U.S. BORDER PATROL

USBP Autonomous Surveillance Strategy

June 2022

U.S. Customs and Border Protection

MESSAGE FROM THE DEPUTY CHIEF

As we approach the 100th anniversary of the U.S. Border Patrol, I am reminded of the hard work and dedication the agents and professional staff of this agency have shown day after day while safeguarding our Nation's borders. From the early days of Patrol Inspectors on horses to today's intelligence-driven operations, we have always leveraged every advantage we could bring to bear to gain an operational edge. From the introduction of two-way radios to the deployment of mobile surveillance capabilities, these tools have enhanced the safety of our personnel and continued to make our communities safer for all Americans.

Goal 1 of the *2022-2026 USBP Strategy* is to gain operational advantage by building an operational capability that meets or exceeds those of criminal networks. Now more than ever, it is critical that we embrace a modernization approach to technology that upgrades our legacy systems and puts us in a position of advantage to leverage future innovations. To meet the technology needs of Goal 1, I am proud to introduce the new *USBP Autonomous Surveillance Strategy*. This strategy is a high-level guide for how the USBP enhances, identifies, and acquires next-generation technologies to integrate into USBP enterprise systems in an ethical and transparent manner.

The *USBP Autonomous Surveillance Strategy* introduces three essential pillars of technology modernization: Pillar 1 – Enhance existing USBP surveillance systems to add autonomous functionality, Pillar 2 – Ensure autonomy is a key design element of future systems, and Pillar 3 – Create a process to monitor and integrate advances in commercial autonomous technology. Together, these three pillars give us a starting point to plan the roadmap of how to increase system performance and efficiency as we look to deploy future systems to enhance border security operations.

Ultimately, the agents and professional staff of the U.S. Border Patrol are the most important factor in performing the mission. It is my belief that moving the organization toward more autonomous systems will provide you with the tactical intelligence you need to achieve success.

As your Deputy Chief, I have never been prouder of the tenacity and resolve you show in the achievement of our mission.

Honor First!

Matthew Hudak
Deputy Chief
U.S. Border Patrol

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Executive Summary

Advances in artificial intelligence (AI) and complementary technologies such as edge and cloud computing enable automation of complex tasks with high precision. For the U.S. Border Patrol (USBP), the primary purpose of employing autonomous technology is to increase border surveillance coverage without reducing agent availability to respond to and resolve illegal activity. Therefore, USBP is following recent investments and research and development (R&D) activities to enhance its surveillance mission by increasing automation and opportunities to return personnel to the field.

U.S. venture capital investments eclipsed $329 billion in 2021, with private investment rapidly driving AI technology further and faster than traditional government R&D activities. USBP is well positioned to leverage this investment by taking an active approach to enhance its autonomy today while collaborating on future investments in technological advances with the U.S. Customs and Border Protection Innovation Team (CBP INVNT) and DHS Science and Technology (S&T). In addition, this investment will further align USBP with Executive Order 13960, Promoting the Use of Trustworthy Artificial Intelligence in the Federal Government. USBP views future investments in autonomous technology across four time horizons, as depicted in figure 1.1.

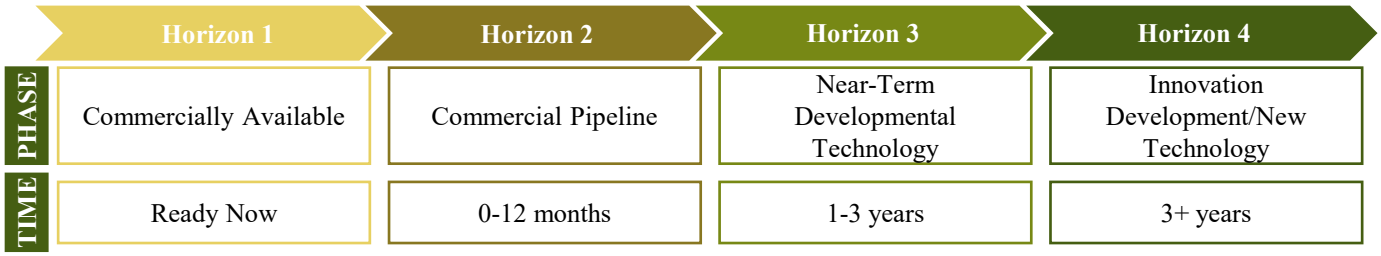


Figure 1.1. Innovation Horizons

During the first two time horizons, USBP Headquarters Directorates and CBP INVNT will enhance their existing capabilities with elements of autonomy and AI and, funding permitting, deploy additional proven autonomous capabilities such as automated surveillance towers (AST) and computer vision. For Horizons 3 and 4, USBP will continue collaborating with CBP INVNT, DHS S&T, and other partners to identify, adapt, and deliver autonomous solutions at the leading edge of technology. In Horizon 4, USBP will leverage its relationship with DHS S&T and other R&D institutions to track the trajectory of technology to inform future strategic investments.

Finally, Horizon 3 and 4 technology tracking provides USBP knowledge of advanced capabilities before they become commercially available products. This knowledge can further USBP's mission by affording operational decision-makers the information needed to plan against threats by using the same technologies to facilitate criminal activities—for example, planning to mitigate smuggling using autonomous vehicles.

Autonomous Definition & Application

Information technology company Infosys characterizes automation as "using technology to monitor, control and/or operate any process or function with accuracy and efficiency without human intervention. Autonomous technology is about enriching automated systems with sensors, Artificial Intelligence and analytical capabilities so that they could make independent decisions based on the data they collect."[1]

For vehicles, autonomy is viewed through a series of levels, as shown in Figure 1.2. These stages indicate the level of autonomous performance one could expect from a given manufacturer or vehicle. USBP would benefit from taking a similar approach by defining the stages of automation for a desired application related to border security surveillance. It is best that USBP strives for a multilevel autonomous approach, with the final goal to allow AI and machine learning applications to identify and initiate actions but never deny lawful trade and travel.

As an example, an agent performing traditional line-watch duties who has access to autonomous systems could move between the autonomy levels for operation, with the goal being to stay at Level 3 or 4. Ideally, the system would make the initial detection and identification while continuing to track the item of interest (IOI). The system would then alert the agent or operator, who is required to determine the need for a law-enforcement response. This process preserves an ethical approach to enforcement AI and automation.

For full autonomy, USBP may leverage Level 5 autonomous solutions for non-enforcement activities. For example, if a suite of autonomous solutions with AI capabilities is incorporated into USBP database and fusion processes (Level 4 status), operators would need only to periodically monitor the system for accountability and compliance.

Figure 1.2. Autonomy Levels

Source: Santosh Rao, "How to Build a Data Pipeline for Autonomous Driving," NetApp (blog), June 27, 2019, https://www.netapp.com/blog/how-to-build-a-data-pipeline-for-autonomous-driving/.

[1]Dr. G. V. V. Ravikumar, "Autonomous Technologies to Power Tomorrow's Enterprises," Infosys Limited (n.d.), https://www.infosys.com/insights/ai-automation/autonomous-technologies.html.

Classes of Autonomous Assets

To refine the definition of autonomy for the purposes of national security, USBP has identified three classes of autonomy specific to surveillance: tactical, persistent, and enterprise (TPE).

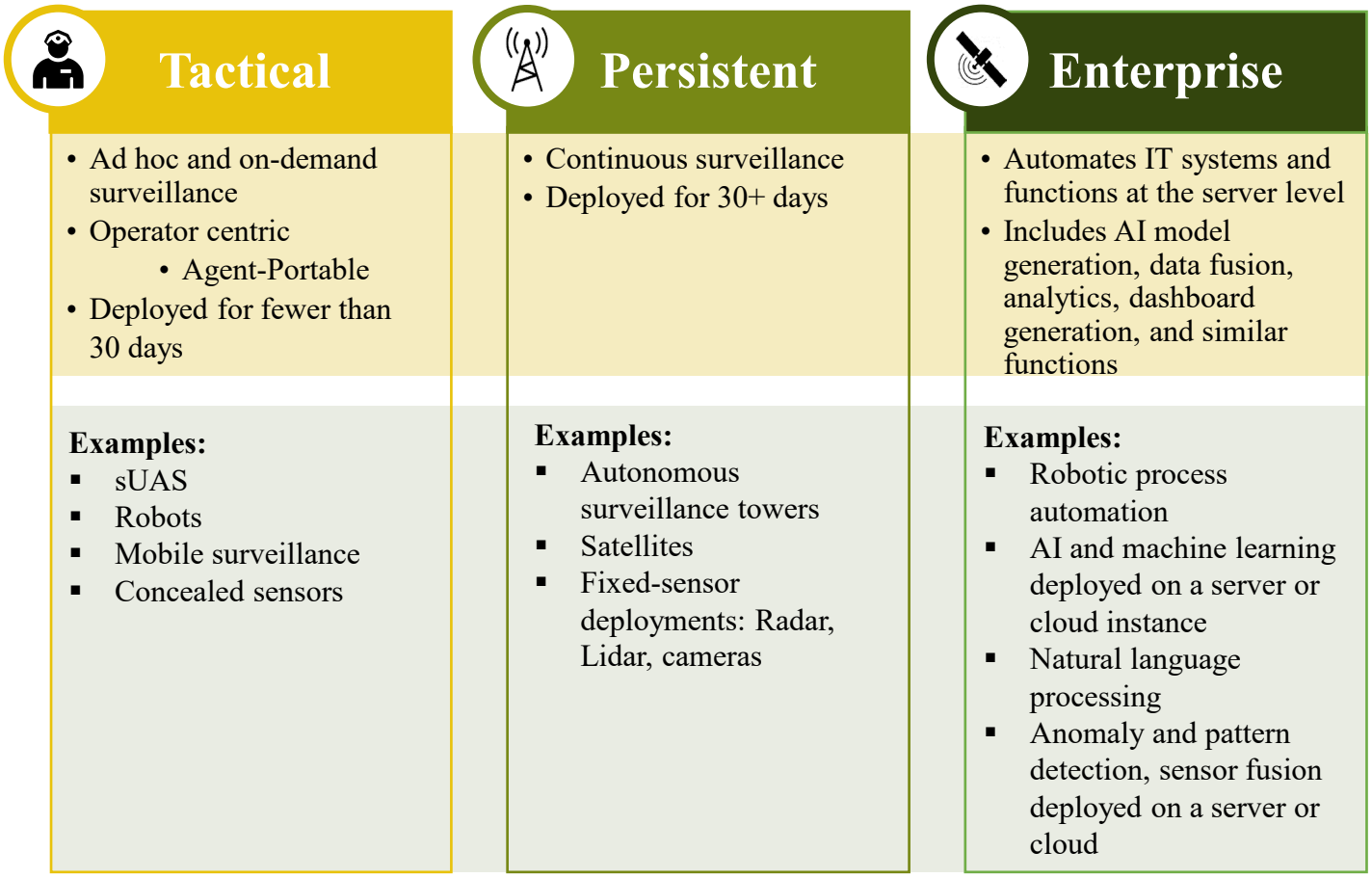


Figure 1.3. Autonomy Classes

Although individual capabilities may have functions that would justify their inclusion in more than one category, it is essential to categorize technologies under one defined class. This enables USBP to architect a better plan and account for the appropriate information technology approach to deployment.

USBP Vision for Autonomous Surveillance

PROBLEM STATEMENT

USBP is at a critical juncture between enhancing its surveillance technologies deployed strategically throughout the U.S. and identifying more autonomous solutions. First, USBP must implement a comprehensive autonomous surveillance approach that positions the organization to capitalize on the rapidly advancing technology landscape for future deployments. Currently deployed surveillance technology solutions rely on USBP personnel to observe and relay operational information received from those technologies. Additional non-autonomous technology investments would increase the number of operators required to monitor them 24/7/365. New autonomous solutions and autonomous enhancements to existing systems are therefore preferable and are expected to reduce the number of personnel required to monitor surveillance systems.

AUTONOMOUS VISION

USBP envisions an autonomous backbone for all future surveillance investments. Enhancements to current surveillance systems will incorporate autonomy and future deployments will require autonomy as a key performance parameter. Autonomous systems can consistently execute redundant tasks such as persistent surveillance, enabling many agent operators to return to the field. These autonomous solutions increase situational awareness and achieve greater consistency in performance across systems and operational domains. To realize this increased level of autonomy throughout all surveillance and intelligence systems, USBP must leverage advances in AI, machine learning, and commercial sensors designed for an ever-evolving, autonomous world.

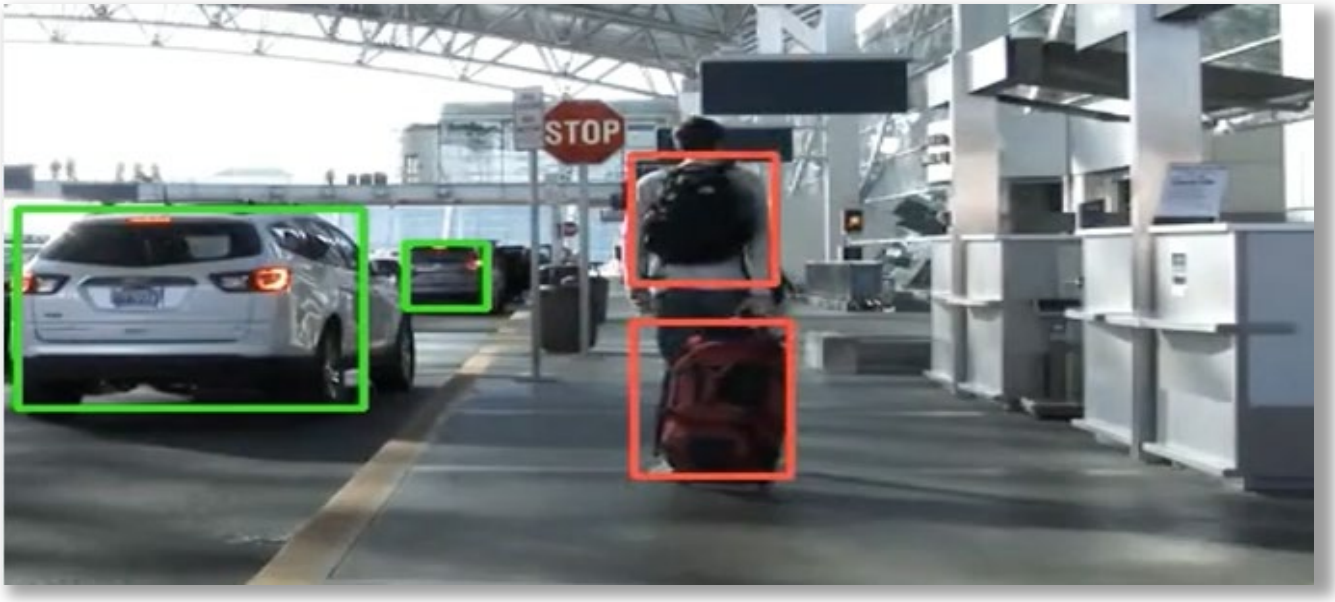


***Figure 1.4. USBP Pilot Technology**, providing computer vision capabilities to automatically detect objects of interest in video*

USBP Autonomous Surveillance Strategy Pillars

Figure 1.5. Blue Unmanned Aerial System (UAS) 1.0

PILLAR 1: Enhance existing USBP surveillance systems to add autonomous functionality

Upgrade surveillance systems by incorporating autonomous controls for detection, identification, and tracking to increase efficiency and reduce operator dependence.

PILLAR 2: Ensure autonomy is a key design element of future systems

Incorporate AI, machine learning, and other descriptions of automation as key performance parameters.

PILLAR 3: Create a process to monitor and integrate advances in commercial autonomous technology

Continue to monitor and plan for the inclusion of technologies on the innovation horizon. Consider USBP needs and requirements early in determining technological feasibility while concurrently identifying how future technologies can be used by nefarious actors.

Pillar 1: Enhance Existing USBP Surveillance Systems to Add Autonomous Functionality

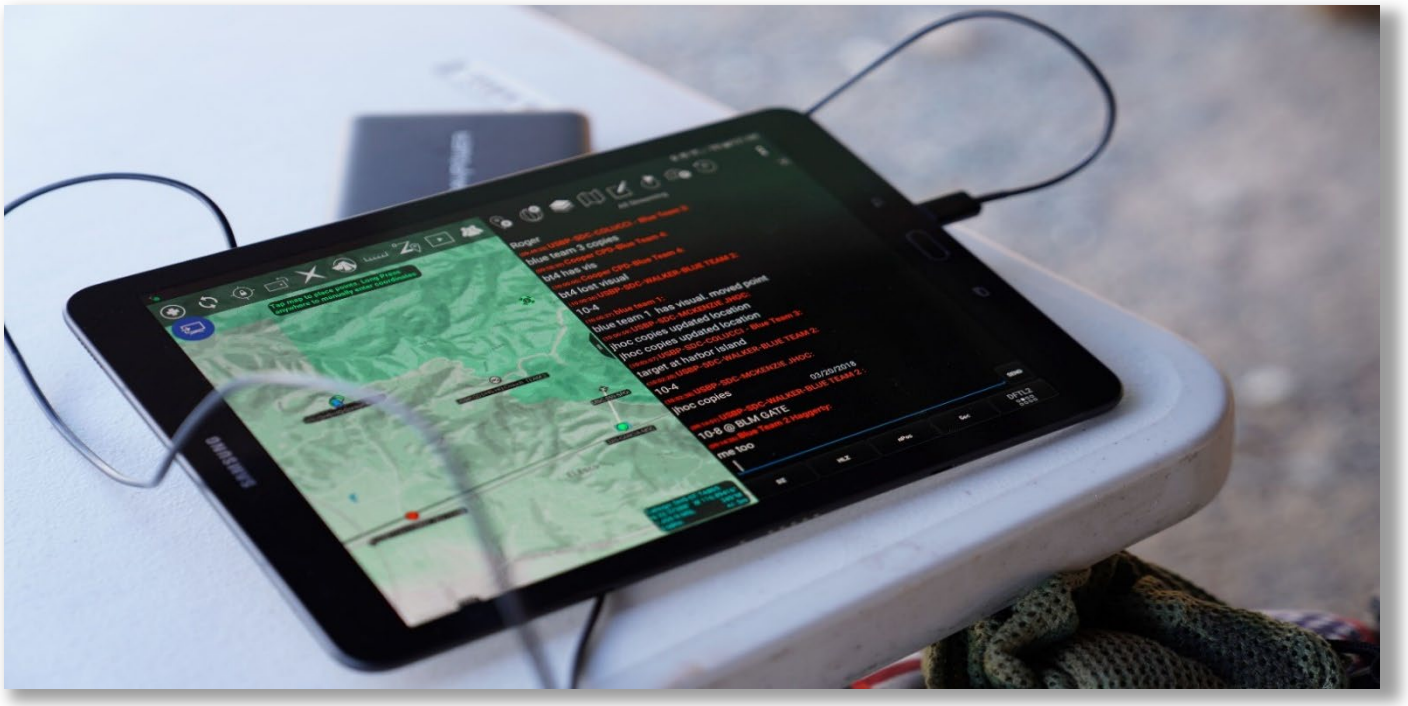


Figure 1.6. Demo of Surveillance Technology at San Diego Sector

While legacy USBP surveillance platforms such as integrated fixed towers provide extensive domain awareness capabilities, these deployments often rely on decentralized data processing and require numerous personnel to support operations. Agent task saturation in Tactical Operations Centers (TOC) is mitigated through increased staffing, resulting in a reduction of agents available for field operations.

Deploying additional autonomous-capable surveillance technologies is critical to USBP operations as a way of returning agent sensor operators back to line-watch operations, ultimately reducing the need for users to monitor sensor platforms. The optimal path forward provides secure system access for users through any CBP computer, laptop, tablet, or interface in a standard web browser. Agents in the field would receive information on identified items of interest through an associated mobile application.

The benefit of this technology is distributed information that allows USBP to crowdsource surveillance monitoring across an entire patrol group regardless of location. When activity requires dedicated monitoring, any personnel in a traditional radio room or from a TOC can enter data into the Tracking, Sign-Cutting, and Modeling platform. For instance, when an IOI is identified, it is beneficial to transfer operational control to station command for monitoring and tactical response, which will allow the agents in the field to focus on their safety and response and the TOC personnel to address resource allocation needs while updating all personnel.

Pillar 1 (cont.)

Autonomy will enable USBP to maintain its levels of surveillance operations during times of high attrition and serve as a force multiplier for stations needing to assign agents to line-watch operations. While standard line-watch operations rely on teachings and lessons passed down through generations of agents, USBP cannot expect to mature surveillance capabilities without leveraging the R&D funding of industry. USBP should leverage computer processing advances in graphics processors, communications, commercial sensors for autonomous vehicles, AI, and analytics collection. These advances have made autonomy a viable solution for current border security problems and will increase efficiency in domain awareness.

To leverage these advancements, USBP requires short- and long-term deployment strategies to ensure it is preparing today's systems for tomorrow's enhancements. USBP has learned similar lessons throughout its history of information and surveillance technology deployments. These lessons learned and our preparation for the future will keep USBP in line with all DHS and CBP IT modernization plans.

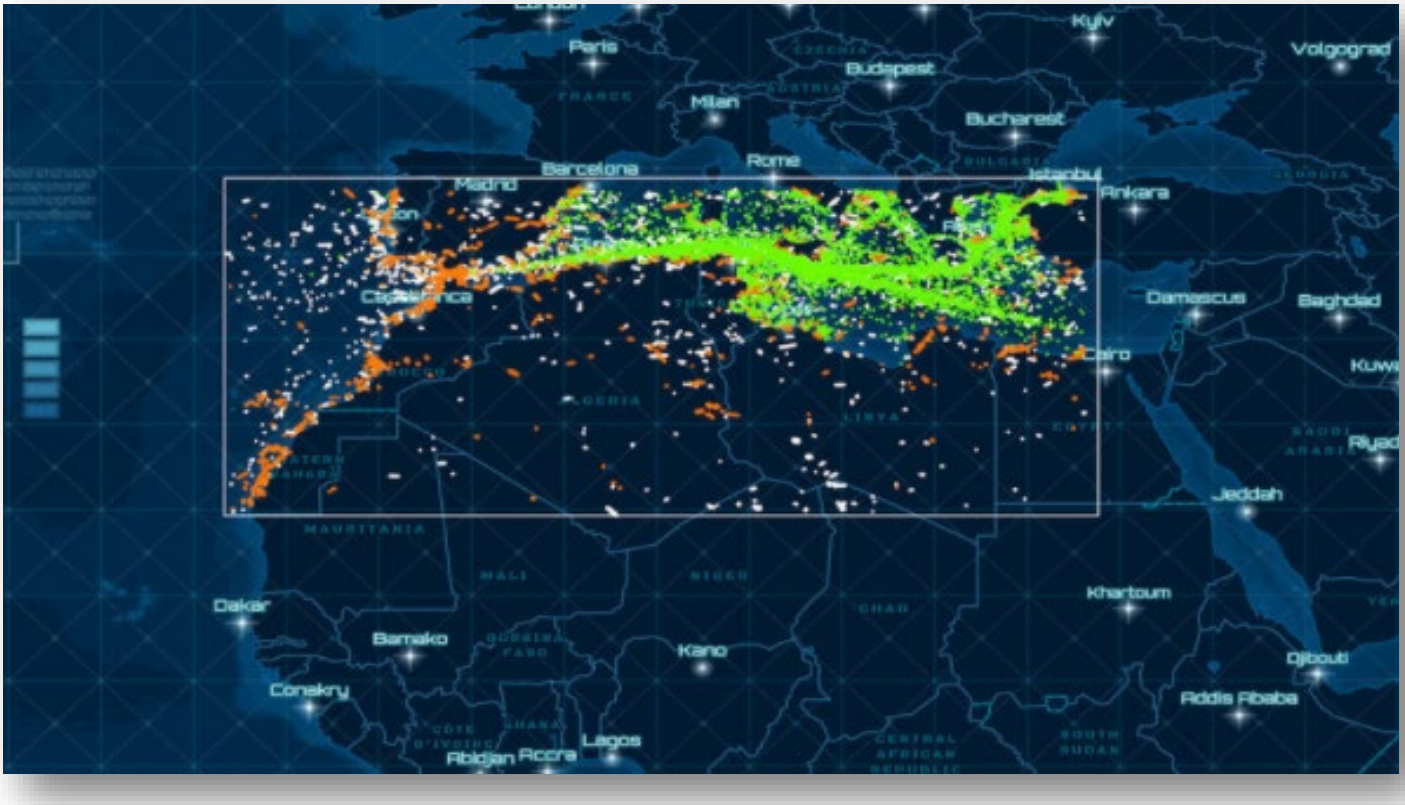


Figure 1.7. USBP Pilot Technology*, Surveillance as a Service (SaaS) technology for wide area surveillance using imagery, radio frequency, telemetry, and other data sources fused into a single intelligence platform*

Pillar 2: Ensure Autonomy Is a Key Design Element of Future Systems

As described in Pillar 1, USBP must enhance surveillance systems with autonomy to reduce the need for users to monitor sensor platforms, sending agents back to the field to perform their crucial law enforcement mission. Development efforts directed at the future of domain awareness capabilities must include autonomy and other enabling functions like AI, edge computing, data connectivity, and computer vision. To accomplish this, USBP must engage with industry and other key stakeholders to ensure that its mission needs are clearly understood and included in vendor development pipelines.

Additionally, USBP must examine requirements documentation at regular intervals to ensure the inclusion of newly identified mission needs meets the desired level of autonomy to support mission operations. When appropriate, autonomy should be added as a key performance parameter in USBP requirements and the testing and evaluation of new capabilities to make sure the established autonomy standard is met. Ultimately, USBP's acquisition and procurement artifacts and strategies must be "future proofed" to include the latest industry standards or risk falling behind both the technology curve and adversaries in the field.

Figure 1.8. U.S. Border Patrol Agent and K-9 partner conducting tracking operations.

Pillar 3: Create a Process to Monitor and Integrate Advances in Commercial Autonomous Technology

As part of its autonomous surveillance strategy, USBP must leverage the commercial advancements and venture capital funding being poured into autonomy across the technological spectrum. It is vital that USBP plans for technology needs on today's horizon as well as on the horizon five years from now. This type of work comes with a level of inherent risk when dealing with startup companies, and those risks must be considered throughout the process. Risks may include technology failure, individual business failure, and business acquisition. USBP must endeavor to forecast the direction of technology, and the individual businesses, by remaining well informed on the latest trends and advancements and continually updating the information in its comprehensive plan.

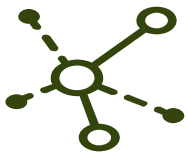
Rather than restricting its technology scouting and procurement to available plug-and-play options, USBP should become a trusted partner to commercial industry by committing time and resources that enable private sector partners, especially startups, to further develop and refine their technologies into mission-enabling capabilities. USBP could also play a vital part in shaping the direction that commercial industry innovates for surveillance by committing to open data standards, publishing those data standards, and informing others of its strategy.

Most of these capabilities are ready to support mission needs today. For those capabilities that are years out, USBP has time to determine a best fit for its mission and to account for how criminal actors will use them for illegal operations. By maintaining awareness of commercial advancements and sharing data to shape future innovative technologies, USBP can prepare for emerging threats and remain at the edge of mission-enabling autonomous surveillance capabilities.

Enabling Concepts

Autonomy is not a single system or a solution unto itself. Rather, AI-enabled autonomy is an attribute of a system and a segment of an overall operating concept. Consider AI-enabled autonomy as both a design element of a system and the means by which various systems interact to achieve results that, in aggregate, are more powerful than the individual systems themselves. The subsections that follow discuss critical enablers and capabilities required to maximize the efficacy of autonomous systems:

Data and Data Annotation



AI models powering autonomous operations must be fueled with data, much of which needs to be annotated, categorized, or classified in a specific way. USBP requires a repository of annotated data to generate AI models and validate system performance. This must be an ongoing effort to enhance the confidence models over time. Critically, USBP and CBP do not possess the ability to annotate data at scale. Therefore, they must leverage private sector data annotation services in the near term.

Edge Computing

Edge devices are capable of processing data and running advanced AI algorithms in real time and at low power consumption. The advantage of edge computing is that it reduces the volume of data that needs to be sent to enterprise servers while decreasing latency. Therefore, edge computing offers the ability to leverage a greater array of communication methods at lower data rates. Essentially, edge computing provides USBP an opportunity to create smart sensors that reduce the nuisance detections sent to operators. It also offers relevant IOI information for further anomaly detection while reducing bandwidth and data storage requirements.

Data Type and Format

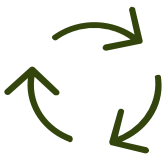
For machine-to-machine (M2M) messages to speak the same language, a data standard must govern the protocols inherent to all systems. M2M interoperability enables inter-autonomy among systems. Like data connectivity, data standards must be identified as an initial design element, should not be proprietary, and should be publishable to allow a variety of vendors to operate in the USBP autonomous ecosystem.

Enabling Concepts (cont.)

Data Connectivity and Communications

In almost all cases, nodes of systems must communicate with one another to cue machines in the network to act. For example, Tower A autonomously passes IOI information to Tower B. Similarly, systems must share connectivity to spur intersystem collaboration. For example, System A autonomously cues Tower A to launch a small unmanned aerial system (sUAS). M2M messages are generally lightweight and consume little bandwidth, similar to edge computing devices, and offer an array of data communication options. As a key design element, systems possess the ability to physically send and receive data and M2M messages using defined communication architecture and protocols.

Autonomous Power Generation



Field technologies should self-generate power to the maximum extent possible as an initial design element, particularly in the southern latitudes where temperature changes and ample solar hours offer a variety of means to generate power without the use of shore power and fossil fuels. Self-generating power options afford a broad spectrum of benefits, including substantially increased deployment flexibility, reduced agent refuel workload, reduced environmental impacts, and improved relationships with landowners.

INCORPORATING INNOVATION HORIZONS IN FUTURE STRATEGIES

Monitoring future innovation horizons, outlined in Figure 1.9, is a fundamental portion of an autonomous strategy. Developing a comprehensive autonomous surveillance strategy comes with inherent risks. Some risks can be mitigated by actively monitoring and engaging with the commercial innovation marketplace and by planning technology deployments around future innovation horizons to ensure USBP is prepared throughout the process.

USBP's Innovation Horizons Framework looks at commercial industry to monitor innovation timelines to determine where new technological capabilities fall within the spectrum. Building an early capability architecture that tracks new technologies and their commercial availability and monitors it through development lends valuable insight into planning and deployment. Specifically, this insight would give USBP enough information to create mission-elastic plans. Enhanced mission elasticity means USBP's autonomous surveillance strategy planning could expand and contract based on the current state of innovation in the commercial marketplace. This elasticity in the planning process can be leveraged for integration as well as procurement and deployment.

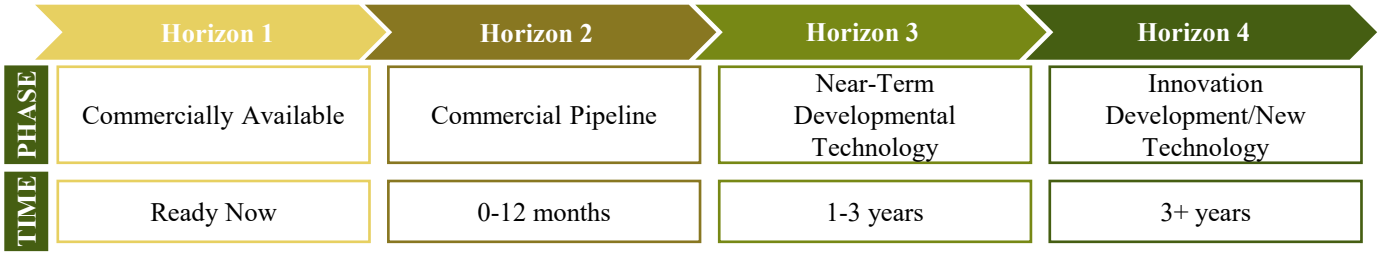


Figure 1.9. Innovation Horizons

To identify appropriate autonomous technologies and plan against their associated time horizons, USBP must continue engaging with CBP and DHS S&T to account for technologies on the near-term and out-year horizons. Working with these innovation partners ensures USBP is creating interoperable systems for future CBP and DHS integration needs.

Conclusion

Implementation of a USBP autonomous surveillance strategy is integral to the increased domain awareness for border security. Inclusion of autonomy can assist in all facets of the USBP enterprise by reducing redundancy, returning personnel to operational roles, and enhancing overall data integrity.

To ensure the strategy guides USBP in the right direction, a comprehensive plan must be developed in partnership with all USBP technology stakeholders. By concurrently moving toward expanding its commercially available surveillance footprint and enhancing its surveillance technology with autonomous functionality, USBP can create a basis for integrating future technological advancements into the USBP portfolio. Continuing along those two paths allows USBP to begin a wide-ranging plan to incorporate TPE autonomy solutions into the enterprise for enhancing surveillance in areas where traditional tower and vehicular platforms are insufficient.

Data integrity, data standards, networking, communications, law enforcement operations, and intelligence are merely a few topics to consider in creating a plan sufficient for addressing USBP's autonomy needs. Creating a comprehensive plan ensures USBP is building with the future in mind, not with a specific deployment date as the goalpost. The plan and associated requirements should afford flexibility to incorporate phasing out end-of-lifecycle technologies and moving away from periodic upgrades for marginal gains. Making the hard decisions early in the process permits better planning and adjustments on the fly.

An autonomous plan requires involvement from all stakeholders in the surveillance ecosystem from across USBP, CBP, and DHS. Engaging these stakeholders should happen as soon as feasible. Through interagency coordination, USBP can identify, adapt, and test appropriate technologies to confirm they integrate with their respective USBP programs before planning procurements.

Finally, through commercially available solutions, USBP can focus on providing 80 percent solutions to all USBP users and personnel. In doing so, USBP will have accomplished a mission that has been a constantly moving target. Deploying commercially available technology reduces cost when those same technologies must also compete in the commercial marketplace. Commercially available technology is beholden to market pressure to continually drive down price or enhance capabilities through iterative development. Furthermore, USBP can be the beneficiary of that cost reduction by finding ways to adapt alternative commercial technologies to meet specific needs and then integrate them into the greater plan.

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