Rapid Technologies for Drug Interdiction

S&T Research and Development

June 11, 2021

Fiscal Year 2021 Report to Congress

Homeland Security

Science and Technology Directorate

Foreword from the Senior Official Performing the Duties of the Under Secretary for Science and Technology

June 11, 2021

I respectfully submit the following report, "Rapid Technologies for Drug Interdiction: S&T Research and Development," which has been prepared by the Science and Technology Directorate (S&T).

This document has been compiled pursuant to direction in the Joint Explanatory Statement, which accompanies the Fiscal Year 2021 Department of Homeland Security Appropriations Act (P.L. 116-260).

Pursuant to congressional requirements, S&T is providing this report to the following Members of Congress:

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

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

The Honorable Chris Murphy
Chair, Senate Appropriations Subcommittee on Homeland Security

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

Inquiries relating to this report may be directed to the Office of Legislative Affairs at (202) 447-5890.

Sincerely,

Kathryn Coulter Mitchell

Kathryn Coulter Mitchell
Senior Official Performing the Duties of the Under Secretary for the Science and Technology Directorate

Executive Summary

S&T is working to develop state-of-the-art capabilities for rapid screening and detection of illicit drugs, like fentanyl, to support the Department's interdiction efforts. S&T delivers this report in response to the Committee's request for an update on the research and development (R&D) of methods and technologies to support rapid scanning, detection, and interdiction of illicit drugs.

S&T is executing several project initiatives focused on development and demonstration of fast and accurate technologies for high-volume screening at U.S. ports of entry. Presently, no single technical approach meets the demands and challenges of the Department's counterdrug mission. Current detection strategies rely on a tiered approach that uses advanced information, drug-sniffing canines, X-ray image-based screening, and search and examination by hand. S&T's R&D efforts are focused on advancing technology within this tiered approach. To enable more efficient high-volume inspection, S&T is enhancing X-ray screening technologies with algorithms to automatically recognize potential threats, like drugs, hidden within the item being screened and to alert the operator that additional inspection is required. To reduce the need for manual searches and to improve safety, S&T is developing technologies that can detect distinct physical and chemical properties of illicit drugs and thus clear or confirm initial alerts without having to open the package. Lastly, to support confident interdiction decisions, S&T is improving the detection equipment used during manual examinations to test the contents of an item for illicit drugs.

This report details current project initiatives and investments made in these areas. The report also includes a discussion of synergistic R&D opportunities, such as those focused on explosives detection, that could be leveraged to reduce potential duplication of effort, to accelerate development timelines, and to enable Department-wide strategic sourcing.

Drug trafficking trends and threats are dynamic. S&T's R&D efforts to advance screening and detection capabilities enable the Department to have an agile, confident response to interdict illicit drugs being smuggled into the United States.

Rapid Technologies for Drug Interdiction: S&T Research and Development

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I. Legislative Language

This document has been compiled pursuant to direction set forth in the Joint Explanatory Statement that accompanies the Fiscal Year (FY) 2021 Department of Homeland Security (DHS) Appropriations Act (P.L. 116-260), specifically the following direction:

> Opioid and Fentanyl Detection.—S&T is encouraged to increase its development of rapid screening technology. Within 90 days of the date of enactment of this Act, S&T is directed to provide a report to the Committees on any S&T research or development efforts to incorporate rapid scanning into the Department's screening methods for drug interdiction. The report shall include screening methods for Schedule 1 drugs as categorized by the FDA and an implementation plan to increase drug interdiction through scanning, electronic detection, or canine detection.

II. Background

Over the past two decades, drug overdose deaths have continued to increase in the United States. Despite a decline in the supply of prescription opioids, more than three out of five drug overdose deaths involve an opioid.[1,2] Recent reports suggest that the Coronavirus Disease 2019 (COVID-19) pandemic has driven further increases in substance abuse and opioid-related overdoses, particularly illicitly manufactured fentanyl.[3,4] DHS has a significant role in countering the trafficking of opioids and other narcotics into the United States, including efforts to interdict illicit narcotics at or before they reach our borders, as well as investigative and intelligence efforts to disrupt and dismantle smuggling operations. However, efforts to combat opioid trafficking face numerous challenges. The high volume of mail, trade, and travel provide a multitude of smuggling points that must be accounted for and screened. High-value opioid shipments can be smuggled in very small quantities, making them difficult to detect and seize. The dearth of rapid and effective automated detection systems increases that difficulty. Lastly, due to open-source and dark-web marketplaces and anonymized currency, it has become even more difficult to discover and disrupt transnational drug trafficking organizations and networks.

The Science and Technology Directorate's (S&T) mission is to enable effective, efficient, and secure operations across all homeland security missions by applying scientific, engineering, analytic, and innovative approaches to deliver timely solutions. To support Departmental efforts to stop the flow of opioids and other narcotics, S&T established the Opioid Detection Program (ODP)[5] to deliver mission-critical counternarcotics solutions. Key requirements and strategies for the program were derived from: Executive Order 13784[6]; the International Narcotics Trafficking Emergency Response by Detecting Incoming Contraband with Technology (INTERDICT) Act[7]; the Synthetics Trafficking and Overdose Prevention Act of 2018 (STOP Act)[8]; the National Drug Control Strategy, the National Southwest Border Counternarcotics Strategy, and the National Northern Border Counternarcotics Strategy; and direct collaboration with U.S. Customs and Border Protection (CBP) to complete a capability assessment report to identify priority areas for R&D investment.

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[1] Hedegaard H, Warner M, Miniño AM. Drug overdose deaths in the United States, 1999–2016. National Center for Health Statistics (NCHS) Data Brief, no 294. Hyattsville, Maryland: NCHS. 2017/Centers for Disease Control and Prevention (CDC). Wide-ranging online data for epidemiologic research. Atlanta, Georgia: CDC, NCHS; 2016. Available at http://wonder.cdc.gov.

[2] Gitis, B. and Soto, I. The Types of Opioids Behind Growing Overdose Fatalities. The American Action Forum; 2018. Available at https://www.americanactionforum.org/research/types-opioids-behind-growing-overdose-fatalities/.

[3] American Medical Association. Issue brief: Reports of increases in opioid- and other drug-related overdose and other concerns during COVID pandemic; October 31, 2020. Available at: https://www.ama-assn.org/system/files/2020-12/issue-brief-increases-in-opioid-related-overdose.pdf.

[4] Haley, D. and Saitz, R. The Opioid Epidemic During the COVID-19 Pandemic. JAMA; 2020. Available at: https://jamanetwork.com/journals/jama/fullarticle/2770985.

[5] Established in 2018.

[6] Executive Order 13784: Establishing the President's Commission on Combating Drug Addiction and the Opioid Crisis (2017) and subsequent Initiative to Stop Opioid Abuse and Reduce Drug Supply and Demand.

[7] H.R.2142: INTERDICT Act (2018), P.L. 115-112.

[8] H.R.5788: STOP Act (2018).

A major focus of the ODP has been improving capabilities for screening international mail at ports of entry. When the program was established, the postal system was exploited regularly, and there were no other S&T programs addressing this smuggling vector. However, all development efforts have incorporated the principle that technologies and approaches should be applicable to other ports of entry (e.g., border checkpoints) if necessary.

Early technology scouting and assessment efforts demonstrated that no currently available technologies would meet specific needs to: increase the amount of mail inspected at international mail facilities (IMF) to near 100 percent; screen incoming packages at the speed of commerce—within the constraints of cost, labor, or time available—to identify suspect packages for manual or intrusive inspection; or reliably detect small quantities or mixtures containing less than 10 percent of the drug of interest. Recognizing these challenges, the ODP sought partnerships with other federal agencies, academia, and industry to develop better technologies in four general areas:

- high-throughput, nonintrusive inspection, such as image-based scanning of containers and international mail, to identify anomalies and alert the operator of suspected narcotics concealments rapidly and automatically;
- detection of distinct physical and chemical properties of drugs to provide more specific information to assist the operator in determining whether an anomaly is a false alarm or illicit drug without having to open or physically handle the shipment;
- improved effectiveness of commercially available handheld and portable detection devices to analyze and identify a drug, even small amounts or when mixed with other compounds; and
- standard methods and safe test materials that technology developers and end-users can use to evaluate the performance of detection equipment.

In 2019, S&T partnered with CBP, along with the U.S. Postal Inspection Service and the Office of National Drug Control Policy to conduct the Opioid Detection Challenge (ODC)[9] to address drug trafficking via international mail. In this multi-stage competition, innovators from the global community across a wide range of fields, including forensic science and artificial intelligence, sought to develop functional prototypes for mail screening with speed and accuracy well beyond current capabilities. From a pool of more than 80 submissions, 8 finalists were selected and participated in a prototyping accelerator, which provided them access to expertise and resources for solution iteration, and then demonstrated technical readiness with live testing at a government facility. The most promising solutions were awarded a grand prize and runner-up prize. In total, finalists and winners were awarded $1.55 million in cash prizes.

DHS is working now with select finalists to develop their prototypes into the next generation of opioid interdiction tools. Beyond the finalist protype technologies, the ODC also highlighted additional promising areas for rapid screening capabilities. Current R&D activities are described below.

[9] https://www.opioiddetectionchallenge.com/

III. Opioid Detection Program: Current Activity

The S&T ODP has several current initiatives to address shortfalls in opioid and other illicit drug detection capabilities. The following tables detail these projects:

Project Title	**Automated Narcotics Alarm Algorithms**
Project Description	This in-house project conducted by the Transportation Security Laboratory (TSL) is supporting, through cooperative R&D agreements with industry partners, the development of algorithms for X-ray computed tomography (CT) imaging systems to recognize and alarm automatically on items potentially containing concealed narcotic contraband.
Project Specifics	This project leverages the processes, relationships, and substantial progress that S&T has made toward the maturation of CT technology for 3-D imaging, as well as the automated detection of explosives for aviation security purposes, and the goal of 100-percent screening of carry-on luggage, checked baggage, and air cargo. This project uses an iterative test and refinement approach where industry partners are provided validated data to develop an initial algorithm that is tested at TSL; data and test results are provided back to the vendors and used to improve the algorithm. This process can be repeated until optimal algorithm performance is achieved. In FY 2020, the Developmental Test and Evaluation branch at TSL completed readiness assistance testing on multiple systems, including the Integrated Defense and Security Solutions (IDSS) DETECT 1000, Analogic ConneCT, Leidos/Reveal CT-80, Smiths CTiX, and the L3 ClearScan. This effort was focused on providing CT vendors with training data of parcels with benign stream-of-commerce items, as well as threat materials consisting of various fentanyl analogues. A technical assessment also has been completed on the IDSS DETECT 1000, which was the Grand Prize winner of the ODC. The TSL team anticipates opioid detection algorithm submissions from additional vendors and plans to conduct additional technical assessments. In FY 2021, S&T is building on these efforts by expanding training data to include additional priority narcotics, like methamphetamine, and additional benign stream-of-commerce items, furthering S&T efforts to develop CT systems and advanced narcotics-specific algorithms to interdict contraband entering at IMFs. When implemented, a single CT system can scan hundreds, to up to 1000, parcels per hour and these on-board algorithms can provide

Project Title	**Automated Narcotics Alarm Algorithms**
	automated threat recognition to assist operators in quickly identifying suspicious items. This project has demonstrated that algorithm advancements can increase drug interdiction; however, the threat posed by drug traffickers is dynamic. The adversary continues to innovate by changing formulations, by developing novel synthetic drug compounds, and by distributing through creative concealments. In order to combat that evolving threat without disrupting the stream of commerce, continued algorithm development for automated, dynamic risk-based threat recognition should be pursued and inclusion of third-party algorithms in any scanning system should be considered.
Implementation Plan	Through the DHS Border Security Technology Consortium Other Transactional Authority, CBP is deploying CT systems for operational pilot programs. For example, the IDSS DETECT 1000 was deployed in FY 2021 to select operational facilities, including the JFK International Mail Facility and the Memphis FedEx Facility. As improvements to narcotic detection algorithms are validated, S&T will work with vendors to include the improved software on commercially available systems, including those potentially deployed CT systems, for immediate assessment and use by CBP.
Obligations	$2,084,000
Project duration	FY 2018 – FY 2022

Project Title	**Automated Alarm Resolution for Mail Screening**
Project Description	S&T is investigating technologies that use distinct chemical and physical properties to distinguish false alarms caused by legitimate commerce from potential contraband in items flagged by primary screening systems without having to open or inspect the item manually.
Project Specifics	Current X-ray screening systems, including 2-D projection X-ray and 3-D CT systems, can locate organic materials (food, toiletries, explosives, etc.) within sealed mail items. However, operational and physical constraints, such as clutter or confounding chemical signatures, may prevent the definitive identification of the contents, which necessitates a manual inspection of the suspicious item. This project is developing technologies that can discriminate narcotic substances from legitimate commerce. The results generated by these technologies are specific to the chemical of interest, resulting in a high probability of detection and ability to resolve false or nuisance alarms. This approach will improve detection performance

Project Title	**Automated Alarm Resolution for Mail Screening**
	significantly, while reducing manpower resources and inspection time required to support the flow of legitimate trade. Technologies being evaluated include Nuclear Quadrupole Resonance and X-ray diffraction (XRD). S&T is funding follow-on development of the One Resonance, Inc. Quadrupole Resonance Detector. This technology, which uses radio-frequency signals to search for specific materials, was the runner-up in the ODC. This system triggers an alarm within seconds when a signal associated with an illicit substance is detected. S&T also is funding follow-on development of another ODC finalist, the Halo X-Ray Technologies, XRD System. This system can detect the presence of concealed opioids and other narcotics based on how the materials diffract X-rays passed through the parcel. For both activities, S&T is expanding the drug targets in the system library, developing algorithms for accurate identification of the concealed materials, and evaluating system performance and potential limitations.
Implementation Plan	It is envisioned that these technologies would be deployed within the next 2-3 years for operational assessment and validation. Though prototype technologies exist, the current state-of-the-art is insufficient to identify narcotics rapidly and automatically in the mail. Once performance is demonstrated under the current project, additional development will be required to configure the system to meet operational demands and to ensure adequate validation in an operational test and demonstration.
Obligations	$3,009,716
Project duration	FY 2020 to FY 2022

Project Title	**Integrated X-ray System for Mail Screening**
Project Description	This project is investigating an integrated CT/XRD system to demonstrate the potential of a layered approach to enhance the probability of detection, to reduce false alarms, and to reduce the need for manual inspection.
Project Specifics	Following the ODC, IDSS and Halo X-ray Technologies partnered to develop and demonstrate a proof-of-concept fused system that could support both DHS counternarcotic and aviation security missions. In this approach, the CT system is used for initial interrogation of a package to locate and target suspicious materials; upon alarm, the package is diverted automatically to the XRD to determine if the material is a drug or explosive threat. The project is focusing on both the mechanical engineering to link the two systems as well the

Project Title	**Integrated X-ray System for Mail Screening**
	software engineering for system-to-system communications and graphical user interface. The fused solution will be evaluated against narcotics and explosives concealed within parcels and luggage.
Implementation Plan	A single prototype system will be developed. S&T will test and evaluate the system at TSL. If performance and development exit criteria are met, S&T will work with DHS Components to test and demonstrate the fused system in an operational environment.
Obligations	$3,131,550.51 [This project is jointly funded by two S&T Programs: the ODP and the Screening at Speed Program.]
Project duration	Project period is FY 2021 to FY 2023.

Project Title	**Illicit Drug Trace Detection**
Project Description	S&T is assessing the feasibility of using trace surface residues and vapors associated with concealed drugs for high-throughput identification of items containing narcotic contraband.
Project Specifics	Currently deployed screening technologies are most effective when detecting large, bulky quantities of concealed materials, which presents challenges in detecting and seizing smaller, potentially more concentrated, concealments. Though dogs can sniff out these concealments effectively, there is a lack of information regarding the chemical signatures of concealed opioids that are detectable by trace methods. In this project, S&T is working with multiple partners with deep expertise in explosives trace detection to identify and quantify measurable opioid signatures to inform operational deployment of existing trace detection technologies for drug detection. The National Institute of Standards and Technology (NIST) analyzed randomly selected packages, as well as drug-containing packages seized by law enforcement, to determine the background contamination on packages and to identify "hot spots" of localized drug residues. Using this information, NIST is optimizing swipe-based sample collection protocols to maximize the amount of sample recovered and is evaluating the efficacy of commercially available systems, such as ion mobility spectrometers. Ion mobility spectrometers presently are not used as a primary screening modality but frequently are employed as a secondary confirmatory method, both in the lab and in the field. The Massachusetts Institute of Technology (MIT) Lincoln Laboratory quantified the trace residue and vapor chemical signatures of various opioid concealments within packages. These studies were critical because they established the requirements for limits of detection of trace detection systems. Based on these results, the MIT Lincoln

Project Title	**Illicit Drug Trace Detection**
	Laboratory developed technology roadmaps to guide development and implementation of the most promising trace detection solutions for screening and interdiction missions. S&T collaborated with the Intelligence Advanced Research Projects Activity, within the Office of the Director of National Intelligence (ODNI), on the final phase of its Standoff ILluminator for Measuring Absorbance and Reflectance Infrared Light Signatures Program, which developed a portable system for real-time standoff detection and identification of trace chemical residues on surfaces using active infrared spectroscopy at a 30-meter range. S&T sponsored the expansion of the on-board library to include frequently encountered illicit drugs and common cutting agents, as well as testing that demonstrated the application of this optical technique for noncontact detection and identification of opioids, cocaine, and methamphetamines, as well as cutting agents, on the surfaces of packages. Lastly, the Pacific Northwest National Laboratory (PNNL) under the U.S. Department of Energy is optimizing vapor sample collection for detection by ultra-sensitive mass spectrometry-based techniques. This approach will be demonstrated in an operationally relevant environment. If successful, this method could be used to analyze large volumes of air, such as air cargo or shipping containers, for the presence of illicit drug materials.
Implementation Plan	This effort made significant advances but did not converge on a single solution because of outstanding questions with the most effective way to implement in operational settings. The knowledge products produced under this project will provide not only a foundation for future technology R&D, but also will guide best practices for sample collection and analysis in the field and laboratory. Outputs from NIST and PNNL are available as peer-reviewed, publicly available literature. The outputs of MIT Lincoln Laboratory and ODNI's Intelligence Advanced Research Projects Activity efforts have been transitioned to the DHS Countering Weapons of Mass Destruction Office for further development. This project has demonstrated the potential utility of trace detection of drug surface residues or vapors. The overall success and applicability of these approaches will require additional maturation of methods and technologies to suit the intended operational environment. Such advancement likely would be 3-5 years from implementation.
Obligations	$1,792,536

Project Title	**Illicit Drug Trace Detection**
Project duration	FY 2019 to FY 2021

Project Title	**Standard Specification for Field Fentanyl Detection Equipment and Assays**
Project Description	S&T sponsored PNNL to lead the development of vetted, consensus ASTM International (formerly known as American Society for Testing and Materials) Standard Specification, Test Method, and User Guide for evaluating field fentanyl detection equipment and assay performance, to ensure that the best equipment is employed by first responders and DHS Component officers.
Project Specifics	PNNL has developed a trio of companion ASTM standards products for repeatable, consistent evaluation of field detection equipment for synthetic opioids, including dilute fentanyl mixtures. These standards were informed and reviewed by a working group of subject matter experts from government and industry and published for comments and voting by the members of the ASTM E54.01 Subcommittee on CBRNE[10] Sensors and Detectors. Collectively, these documents provide to users a comprehensive, repeatable approach to evaluating performance of detection equipment. The Standard Specification describes the types of test samples needed to assess performance of chemical detectors and assays for synthetic opioids, including fentanyl and fentanyl-related compounds. The Test Method provides details about the equipment and protocols required to achieve satisfactory results. Lastly, the User Guide provides information on the optimal use and limitations of assays and instrumentation designed to detect synthetic opioids and opioid analogues. ASTM Standards are the internationally recognized "gold standard" for a wide range of materials, products, systems, and services. As new detection technologies emerge, incorporating the ASTM Standards developed under this project will ensure that end-users can have confidence in the detection performance of their equipment.
Implementation Plan	The standards are expected to be published and publicly available by the third quarter (Q3) of FY 2021.
Obligations	$1,108,328 [This project is jointly funded by the ODP and S&T Office of System Engineering and Standards]
Project duration	FY 2019 to FY 2021

[10] CBRNE – Chemical, Biological, Radiological, Nuclear, and Explosives.

Project Title	**Development of Synthetic Narcotic Library Reference Data**
Project Description	S&T is working in cooperation with PNNL and detection technology vendors to collect library reference data (e.g., spectral libraries) on narcotics of interest to the Homeland Security Enterprise for use by vendors and government partners. The project will assess detection performance against multiple synthetic opioids, in pure form and in dilute mixtures, and will enhance detection capabilities.
Project Specifics	DHS Components and first responders use a wide range of commercial-off-the-shelf chemical detection technologies for field analysis of substances that may contain one or more drugs. Despite their widespread use, little independent testing information is available to characterize their performance for screening unknown substances, especially "real-world" samples. These types of complex samples, such as low-purity drug mixtures, may affect equipment performance during field screening, resulting in a false positive or negative result, or no result at all. Furthermore, many new and emerging synthetic narcotics are not in spectral reference libraries for commonly used field detection equipment. To address these shortfalls, vendors will work with the government to obtain reference spectra for a variety of Drug Enforcement Agency-controlled substances to expand their instruments' spectral libraries, and in return, provide system updates with the expanded libraries to end-users at no cost. Subsequently, S&T will follow the ASTM "Standard Specification for Field Detection Equipment and Assays Used for Fentanyl and Fentanyl-Related Compounds" to assess the performance of those instruments against complex sample mixtures, which will provide to the interdiction community a broad understanding of the capabilities and limitations of current field detection products. This work supports efforts to address recommendations and requirements outlined by the Office of Inspector General (OIG)[11] and Congress.[12]
Implementation Plan	Once the data collection effort is complete, S&T will collaborate with its industry partners to distribute the library improvements to deployed devices within 180 days. The performance assessment report will be made publicly available at the conclusion of the project in FY 2023.
Obligations	$3,839,302
Project duration	FY 2020 to FY 2023

[11] OIG. February 2019. "Limitations of CBP OFO's Screening Device Used to Identify Fentanyl and Other Narcotics." OIG-19-67.
[12] 116th Congress. DHS Opioid Detection Resilience Act of 2019. P.L. 116-254.

IV. Other Current Activities

The CBP Innovation Team is supporting the development of a millimeter wave technology that can detect certain types of metal objects such as blister packs, Mylar bags, and weapons hidden within shipments at IMFs. This technology is particularly suited to certain mail types that challenge current detection methods and could enable rapid pre-screening for shipments potentially containing illicit materials. S&T is supporting CBP in this project by conducting a unique data collection in Q3 FY 2021 at the TSL to provide training data to the developer and a test event to assess system performance in FY 2022. If successful, this technology would provide additional capability to CBP for a multifaceted approach in interdicting illicit materials entering the country.

The S&T Vehicle Inspection Early Warning (VIEW) Project is developing a technology that enables detection of concealed objects under vehicles. In this effort, S&T is partnering with CBP and the Federal Protective Service to design, develop, and test under-vehicle inspection systems that are easily deployed at vulnerable locations to provide early warning of contraband smuggling (e.g., drugs, weapons, explosives, money, human trafficking). The VIEW system is designed to be low-cost, automated, fast, and resilient with both permanent and mobile configurations. The VIEW system will offer the following advantages:

1) 1/6th the cost of current technology;
2) Reads a bar code from a spinning axle or drive shaft four times faster (20 miles per hour) than current technology;
3) 8-10K resolution visualization;
4) 3-D visualization and fly-through of undercarriage to enable viewing of dark scenes and behind certain features, such as a muffler or wheels; and
5) Mobile and fixed-form factors.

This $3.75 million project will transition to CBP in FY 2022, with plans to integrate into operations at the border already underway. Additional information on the VIEW system can be found here: https://www.dhs.gov/medialibrary/assets/videos/19082.

The S&T Center of Excellence (COE) for Awareness and Localization of Explosives-Related Threats (ALERT) supports academic and industry development of next-generation systems to address technology gaps for Homeland Security applications. The ALERT COE recently expanded its scope to conduct research to support CBP. In particular, the ALERT COE has created a workshop series to identify topics of interest that could be solved by academia and other third parties. ALERT COE's understanding of the detection of explosives is directly applicable to the detection of many of the prohibited items that CBP needs to detect. Leveraging its base systems, methods, and algorithms for explosive detection, the ALERT COE recently completed the Novel Features and Emerging Technologies for Opioid Detection Project, which identified new signatures that could be used to detect opioids within packages at IMFs and express consignment carrier facilities; developed sensor technologies that could use the new signatures to detect opioids; and predicted the operational performance and general feasibility of the new technologies. The ALERT COE will build upon the outcomes of that effort in the Novel

Technologies and Processes to Support Interdiction of Illicit Materials Project, improving performance and lowering the costs of detection and development. The project also aims to improve process development and includes a broad range of research personnel to improve visibility on the drug detection problem. Upon completion of the project, the ALERT COE will deliver a set of methods to assess technologies through subsequent demonstrations, evaluations, and modeling of systems deployed at ports of entry to S&T for distribution to the Homeland Security Enterprise at the conclusion of the project in FY 2022.

V. Discussion

The S&T ODP has focused largely on technologies to address interdiction challenges in the international mail vector. While international mail remains a conduit for smuggling of illicit drugs and precursors, current trends indicate a shift from traditional shipping methods to the southern border. Many of the technologies evaluated under the S&T ODP could be applied to additional missions and environments. The body of knowledge and technologies developed to date should be leveraged for these vectors, though some additional evaluation may be required to ensure that specific operational requirements are met. Further, there are other existing S&T programs focused on the scanning of cargo, vehicles, and on-person or personal property (e.g., Air Cargo Security, Screening at Speed) for explosives, weapons, and other contraband that could be expanded to include narcotics to increase DHS screening and interdiction efforts.

S&T is funding the development of open architecture prototypes that allow third-party vendors to develop and implement new security capabilities for deployed screening technologies. S&T recognizes the mission need for flexible and dynamic risk-based threat detection capabilities that can adapt screening to the constantly evolving threat space. Underpinning this challenge is the fact that current systems are highly complex and proprietary, with little data, image, or interface standardization. This can slow S&T's response to emerging needs by limiting the broad application of solutions. In order to address this limitation, open architectures and third-party software are critical to implementing dynamic threat detection. The ability to develop third-party applications (hardware or software) could drive innovation by supplying a market incentive and by increasing competition. Leveraging this ongoing work, which is focused primarily on detection of explosives and other contraband, would provide opportunities for rapid and significant advancements in technologies for the detection and interdiction of illicit drugs.

A critical element of CBP's screening and interdiction strategy consists of narcotics detection canine teams. The S&T Detection Canine Program maintains a robust and dynamic research portfolio, pertaining largely to explosives detection, for DHS Components, including the Transportation Security Administration, the Federal Emergency Management Agency, and CBP. However, the S&T Detection Canine Program has not received any Component requirements regarding the detection of synthetic opioids, or other substances of abuse, and therefore is not conducting R&D actively in this area. Instead, the CBP Laboratories and Scientific Services Directorate produces canine training aids and provides analytical support to the CBP Canine Training Program, including controlled substance purity determinations, training aid quality analyses, and research on delivery mechanisms that maximize safe vapor delivery during training exercises.[13] A recent OIG audit highlighted a lack of research characterizing the effectiveness of narcotics training aids based on age to inform how often training aids should be replaced,[14] which CBP plans to address in FY 2021.

[13] Harvey, Melanie. 2017. "From the Border to Disasters and Beyond: Critical Canine Contributions to the DHS Mission." [Accessible at: From the Border to Disasters and Beyond: Critical Canine Contributions to the DHS Mission | Transportation Security Administration (tsa.gov)]

[14] OIG. February 2021. "CBP Needs to Improve the Oversight of its Canine Program to Train and Reinforce Canine Performance (REDACTED). OIG-21-19.

VI. Conclusion

Under the S&T ODP, multiple rapid screening approaches have been demonstrated for drug interdiction, specifically in the international mail environment. Though largely focused on synthetic opioids, like fentanyl, all approaches evaluated may be applied to methamphetamines, cocaine, other Schedule 1 drugs, and other chemicals of concern. The goal is a layered system-of-systems to offset inherent limitations of technological approaches. For example, a single approach may enable high-speed screening, but may lack any resolution or identification of the threat, necessitating a manual inspection of the contents. A single approach may be able to provide an identification but may do so too slowly to be considered as a primary screening approach. A layered approach enables both high-throughput screening with increased positive detection and reduced nuisance detections. The ODP will provide recommendations for technology combinations for further development, testing, and future deployment. Once implemented, these technologies will assist in the Department's overall drug interdiction mission.

Because of changes in DHS Component priorities and the progress made to-date mentioned above, the S&T ODP will begin to sunset R&D of technology for illicit drug screening and detection in FY 2021. S&T has transitioned solutions to CBP, which is already fielding the solutions identified and developed under this program, including the winning ODC solution, IDSS DETECT 1000. Other promising solutions are being transitioned to ongoing R&D efforts for advanced development. Minor adaptations (e.g., refinement of an algorithm) and adequate testing may be required to confirm that the technology meets desired performance requirements for detection of concealed illicit drugs. This approach will provide a more agile and consistent mechanism for S&T to ensure that cutting-edge rapid-scanning technologies are at the forefront of the Department's screening methods for drug interdiction.

Efforts to improve the evaluation of handheld technologies prior to investment, as well as the development of narcotic libraries and the assessment of current technologies, have the potential to increase the effectiveness of current technologies as well as to spur innovation in the industry. The development of ASTM Standards for opioid detection provides the first standardized guidance for evaluating handheld detectors, driving cost-effective, informed procurement, since federal, state, and local entities will have reliable ways of evaluating technologies prior to purchase. By partnering with industry to expand and provide access to their chemical detection libraries, S&T is increasing vastly the efficacy of these detection technologies. At the same time, the comprehensive testing, including samples at less than 10 percent opioid purity, of all participating technologies will enable direct comparison of detection performance, which may promote competition further and may spur innovation within the industry to develop the most effective detection solutions.

As detection-focused work transitions, S&T's Opioid Program will pivot to fulfill U.S. Immigration and Customs Enforcement (ICE) Homeland Security Investigations (HSI) priority needs for improved intelligence and investigative capabilities to counter illicit drug trafficking. In particular, S&T will support ICE HSI in developing specialized training for ICE agents and their law enforcement partners. S&T also will develop advanced analytical tools, including data

management platforms for collection and sharing of information, big data applications for fusion of disparate investigative data, and machine learning for automated discovery of high-value targets, to assist agents in investigations and support prosecution. The overall goal of these efforts is to provide ICE with the knowledge and tools to identify patterns, participants, and methods used by drug trafficking networks in order to disrupt and dismantle drug trafficking organizations to stem the flow of illicit drugs into the United States. This project complements the Department's physical screening approaches for illicit materials by generating key information to improve pre-screening and targeting of high-risk smuggling attempts for more effective and efficient interdiction efforts.

VII. Appendix: List of Abbreviations

Abbreviations	Definition
ALERT	Awareness and Localization of Explosives-Related Threats
ASTM	(Formerly) American Society for Testing and Materials
CBP	U.S. Customs and Border Protection
CBRNE	Chemical, Biological, Radiological, Nuclear, and Explosives
CDC	Centers for Disease Control and Prevention
COE	Center of Excellence
COVID-19	Coronavirus Disease 2019
CT	Computed Tomography
DHS	Department of Homeland Security
FDA	Food and Drug Administration
FY	Fiscal Year
HSI	Homeland Security Investigations
ICE	U.S, Immigration and Customs Enforcement
IDSS	Integrated Defense and Security Solutions
IMF	International Mail Facility
INTERDICT Act	International Narcotics Trafficking Emergency Response by Detecting Incoming Contraband with Technology Act
MIT	Massachusetts Institute of Technology
NCHS	National Center for Health Statistics
NIST	National Institute of Standards and Technology
ODC	Opioid Detection Challenge
ODNI	Office of the Director of National Intelligence
ODP	Opioid Detection Program
OFO	Office of Field Operations
OIG	Office of Inspector General
PNNL	Pacific Northwest National Laboratory
Q3	Third Quarter
R&D	Research and Development
S&T	Science and Technology Directorate
STOP Act	Synthetics Trafficking and Overdose Prevention Act of 2018
TSL	Transportation Security Laboratory
VIEW	Vehicle Inspection Early Warning

Abbreviations	Definition
XRD	X-Ray Diffraction