# Commercial Customs Operations Advisory Committee (COAC) Secure Trade Lanes Subcommittee

## Remote & Autonomous Cargo Processing Working Group White Paper

June 7, 2021

COAC

COMMERCIAL CUSTOMS OPERATIONS ADVISORY COMMITTEE

## INTRODUCTION

The transportation industry is on the verge of a transformation related to automated vehicles and navigation technologies. Deliveries by drones[1] and driverless vehicles[2] are already being tested and operating within domestic borders in cities around the world.

Autonomous driving normally refers to self-driving vehicles or transport systems that move without the intervention of a human driver. In 2014, SAE International (Society of Automotive Engineers) published the J3016 standard to define the various development levels up to fully autonomous vehicles. The levels for autonomous driving include:

Level 1: Driver Assistance
Level 2: Partial Driving Automation
Level 3: Conditional Driving Automation
Level 4: High Driving Automation
Level 5: Full Driving Automation[3]

CBP established the Remote & Autonomous Cargo Processing Working Group (RACP WG) in October 2019 to provide a clear vision of autonomous conveyance and speculate how customs operations should be built to afford efficiencies both to traders and to the US government. The working group divided our analysis into four environments based on the mode of transportation: Truck, Rail, Ocean and Air to address the following:

1. Illustrate autonomous conveyance in each environment
2. Provide an analysis and identify the tipping point at which this technology will be widely adopted.
3. Provide an analysis from the US government perspective that would establish the business case to enable this technology.
4. Identify areas where Customs operations needs to modernize some of its process to see efficiencies from these technologies.
5. Identify individual approaches that need to evolve as the trade moves to autonomous conveyance and CBP moves toward automated cargo ports of entry.

This white paper will discuss the anticipated impact of remote and autonomous vehicles will have on US Customs and Border Protection as the adaptation expands and the need for global border crossings arises. The end-goal of this effort is to provide insight on potential trade efficiencies while not compromising safety and security at our national borders.

## TRUCK

There is an opportunity for the adoption of autonomous technology as the trucking industry struggles with driver retention. Self-driving trucks offer sizable economic and operational benefits for companies across the supply chain; most notable is a per-mile cost reduction as compared to the current human driven truck model. The savings could be achieved through decreased labor costs, enhanced driving times and range, improved fuel efficiency, and possible better safety performance of an automated driving system. Self-driving trucks could also realize a sizable

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[1] UPS Tests Residential Delivery via Drone https://www.youtube.com/watch?v=xx9_6OyjJrQ
[2] Electric, autonomous T-Pod truck making delivery in Sweden https://electrek.co/2019/05/16/electric-autonomous-tpod-sweden/
[3] SAE International https://www.sae.org/standards/content/j3016_202104/

productivity gain and increase system capacity by being able to operate nearly 24/7 without restrictions on daily driving time, doubling their daily range, from 600 to 1,200 miles.

TuSimple, a San Diego based Autonomous truck Company, is already conducting test operations in Arizona and Texas, including depot-to-depot SAE Level 4 autonomous runs. These are being run under what's known as "Safety Driver", in which somebody rides in the cab and is ready to take the wheel if needed. There are still a lot of regulatory hurdles that need to be cleared for the supply chain to become more reliant on autonomous vehicles, but the framework and possibilities of artificial intelligence (AI) maneuvering trucks on the road could be a probability within the next decade.

Autonomous vehicles require high definition digital, real-time maps. The mapping is beyond typical GPS which is common apps today. While the maps are of the road itself, they also include lanes, the radius of curves, lane widths, street signs, bridges, inclines or declines, guardrails, trees, embankments, ditches, and buildings, as well as their distance from one another. These billions of data points are used to create a machine-readable image of the entire surrounding much like a unique "fingerprint" of every stretch of the road.[4] Maps must be kept up-to-date and the AI must take into consideration outside factors for example weather.

In addition to the RACP WG COAC Recommendations from July of 2020[5], the following considerations of how to take current technology and move it into a cross-border processes were discussed.

1) Identify a single prototype port to test concept.
2) High definition map the entire port; each port of arrival is different with different layouts requiring individual mapping.
3) Eliminate paper documents required for customs clearance; partner with other COAC Working Groups who are in the process of identifying all paper documents.
4) Test and implement a pre-arrival advanced electronic information procedure.
5) Resolve the challenge of diverting vehicles for an inspection or secondary inspection with no driver present.
6) In port Customs Agents training would be required.

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[4] ZF https://www.zf.com/mobile/en/stories_3264.html

[5] #10462 COAC recommends that CBP establish a multi-tiered FAST program/process that allows for FAST eligible drivers to take advantage of the FAST infrastructure when driving for a CTPAT approved carrier. Through the tiered approach, using a FAST card and a FAST manifest, the driver will be able to take advantage of the FAST lanes, automating a portion of the data and thereby expediting the cargo release process and avoiding longer wait times associated with non-FAST freight.

# 10463 COAC recommends CBP continue efforts to enhance existing Decal & Transponder Online Procurement System (DTOPS) and the new Gen-2 RFID transponders and infrastructure which supports Non-Invasive Inspection (NII), FAST manifest data and additional efficiencies in remote and autonomous cargo processing.

# RAIL

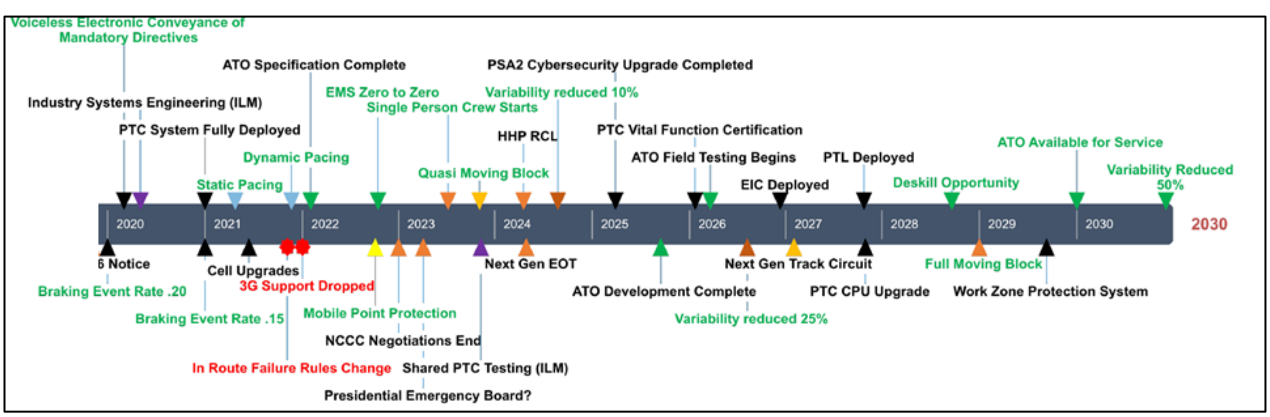
## Railroads' Path to Autonomous Capabilities

On May 1, 2007, U.S. Rep. James Oberstar introduces H.R. 2095 that would become the Rail Safety Improvement Act of 2008, requiring PTC (Positive Train Control) implementation. Since that time the industry has been working towards the goal of autonomous rail operations which will enhance the safety and performance of the North American Rail system. To give an example of the time it takes to implement systems that allow for autonomy, after President George W. Bush signed the Rail Safety Improvement Act in October 2008 it took the industry almost 12 years to finally implement Positive Train Control, the final commercial solution to the regulatory mandate.

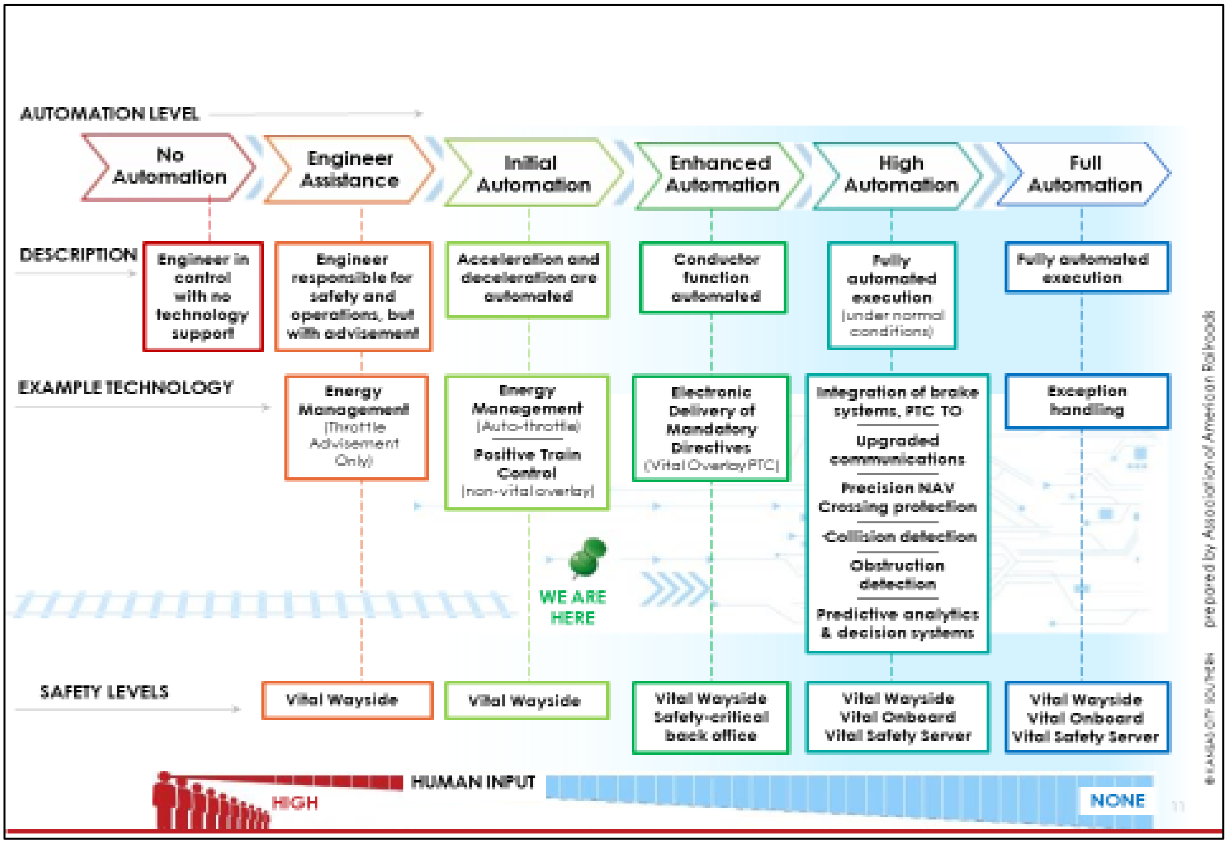
Almost 2 years after the presidential signing, the Federal Railroad Administration (FRA) issued final rules for PTC implementation and another year in court to get agreement between the Class 1 railroads on the technical solution requirements. The final rules were agreed upon by the FRA and the AAR (Association of American Railroads) in December 2012. Almost 5 years after the bill was introduced, the industry finally had agreed on what needed to be done. In August of 2013, the Senate passed a bill extending the time for railroads to comply with the law to December 2020 which was the actual date of final implementation.

After approximately $20 billion dollars of investment and 8 years of implementation, the rail system finally went live on January 1, 2021. The system is only focused on the ability of a rail operator to stop a train if certain protocols are not followed or if a safety event occurs. This system primarily prevents catastrophic crashes caused by operator error. In the initial phases of PTC implementation, there was not wide spread support that PTC would make the railroad safer, but as the technology has matured, there is a much better sense of the impact on the security of the rail system. Railroads initially thought the money was not the best use of their resources but have sense realized that the infrastructure required for PTC allows them to look ahead to a time when remote control of a locomotive is a definite possibility.

The AAR has recently been working to develop a plan that allows railroads to implement what has been termed "Advanced Train Control". The plan is a roadmap that takes Class 1 railroads from PTC operation which allows for remote location braking control to an implementation of not only braking control but full throttle control as well. The diagram below illustrates the necessary steps for railroad to be able to achieve full autonomous operations.



Any plan that would proceed toward an autonomous rail network would need to address at least three key areas of implementation: Technology and Infrastructure, Regulatory, and Labor. These issues are integrated into the process and technology changes described in the diagram below which shows movement from Enhanced Automation to Full Automation.




## Three Key Risk Areas:

Technology and Infrastructure: The PTC infrastructure is a key component in developing and infrastructure for autonomous trains. This will include an objective of high automation with a time frame of 10 years. The work that will need to be done will include standardized specifications, implementation, testing, and production. Key areas of focus will include:

- ATO (Advanced Train Operations) concept: Railroads will leverage PTC and Energy Management Systems. Minimize impact to PTC. Enhance Energy Management System (EMS) to achieve: (1) data and HMI integration with PTC; and (2) speed control from zero mph to zero mph.
- New ATO Sensor System will detect and classify objects and formulate the appropriate train response. Sensor System performance will be as good as a human operator.
- New ATO interfaces will monitor train health. This will give ATO the ability to take the necessary steps to mitigate hazards.
- ATO system will be interoperable and will function in interchange service.
- Road Remote Control Locomotive (RRCL) system fills the gap between High and Full automation. RRCL enables an operator to deal with variability (en route defects) and perform switching functions.

- KCS RRCL concept: leverage PTC and EMS. Develop new, simplified HMI between the operator and EMS to enable remote control operation (RCO) by a de-skilled worker (no Class 1 license required).
- Next Generation End of Train device and the Precision Navigation Module on locomotive will incorporate precision location functionality with sufficient accuracy and resolution to turn PTC into a vital system (no operator prompts, or operator input required).

Regulatory: The regulatory barriers to autonomous trains will be critical as we address issues like:

- Regulations concerning crew size and, potentially, skill level.
- PTC subject to 49 CFR 236 Subpart I - Positive Train Control Systems. Movement Control (EMS and Locomotive Propulsion) subject to 49 CFR 236 Subpart E - Automatic Train Stop, Train Control and Cab Signal Systems.
- Risks: FRA manpower to review and certify/approve the system.
- Granting of waivers for conducting engineering tests and revenue service demonstration runs.
- Regulatory approval of ATO safety plans and certification protocols.

Labor: The final barrier will be addressing the impact on Labor. This will include retraining and other requirements to ensure safe operations of the autonomous network.

- Technology for High Automation enables zero-man crews.
- Class 1 RRCL will be designed for use by a de-skilled RCO.
- Number of crew members on board is a business decision. Decision factors: variability, route switching, and availability of RRCL to mitigate variability. Possible permutations in table below.
- Where zero-man crews are indicated, there may be a business reason to operate ATO with an Attendant on board.
- Demographic changes over time: reduction in Engineers and Conductors. Increase in RCOs and Ground Expediters (utility workers).

| Variability | En Route Switching? | RRCL Available? | Options |
|---|---|---|---|
| High | Yes | No | One-man crew: Engineer on board assisted by ground person. |
| High | Yes | Yes | One-man crew: Engineer or RCO on board. |
| High | No | Yes | One-man crew: Engineer or RCO on board. |
| High | No | No | One-man crew: Engineer or |

| | | | |
|---|---|---|---|
| | | | RCO on board. |
| Low | Yes | No | One-man crew: Engineer on board. Zero-man crew: Engineer standing by at switching location. Support from ground expediter as needed. |
| Low | Yes | Yes | One-man crew: RCO on board.<br>Zero-man crew: RCO standing by at switching location. Support from ground expediter as needed. |
| Low | No | Yes | Zero-man crew. Support from ground expediter as needed. |
| Low | No | No | Zero-man crew. Support from ground expediter as needed. |

# OCEAN

## Definition of Unmanned and Fully Autonomous Vessels

It is important to draw a distinction between unmanned and autonomous vessels. For the purposes of this paper, unmanned vessels (UVs) are defined as vessels without crew on board, but which are controlled remotely from the shore or from other locations not physically on board the vessel. Fully autonomous vessels (ASVs) are pre-programmed vessels that operate using algorithms. To date most development on vessel capability whether fully Autonomous or unmanned have been with small coastal or inland waterway conveyances. Smaller (non-cargo vessels) have been tested cross ocean with limited success or capability. A recent development on the containerized inland waterway vessel is under development in Norway – with an intent to develop an unmanned 120 TEU vessel that will sail on a planned trajectory / route between Heroya, Brevik and Larvik. The intent is to reduce emissions created by Truck moves between these ports. Some initial trials were conducted with a small crew on board. Further testing and development are planned in 2021 with a plan to deploy in 2022 subject to successful testing.

## Regulatory Issues Related to Autonomous Vessels

Questions have arisen during the development of both UVs and ASVs regarding the application of key international conventions such as the UN Law of the Sea Convention 1982 (UNCLOS), the International Convention for the Safety of Life at Sea 1974 (SOLAS) and perhaps most importantly, the International Regulations for Preventing Collisions at Sea 1972 (COLREGS).

Attention has focused on Rules 2 and 5 of the COLREGS as both assume some human involvement. For example, Rule 2 requires the Master and crew to comply with the Rules and Rule 5 requires every vessel to maintain a proper look out. This poses the question – how can either Rule be complied with when there are no crew on board? For example, would shore side personnel remotely operating a UV constitute a Master or crew for the purposes of Rule 2? Would a UV with fitted cameras constitute a 'proper look out' and is it even necessary or possible for an ASV to comply with Rule 5 if it is operating on a pre-programmed route?

When considering the application of existing civil liability conventions, such as the Limitation of Liability for Maritime Claims Convention 1976 (LLMC), this adds another layer of complexity. Helpfully, the LLMC 1976 defines the right to limit by reference to 'shipowners and salvors' and would therefore seemingly apply to UVs and ASVs. However, as with the other conventions, it was not drafted with them in mind and the application varies depending on the jurisdiction.

Amendments will need to be made to the existing regulatory framework to ensure it remains relevant to UVs and ASVs. It is therefore encouraging that the Comité Maritime International has established an International Working Group on Maritime Law and Unmanned Vessels to draft a Code of Conduct. However, given the length of time it takes to garner international consensus on such issues, it seems likely that the technology and use of UVs and ASVs will soon overtake the existing legal regimes. In the interim, national legislation, contractual wordings and insurance is likely to fill the void. For example, Maritime UK has already published an Industry Code of Practice for Maritime Autonomous Systems Ships (MASS), the intention of which is to set standards and best practice for ASVs of less than 24 meters in length.

Autonomous cargo ships are by some in the shipping industry viewed as the next logical step within maritime shipping, noting the general trend of automating tasks and reducing crews on ships. It is more likely that feeder vessels with limited capacity and defined routes within inland waterways may be the first level of Autonomy or unmanned vessels – but the limitation may still exist – for example leveraging autonomy through the Rhine / Ruhr valleys and waterway may take over the voluminous trade currently used through unmanned barges using tugs as propulsion, but the sheer volume and capacity / berthing may negate some of these capabilities.

With regard to the huge ocean-going containerships in excess of 20,000 TEU – plying the transpacific and Europe Asia trades – it seems less likely that these will develop into fully autonomous conveyances. The sheer maneuverability constraints of a large vessel in water with a stopping distance measured in miles not feet – will limit this capability. The recent Evergreen vessel incident through Suez (even with commentary that human error contributed to the incident) demonstrates the logistical means needed to drive these vessels within a constrict waterway, and into larger bodies of congested waters – like the Mediterranean.

The CEO of one of the largest shipping company in the world, Soren Skou from Maersk also confirmed this situation and remarked that he does not see the advantages of removing the already downsized crews from these mega vessels, adding: "I don't expect we will be allowed to sail around with 400-meter long container ships, weighing 200,000 tons without any human beings on board. I don't think it will be a driver of efficiency, not in my time." Regulatory, safety, legal and security challenges are viewed as the largest obstacles in making autonomous cargo ships a reality as per the above comments.

## Areas That Can Drive Efficiency and Automation

During the review of autonomous or unmanned vessels – an area of focus also rested with the current level of documentation required to allow vessels to arrive, work and depart from various seaports. An opportunity exists to automate some of these documents that can address a faster approval and prework. Some years ago an initiative was started between CBP and two ocean carriers to look at automating the pre arrival and departure (eNOAD communication with the US Coast Guard) was reviewed with a view to creating a database and infrastructure that would allow automation of the required approval documentation process. Further reviews within the COAC working group including information gathered from Vessel agents at the port fully support the capability for automation and payment for CBP managing vessel arrivals.

The understanding is that an existing framework was developed for Internal use by CBP and that further reviews would take place to look at automation with an external interface were being discussed.

Communication is also central to the effective management of any autonomous conveyance to ensure the ability to manage and review and issues could be completed where no crew existed within the conveyance itself. Cybersecurity would be a key issue from an ocean vessel perspective as any intrusion could be catastrophic in the evet that any significant conveyance were "hijacked" and potentially secured by hostile individuals that would ransom or use the conveyance as an instrument for potential destruction.

While we do see development both in handling and managing vessel arrivals and departures as well as some autonomous conveyance development within limited capacity and waterways (inland waterways – coastal movements etc.) – it is unlikely that any of the mega containerships being developed would have the capability to be fully automated beyond what has already been achieved – reducing the crew capacity to "acceptable" minimum levels – with the near future.

# AIR

## History of Autonomous Aircrafts

The first documented unmanned aerial vehicle/system (UAV or UAS) dates back to ancient civilizations, around 200 AD, with the use of paper balloons equipped with oil lamps to scare enemies during battle.[6] Since then, UAV technology has grown drastically, mainly for use during times of war. During the United States Civil War, militaries flew unmanned balloons laden with explosives. In 1918, during the First World War, an American aerial torpedo called the 'Kettering Bug' flew for the first time. Ahead of WWII, the United Kingdom developed a radio-controlled aircraft to be used as a target for training purposes, called the 'DH.82B Queen Bee'. And in more recent history following the September 11, 2001 attacks on the United States, UAVs have been used by militaries, particularly the U.S., for reconnaissance, surveillance, and targeted attacks.[7]

## Current State of Autonomous Aircrafts

The development of autonomous aircrafts is growing at a record pace. In 2020, Ohio University reported that the worth of the UAV market in 2015 totaled $10.1 billion and by 2022, the market is estimated to increase to $17.41 billion. About $6.4 billion is currently spent each year on UAS technology, and that number is expected to double in future years, with the total amount spent on drones by 2024 at $11.5 billion annually.[8] In the U.S. alone, the Federal Aviation Administration (FAA) reports that there are currently 873,265 drones registered – 365,870 for commercial use and 503,896 for recreational.[9]

[6] PennState College of Earth and Mineral Science, "UAS History"
[7] Imperial War Museums, "A Brief History of Drones"
[8] Ohio University, "The Benefits and Challenges of UAVs"
[9] Federal Aviation Administration, "UAS By the Numbers"

U.S. firms have the largest share of both the domestic and global defense UAS markets and also the most investment in acquiring new UAS technology. While U.S. firms mostly control the U.S. defense UAS market, these firms' ability to compete globally and expand their position is curtailed by export regulation, limiting to whom U.S. companies may sell their aircraft.[10]
Product delivery has the potential to become a large market. However, development has begun with narrow uses such as domestic deliveries to remote locations and for high-value and time-sensitive products, like medical supplies from pharmacies to individuals, as comprehensive regulation has yet to be established. UAV use in construction, insurance, and energy will grow quickly in the coming years, and customers in those industries will soon amass fleets of UAVs.[5] Large logistics companies in recent years have begun to purchase UAVs, such as Beta Technology's EVTOL, for cost-effective and flexible delivery of healthcare products/pharmaceuticals, as well as to assist small and medium sized businesses (SMBs) customers.[11]

## Regulatory Framework

Within the United States, the FAA sets and enforces all rules for aircraft using the nation's airspace. The U.S. has taken a leading role shaping international norms and regulations for UAVs. Two of the main regulations are a Part 107 certification, required for the use of drones under 55 pounds[12], as well as a Part 135 certification, needed for small drones to carry the property of another for compensation beyond visual line of sight.[13]

Globally, the International Civil Aviation Organization (ICAO) developed a model regulatory framework for UAVs to be copied and implemented by member states. Their model consisted of three certifications: a Part 101, establishing that all UAVs should be registered; a Part 102, enabling on-going operations or one-time events through certification; and a Part 149, promoting the use of an Approved Aviation Organization to serve as a designee authorized by the Civil Aviation Authority (CAA) to perform specific tasks.[14] There are also eight countries that prohibit the commercial use of drones entirely – Algeria, Belarus, Chile, Colombia, Egypt, Kenya, Nicaragua, and Nigeria.[15]

## What Is Next?

With the demonstrated success of intra-country delivery via autonomous aircraft, it is only a matter of time before demand escalates for international cross-border transportation and delivery of products and cargo. It is reasonable to envision the possibility of a Canadian made product being delivered directly to a U.S. home address via an autonomous aircraft in the not-too-distant future. It would also be reasonable to envision multiple orders of Mexican made products departing from the parking lot of the manufacturer and delivered by an autonomous aircraft directly to a U.S. warehouse for final delivery to the U.S. purchaser, bypassing traditional airports and customs ports. The technology for both scenarios exists today.

The most significant challenge facing the transition to cross-border autonomous aircraft deliveries is/will be identifying and updating the legislation, regulations, and policies of a significant number of government agencies within the countries pursuing these capabilities.

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[10] International Trade Administration, "Unmanned Aircraft Systems (UAS)"
[10] UPS Stories, "UPS Flight Forward adds innovative new aircraft, enhancing capabilities and network sustainability"
[12] Federal Aviation Administration, "Fact Sheet – Small UAS Regulations (Part 107)"
[13] Federal Aviation Administration, "Package Delivery By Drone (Part 135)"
[14] ICAO, "Model UAS Regulations"
[15] Rand Organization, "International Commercial Drone Regulation and Drone Delivery Services"

## SUMMARY

In conclusion, our Working Group has met many of the requirements of the original SOW to illustrate autonomous conveyances in each environment as well as the different risk analysis for each mode. We believe CBP will need to issue a Notice of Proposed Rule Making (NPRM) to consider a full cost/benefit analysis to further review this Remote & Autonomous Cargo Processing.

In the meantime, CBP will need to modify regulations and processes to handle the non-traditional means of cross border traffic using drones and UAVs. CBP should consider how it currently handles pipeline movements from Canada since they may not enter the U.S. through standard ports of entry or have traditional means of moving in-bond through the U.S.

CBP may need to consider bulk reporting of drone or UAV shipments in a similar manner to meet US. Census reporting requirements as suggested in recommendations from the COAC Pipeline Working Group in February 2019. https://www.cbp.gov/sites/default/files/assets/documents/2019-Feb/COAC%20STL%20Pipeline%20Recommendations.pdf.

In addition, CBP needs to consider previous recommendations made by our Working Group on ways they can streamline border traffic as they did with rail shipments in Laredo. Through Unified Cargo Processing between CBP and Mexican Customs (SAT), CBP received between a 33% to 60% reduction in processing time saving 20 minutes per train. This has helped increase border input in Laredo by 50% helping to make it the #1 port in the country by volume.

- Support International Crews crossing land borders. Eliminates need to switch crews mid-bridge at the border. Successful Pilot Programs at Laredo should be expanded to other Southern and Northern ports of entry to reduce congestion and speed up processing time.

- Support expansion of non-intrusive image (NII) technology for trains crossing land borders. Utilizing a single image by CBP and SAT should also be used at every port of entry and along the Northern Border with CBSA.

- Expand the rail bridge at Laredo to allow North and South bound international rail traffic. Although a second bridge is being added in Laredo, there is a need to support bridge expansions in other ports of entry along the Southern and Northern border to achieve the same success as Laredo.

This same level of synergy could be achieved at the Northern Border if our recommendations for rail as well as those recommendations from the COAC North American Single Window Working Group made in November 2016 could be adopted and fully implemented by CBP: https://www.cbp.gov/sites/default/files/assets/documents/2016Nov/1USG%20Draft%20Recommendaitons%20November%2017%202016.pdf.

Remote & autonomous vehicles are an emerging actor and require cargo processing that is void of ink, paper, and hours of manual data entry. Operators of such technologies need to provide transparency in their supply chains early in their voyage through data transmissions to expedite the entry process. Shipment status and decisions need to be made by CBP based on such data and communicated in real time to ensure compliance, which are both key changes being driven by the 21st Century Custom Framework, modernization approach.