that meet the future vision and needs of TSA while providing the passenger with a process that is more reliable, less invasive, and efficient. While extensive details on these systems have not been released, the following information has been gleaned from public websites and official press releases.

Liberty Defense has developed a High-Definition Advanced Imaging Technology (HD-AIT) upgrade kit for AITs currently in use. It adds high-definition imaging and AI technology to an existing AIT for greater detection capability with fewer false alarms, allowing travelers to wear light sweaters or jackets while being screened. This modification is designed to work with all tools and platforms regardless of manufacturer, supplier, or design and utilizes open architecture with third-party participation for quicker updates. It could be a low-cost interim body scanner upgrade for airports on a budget, increasing throughput by reducing the number of loose items being put through the baggage x-ray scanner.

FIGURE 5. ROHDE & SCHWARZ EAIT R&S QPS SCANNER (ROHDE & SCHWARZ)

Second-generation enhanced Advanced Imaging Technology (eAIT) units have recently been made available to be used as an alternate to AITs. Among the features that have been incorporated are a more open design with a smaller footprint, no moving parts, and scanning time in the millisecond range using millimeter wave radio technology, which does not penetrate the skin or alert on people with medical implants. These new scanners also allow for a more natural "arms down" position for better passenger comfort during the quick scanning process **(Figure 5)**. Initial distribution of these devices by TSA will be selective as they are slowly incorporated into the TSA Acquisition Program Management's inventory. The physical footprints and power requirements between AITs and eAITs differ (120V and 208V), which will require some design modifications and power circuit upgrades, but airports can opt in to purchasing the units and donating them to TSA through the TSA Capability Acceptance Process Donation Program (CAP) to stabilize their project design and planning work and prevent the maintenance and spares issues that would be incurred when fielding a mix of equipment types.

FIGURE 6. MICRO-X BOOTH (PIC COURTESY OF MICRO-X.COM)

New ASL designs under development and testing at this time are participating in a self-screening program in which several manufacturers are funded under DHS's Science and Technology Directorates. One system by Micro-X costs around twice that of a current ASL but has the potential to increase a lane's throughput to a rate of 400 to 500 passengers an hour **(Figure 6)**. It uses a row of booths or pods that combine passenger and baggage screening with millimeter wave scanning technology and has a goal to reduce an individual's screening time to 60 seconds or less. An avatar directs the passenger to put their items into the cabinet of a miniature CT scanner while a camera and eAIT scans the traveler. The avatar can provide additional directions if the passenger has forgotten to empty their pockets or requires additional screening. A TSO would only interact with the traveler if help were requested or additional screening is required.

Another design currently being tested was developed by Vanderlande Industries uses a Dormakaba Group gated system to control access to the two-lane screening checkpoint similar to the exit lanes currently being incorporated into airport terminal designs **(Figure 7)**. A single CT scanner that handles four divest stations for baggage screening and Rohde & Schwarz QPS millimeter wave body scanners are incorporated into the concept along with a virtual PAX Divest Assistant that prompts passengers through the screening process. This configuration increases throughput within a smaller footprint making it a viable system for airports that are renovating an existing narrow checkpoint space.

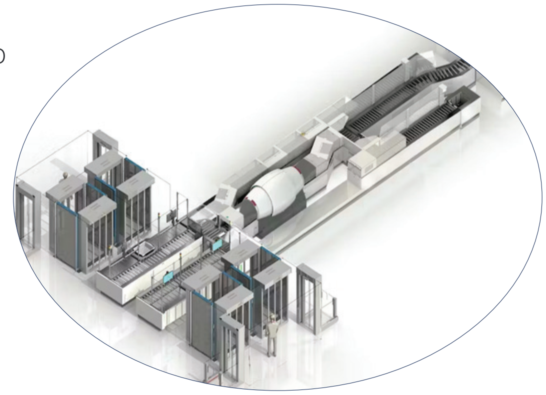


FIGURE 7. VANDERLANDE CONCEPT (PICTURE COURTESY OF VANDERLANDE.COM)

CONCLUSION

Legacy passenger screening systems in use today have reached their throughput limitations and are unable to handle the passenger traffic growth that airports are struggling to manage. The FAA Aerospace Forecast for Fiscal Years 2024–2044 predicts enplanements to increase at a rate of 2–3 percent every year. Longer queues during peak times stress the screening process, increase passenger dissatisfaction, and generate bad press for an airport. The TSA's Checkpoint Requirements and Planning Guide (CRPG) incorporates emerging technology information of qualified and soon to be qualified equipment to assist airports and their architectural design teams with creating checkpoints that meet and exceed their current needs and projected growth rates. Automated Screening Lanes, eAITs, and CT scanners are recent improvements to the screening equipment inventory that can increase throughput and make a checkpoint area more efficient. With several size configurations to choose from, these lanes can be built to fit into existing spaces. New construction designs should incorporate an area for remote screening operations as required by the CRPG and install infrastructure that will allow easier upgrades for future equipment, such as eAITs and self-service screening lanes.

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