Study Report on Disruptive Technologies
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World Customs Organization
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Forward by the WCO Secretary General

The potential benefits of new technologies could be tremendous and it is key that policy leaders understand which ones could be relevant to them and to prepare accordingly. This Study Report aims to share insights into what is today commonly referred to as “disruptive technologies”, and to allow Customs Administrations to reap the benefits of the opportunities they present. Although the word disruptive might have a negative ring, we are actually talking about a natural evolution of technology. Our lives are enriched in many respects by the so called disruptive technologies.

Bearing in mind the importance of exploring new and emerging trends for successful policy making, the Permanent Technical Committee and its Virtual Working Group on the Future of Customs have included, as an important part of their work, an exploration of disruptive technologies, the majority of which have already become part of our lives. Some of them could change the way Customs works and influence the trading environment more broadly, while others might have a limited impact in the future. Blockchain technology and artificial intelligence are, for example, already showing important benefits and further future advantages for border and supply chain management.

The objective of this Study Report is firstly to demystify and raise awareness of the latest technologies. It is also to support Customs administrations in gaining a better understanding of what they are about, how they are used today and how they could potentially be used in the years ahead, by both Customs and other stakeholders in cross-border supply chains, for the purpose of securing, facilitating, as well as boosting global trade and ensuring proper revenue collection.

With this Study Report, the WCO is responding to a growing Customs appetite to learn about the potentials of disruptive technologies and ways in which we can manage their introduction. A robust strategy behind technology will allow Customs to keep pace with the accelerating speed of IT advances, and to make full use of the opportunities they bring. The cooperation with the private sector is valuable in that respect and a number of recommendations have been laid out for consideration.

I hope that the Study Report will also have a positive impact on progressing SMART borders for seamless Trade, Travel and Transport, which is the theme of the WCO in 2019. By SMART we mean that Customs should ensure that the following guiding principles are at the centre of Customs compliance, enforcement and facilitation efforts: Secure, Measurable, Automated, Risk Management-based and Technology-driven.

“Technology-driven” means that digital disruption has brought about new opportunities and challenges for Customs and partner government agencies. This triggers the need to explore the use of other information and communication technologies for cargo, containers and conveyances.

I therefore hope that the insights on the potential use and impact of blockchain technology, artificial intelligence, internet of things, biometrics, drones, virtual reality and 3D printing, which this Study Report brings forth, as well as other disruptive technologies that will need to be taken into consideration, will inspire Members and initiate actions at both national and international level, and that this will lead us towards shaping forward-looking inter-connected digital Customs of the future.

Dr. Kunio Mikuriya
Secretary General
Background

Based on the proposal submitted by the Permanent Technical Committee (PTC) delegates, the Future of Customs topic was launched at the 207th/208th Sessions of the PTC in March 2015. This came as a result of discussions on the role of the PTC, where it was agreed that the Committee take a more active role in discussing strategic matters and future-oriented topics.

The March 2015 PTC discussed new and emerging threats and how this would affect the roles and responsibilities of Customs in the future. The discussions resulted in the establishment of a Virtual Working Group on the Future of Customs (VWG FC or Group) under the PTC, consisting of Customs administrations, the private sector, international organizations and academia.

The Group, which consists of over thirty members, worked on papers that steered discussions in the PTC meetings on a number of topics, such as the Customs in the 21st Century strategic document, 3D printing, drones, biometrics, Internet of Things etc.

At its 215th/216th Sessions in March 2017, the PTC discussed the way forward for the Group, two years after its establishment, to ensure more focused and results-oriented discussions. Consequently, and bearing in mind the importance of exploring new and emerging trends for successful policy making, the PTC decided that the Group would, amongst other, focus on exploring disruptive technologies which were gradually becoming part of people’s lives. However, the benefits of these technologies for Customs and border management had not yet been fully explored.

It was therefore deemed relevant to carry out further exploratory work and research on these topics and to provide more information on their use, benefits, risks, role in the supply chain, in Customs, etc. The aim was also to take into consideration the interlinkages between the different technologies and to gain a more holistic picture of how they impact or support Customs work.

At its sessions in October 2017, the PTC explored the topic even further in a break-out session resulting in a list of recommendations which can be found in the “Conclusions” chapter of this Study Report. It also decided to have another full day devoted to this topic at the following meeting in April 2018.

In addition, the PTC decided to develop a Study Report on Disruptive Technologies, that will collate all the work already carried out under the Group, including papers developed by a number of its members, and to more broadly bring together relevant information from open source, as well as outcomes of discussions under the PTC and other WCO working bodies and meetings, including the WCO IT Conferences. Bearing in mind the fluidity of the topic, the Study Report is meant to be a living document, to be updated on a regular basis to include lessons learnt and recommendations stemming from on-going discussions.

The objective of the Study Report is to raise awareness within the Customs community of the latest technologies and their potentials, by firstly demystifying each of them individually and providing practical examples and use cases, but also by sharing some more aspirational and innovative propositions on their use in the future.

The first draft was presented at the April 2018 PTC when the Meeting expressed high level of appreciation for the quality and usefulness of the Study Report that was felt to be topical and timely. The PTC agreed on the objectives and the structure of the Study Report and to continue exploring the topics and collecting experiences to be included before the next PTC meeting in March 2019.
This version of the Study Report is therefore an updated one and includes new chapters on artificial intelligence, virtual reality and strategy behind technology. The Study Report has also been supplemented by a series of use cases provided by Members and Observers or collected from open source. The Study Report on Disruptive Technologies will continue to be a living document, to be updated as required.
Executive Summary

I. Introduction: Disruptive... or (just) emerging technologies?

According to the WTO World Trade Report 2018, we are entering a new era, in which a series of innovations that leverage the internet could have a major impact on trade costs and international trade. The Internet of Things (IoT), artificial intelligence (AI), 3D printing and blockchain have the potential to profoundly transform the way we trade, who trades and what is traded. What needs to be taken into consideration are the capacity building programmes that can support a more balanced spread of adoption across the globe.

Having direct frontline interaction with trade, Customs must be aware of and adapt to the way trade innovates and develops. This can be observed through the development of supply chains and the manner in which information is created and stored, which can be seen through the emergence of blockchain technology and the way it has caught the imagination of many.

There is a myriad of technologies on the horizon that have the potential to not only revolutionize the consumer markets in which they will operate, but also for Customs, the way its work is done.

II. The technologies

1. Blockchain technology

Blockchain technology is applicable to trade and Customs environments where participants in a transaction need to exchange information. Considering the potential of blockchain and related emerging developments, the WCO has started exploring the use of this technology in the Customs domain, primarily from the following perspectives: use of the blockchain technology in Customs regulatory processes for improving compliance, trade facilitation, and fraud detection; regulatory challenges in the area of blockchain-based E-Commerce; and misuse of blockchains (including bitcoins) for illicit trade, evasion of duties and taxes/VAT, IPR violations, money laundering and other financial crimes.

With the blockchain technology, efficiencies in the supply chain can be improved not only in the reduction of intermediaries and paper/manual tasks but also in improving certainty and predictability based on the reliable real-time data available to all the stakeholders in a supply chain (the participants in a blockchain). This allows for traceability and end-to-end visibility, thus enhancing supply chain security and facilitation. Solutions based on blockchain could be expected to improve significantly Customs capacity for risk analysis and targeting, thus contributing to greater trade facilitation.

2. Internet of Things

Asset tracking has become very important for supply chain management. It gives companies a way to make better decisions and save time and money. In that respect, IoT is used for monitoring the movement of goods in real time. This includes monitoring the position of the container, which can help in voyage optimization. Special apps can also help the customer receiving the goods verify whether the arriving parcel is correct, by using a bar code reader.

IoT has contributed to the growth of E-Commerce. It has transformed how people buy – through Omni channel sales and superfast shipments. Suppliers and consumers are digitally connecting in real time. Big companies are using IoT to track their goods and improve customer service.
The question is how can Customs and other border agencies plug into this network and benefit from this information, based on integrated supply chain management principles, to ensure that trade facilitation and security requirements in the movements across borders are met. With information available via IoT technology, Customs administrations would be able to focus on using analytical tools to identify priority cargo, high-risk and low-risk shipments and supply chains.

3. Artificial Intelligence and Machine Learning

Use of AI in Customs and Border Management presents a tremendous opportunity in the cross-border movement of people and on the commercial side. As huge volumes of data are generated by people and goods moving across borders, AI provides the ability to make sense of this huge and ever-increasing amount of data. AI technologies can be used to ingest all this data, detect and predict patterns more accurately than humans can. Visual search and facial recognition, behavioral and predictive analytics that is being used already in other sectors can also be further tailored for use in Customs and Border Management.

AI can be used for the following purposes: revenue collection models, classification of products, Customs audits, risk-based targeting, analyzing container image made by X-Ray scanners, logistics monitoring and control in the Customs warehouses and bonded areas, identifying high risk passengers and vehicles by using facial recognition and visual search at the border, providing better service by placing enquiring robots for passengers at the border, providing Customs duty self-payment service by developing mobile apps at the border, etc.

Implementation of chatbots in government agencies can greatly enhance the communication between the government, companies and citizens. Use of AI with augmented or mixed reality glasses could be used by Customs for training purposes as well as for shipment inspections and in the detection of counterfeit and contraband goods.

4. Biometrics

Access to biometric data of individuals who are engaged in crimes related to trade (goods) can facilitate Customs' efforts to identify, investigate, apprehend, and prosecute these wrong-doers. In addition, Customs administrations are uniquely situated to demonstrate useful methods for interagency coordination, which biometrics requires. Customs administrations have a long history of coordination and interagency work, as they enforce laws and regulations for partner government agencies. They are often co-located with immigration agencies, and can work to promote the adoption of and facilitation of implementation of these efforts.

Customs agencies, other government partners, and private actors should monitor this field closely to identify additional uses, potentially for the following purposes: verifying identities and controlling access of Customs operators; identifying the different actors in the supply chain such as Customs brokers, freight-forwarders, logistics operators and others; etc.

5. Drones

The use of drones in the Customs environment does no longer belong to the "generation next". It is already being used by a few Customs administrations for surveillance and monitoring purposes.

But there are emerging opportunities, as well as challenges regarding the use of drones as a mode of delivery. Clearly, Customs need to monitor, analyze and comprehend emerging developments concerning the use of drones and related regulatory developments and come up with an appropriate policy response, together with potential adjustments of Customs procedures and requirements, where needed. Another area to explore is the Customs
regulatory perspective to meet the current and emerging challenges, especially in the context of the use of drones for cross-border delivery of illegal and legal goods.

6. Virtual, Augmented and Mixed Reality

As regards Customs, augmented and mixed reality can be used to project visual assistance in the physical world, e.g. when doing a physical inspection. This assistance can be in two formats. The first is general assistance that is provided in advance to all employees. The second is the possibility that the assistance is provided by someone that can see what the Customs officer sees, in real time.

Another potential use is the visualization of big data sets. When using mixed reality, data can be projected in the physical world as digital artifacts that can be manipulated as real objects.

Last but not least, virtual reality can be used in training Customs officers. Different kinds of training environments can be created that are difficult to recreate in the physical world. For example the machine room of a large container vessel.

7. 3D printing

There are estimations of a potentially important impact of 3D printing on the work of Customs in the future. Some feel that the enhanced use of 3D printing would probably have more impact on movements on the domestic market rather than across borders and that based on current legislation that might mean 3D printing could have more implications on other governmental agencies than on Customs (e.g. tax administrations, national police, etc.).

However, others feel that Customs should be involved in monitoring the virtual supply chain, and the question was raised on how this could this be achieved, including whether existing legal instruments are sufficient to cover such responsibilities. In general, cooperation of Customs with tax and other relevant agencies (maybe a new dimension of Coordinated Border Management) is seen as important in the area.

Implications of 3D printing on origin, valuation, IPR and security have been stressed in the WCO, and especially VAT implications. It was also raised that there might be a need to redefine the term “goods” in the future. There is an overarching feeling in the Customs community that the administrations should play an important role in monitoring cross-border movement of intangible goods.

III. Strategy Behind Technology

There is a need to harness latest technologies as traveler and trade growth, including E-Commerce, has significantly outpaced the typical Public Service rate of evolution, challenging our conventional operations, program policies and legislation.

Technologies such as blockchain, biometrics and artificial intelligence are more than business enablers, they set expectations for our clients and change how we work. It is essential, however, to focus technological changes on those key to an organization’s mandate or risk over committing.

Options for emerging technology implementations must be evaluated based on the services required and the needs of the organization. The high rate of failure in large, multi-year IT-enabled projects has resulted in organizations moving aware from large IT system development and instead selecting technologies that can easily migrate to new hardware in the future. Key to the new methodologies used is the principle of failing fast and recovering quickly.

IV. Recommendations

The PTC extensively discussed disruptive technologies, and provided a set of mainly general, but also some specific recommendations for consideration by policy makers which
aspire to serve as key guiding principles for the future. In addition, the annual dialogue held between the Private Sector Consultative Group and the Policy Commission in June 2018 discussed disruptive technologies and provided a number of recommendations on how Customs and the private sector can cooperate in making best use of them for the purpose of facilitating and securing trade.

**V. Conclusion**

It is evident that bringing forth specific conclusions and recommendations in this domain is to a large extent a moving target. Nevertheless, there is a general understanding around the need of keeping abreast of the developments in this field and continuously seeking to understand the challenges and opportunities that latest technologies can bring to Customs and border management. The Study Report will continue to be updated with latest insights and information on pilots.
I. Introduction: Disruptive... or (just) Emerging Technologies?

When we talk about “Disruptive Technologies”, what exactly do we mean? According to the Cambridge Dictionary, a disruptive technology is a new technology that completely changes the way things are done. Even though we cannot be certain which technologies will accomplish this in the future, the public has over the past years broadly accepted “disruptive technologies” as a term which refers to blockchain, internet of things, artificial intelligence, virtual reality, drones, 3D printing and other latest technologies, which are the subject of this Study Report.

The term emerged from an examination of the failure of once dominant corporations, when the technology their dominance was based upon, changed. The authors, Clayton M. Christensen and Joseph L. Bower, examined the hard-disk-drive industry to illustrate their point. They focus on the challenges faced by a corporation, as they attempt to introduce a new technology which often struggles against the existing dominant force in the market place. In subsequent work, it is argued that disruptive technology does not disrupt at a single point in time, but that what is disruptive is the path the technology follows from a fringe product to the mainstream.

When we speak of disruptive technologies or disruptive innovation we are not talking about a negative reaction within a certain market, but rather the natural evolution of technology. Our lives are enriched in many respects by disruptive technologies. History is full of technologies that were set to transform the way we do business or live our lives.

According to the WTO World Trade Report 2018, we are entering a new era, in which a series of innovations that leverage the internet could have a major impact on trade costs and international trade. The Internet of Things (IoT), artificial intelligence (AI), 3D printing and blockchain have the potential to profoundly transform the way we trade, who trades and what is traded. This comes as a consequence of a number of forces. The past half-century has seen a massive increase in processing and computing power, an equally enormous decline in its cost, and widespread adoption of personal computers. This has been accompanied by an equally rapid increase in bandwidth – the carrying capacity of a communication system – that has proved to be an important catalyst for the swift growth of the internet and mobile networks. Finally, the ability to turn many forms of information that once existed solely in analogue form into digital information and to collect, store and analyse it has expanded enormously.

However, one of the major challenges facing the digital economy is the digital divide between developed and developing countries. It remains wide in terms of access to broadband services and e-commerce platforms, quality of infrastructure and legal framework. Therefore, what needs to be taken into consideration are the capacity building programmes which can support a more balanced spread of adoption across the globe.

Customs is a consumer who is affected by the evolution of the marketplace and technology. The key understanding must be how Customs reacts not only to the use of technology by its stakeholders, but also how it utilises the emergence of new technologies which itself changes the manner of conducting business. The challenge for Customs administrations, like any consumer, is that the fervour which surrounds an emerging technology can dominate any discussions on reform and renewal.

However, paramount to Customs administrations is the ability to ensure that efficiency and effectiveness are constantly improved, and latest technologies are in most cases aimed at achieving these goals.
Annex to
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It should also be noted that disruptive technologies can be a catalyst for strategic decision making, with an administration having to review the emergence of a technology and to make a strategic decision on its use in the short to medium term. Having direct frontline interaction with trade, Customs must be aware of and adapt to the way trade innovates and develops. This can be observed through the development of supply chains and the manner in which information is created and stored, which can be seen through the emergence of blockchain technology and the manner in which it has caught the imagination of many.

Blockchain technology is a prime example where a Customs administration must be aware of how trade is adapting to a new environment. In order for a Customs administration to be able to interact with their primary stakeholders, they must be able to share information in the most efficient way possible, both for the administration itself, as well as for trade. However, while this certain technology is being heralded as the future of information security, as well as accessibility of information, it is key that Customs administrations observe and inform themselves as to how this technology works. An important example where Customs faces an evolution in the market comes with E-Commerce. Here we can see how disruptive technology such as the E-Commerce platforms and supply chains have changed the manner in which global trade functions. No longer is a consumer reliant on a physical storefront to gain access to the goods they desire. With just a click of a mouse, goods from all over the world are available and it is for the Customs administrations, as the front-line governmental body, to deal with the seismic shift in trade. It should not be forgotten that while the adoption of latest technologies can benefit Customs, like with any other infrastructural project, appropriate measures should be taken to ensure that any technology adopted by an administration should be viewed through the prism of a Cost-Benefit Analysis or by way of a SWOT Analysis.

Reviewing the detailed examinations contained within this Study Report, it is apparent that there is a myriad of technologies on the horizon which have the potential to not only revolutionise the consumer markets in which they will operate, but also for Customs, the way in which its work is done.

However, as noted, all such technologies should be viewed through the prism of a calculated and strategic vision based upon an examination of not just the potential benefits and pitfalls of these disruptive technologies, but also based on an assessment of whether the technology which is currently in use, does in fact require further implementation. The future is certainly exciting with the evolution of technologies offering both trade and Customs administrations multiple opportunities to embrace further efficiencies and effectiveness.
II. The technologies

1. Blockchain technology
a. What is blockchain technology

The blockchain is a type of sophisticated cryptographic distributed ledger architecture, a continuously growing list of records called blocks. It has the capability to move any kind of data swiftly and securely and, at the same time, make a record of that change, movement, or transaction available instantly, in a trusted and immutable manner, to the participants in a blockchain network, called validators or nodes.

Each block typically contains a cryptographic hash of the previous block, a timestamp and transaction data. By design, a blockchain is inherently resistant to modification of the data. Once recorded, the data in any given block cannot be altered retroactively without the alteration of all subsequent blocks, which requires collusion of the network majority.

Therefore, blockchains are considered to be secure and provide a ‘decentralized consensus’. This makes them potentially suitable for the recording of events, medical records, and other records management activities, such as identity management, transaction processing, documenting provenance, food traceability or voting, where it involves multiple stakeholders and where there is no central authority.

Blockchain was invented by Satoshi Nakamoto in 2008 for use in the cryptocurrency bitcoin, as its public transaction ledger. The invention of the blockchain for bitcoin made it the first digital currency to solve the double spending problem without the need of a trusted authority or central server. The bitcoin design has been the inspiration for other applications.

Blockchain technology has been used in recent years for writing and executing smart contracts, avoiding intermediaries which act as arbiters of money and information. However, at the present time, smart contracts are not legally recognized and thus might not be legally enforceable. The term ‘smart contract’ had been coined by the world of finance; it was a set of rules that were written down and executed automatically. Their legal enforceability depends on existing regulations in each country. With respect to immutability, once information has been put in the blockchain, it remains there forever and cannot be modified/changed. It could, nevertheless, be supplemented by new business information.

In terms of governance, blockchain technology is decentralized. There is, however, an operator function that sets the rules for everyone in the network, along with regulators and government organizations. If the network detects that something untoward is going on, the associated individual participant would be frozen out of the network. If any untoward activity is an accident, the participant would be re-admitted. In contrast, in the case of an attempt to defraud, the operators would work with the relevant authorities to take appropriate action.

Although blockchain has initially been thought about mainly from a financial services perspective, this distributed ledger technology (DLT) can serve as a basis for many useful applications including information management far beyond monetary transactions.

The blockchain technology provides several important features that could be leveraged in the international supply chain management:

- The technology operates on a distributed, rather than centralized platform, with each participant (node) having access to exactly the same ledger records.
- It provides “trust” between and among unknown parties to transact business and exchange information without an intermediary, whilst ensuring data integrity and providing a full audit trail.

- Transactions are verified and approved by consensus among participants in the network, making fraud more difficult. (However, one needs to take into consideration the complexity of most supply chains today, which would make the trust amongst its stakeholders, a blind trust in many cases).

- The full chronology of events (e.g. transactions) that take place are tracked, thus allowing anyone (having access) including regulatory authorities to trace or review prior transactions.
Although blockchain technology presents interesting features in terms of security, immutability, transparency, traceability and automation, its wide-scale deployment currently hinges on various challenges. Scalability remains limited, existing blockchain networks and platforms do not “talk” to one another, and there are a number of unresolved legal issues, ranging from the legal status of blockchain transactions to the question of liability.

In addition, one might question whether the developers of a blockchain are impenetrable to cyber security issues.

Source: Digital McKinsey


b. Potential future use in Customs and border management

This technology could equally be applicable to trade and Customs environments where participants in a transaction need to exchange information. Through this technology, the same copy of a ledger would instantly be available to all parties at different nodes in a most updated, trusted, secure and immutable manner. It would obviate the need of maintaining separate ledgers by each party as per the current practice.

Considering the potential of blockchain and related emerging developments, the WCO has started exploring the use of this technology in the Customs domain, primarily from the following perspectives:

- use of the blockchain technology in Customs regulatory processes for improving compliance, trade facilitation, and fraud detection,
- regulatory challenges in the area of blockchain-based E-Commerce, and

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- misuse of blockchains (including bitcoins) for illicit trade, evasion of duties and taxes/VAT, IPR violations, money laundering and other financial crimes.

An exploratory discussion was held at the April 2017 Permanent Technical Committee (PTC) meeting, where IBM shared its perspective and the preliminary outcomes of the pilot - Global Trade Digitization (GTD) - using blockchain.

Following that, this topic was discussed from a more technical perspective at the May 2017 Information Management Sub-Committee (IMSC) meeting, as well as at the WCO IT Conferences in 2017 and 2018, as well as at the WCO Technology and Innovation Forum in 2017.

Discussions on the use of blockchain by Customs have since taken place in other WCO bodies and meetings.

More recently, in June 2018, the WCO issued the Research Paper No. 45 “Unveiling the Potential of blockchain Technology for Customs” with the objective of identifying possible case studies and uses of blockchain for Customs and other border agencies with a view to improving compliance, trade facilitation, and fraud detection, while touching on associated adjustments in legal and regulatory frameworks. The research paper elaborates in more detail the above mentioned concepts. The May 2017 IMSC explored potential opportunities for the use of blockchain technology and suggested collecting case studies and outcomes of pilots and other emerging initiatives concerning its use in regulatory and supply chain management processes. It also identified several use cases of blockchain technology in Customs business processes and overall supply chain management for carrying out future work through engagement with relevant stakeholders and technology experts/solution providers.

With the blockchain technology, efficiencies in the supply chain can be improved not only in the reduction of intermediaries and paper/manual tasks but also in improving certainty and predictability based on the reliable real-time data available to all the stakeholders in a supply chain (the participants in a blockchain). This allows for traceability and end-to-end visibility, thus enhancing supply chain security and facilitation. As a start, however, one would need to map the data elements at different points in time to demonstrate what the inputs are and at what level, as well as what are the outputs, at perhaps different levels.

As for the Customs administrations and other border agencies, solutions based on blockchain could be expected to improve significantly their capacity for risk analysis and targeting, thus contributing to greater trade facilitation.

The blockchain technology can potentially be used in Customs business processes to validate transactions/actions of different parties in the international supply chain through permissioned blockchains - clearly defining roles, responsibilities, levels of access, and rights of validation for each party. It could equip Customs with necessary tools to tackle problems of compliance, as it provides an unbiased tool essentially designed for uploading and sharing

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Source: IBM

information between unrelated parties. This can help in the end-to-end integrated supply chain management in a transparent and trusted manner.

Going forward as suggested by the IMSC, the following specific use cases in Customs and border processes have been identified for future work:

- Customs declaration:

Creation of Customs declaration documents is a very complex task, involving multifarious activities. There are challenges in collating (often manually) correct information from various documents and various stakeholders, such as sales data, product information, manufacturing details, as well as logistics information. Because of outsourced services and distributed data sources, this process is cumbersome and runs with a potential risk of non-compliance. In many cases, traders involve 3rd party providers to handle the Customs declaration process.

Blockchains can help collecting all the required information from ordering, preparing and shipping the products in a common ledger. Going a step further, Customs could automatically pull the required information for a Customs declaration from the primary sources, having improved data quality and immutability thereof.

This will provide benefits on the trader side due to significantly reduced work to accurately assemble the required pieces of Customs information as well as on the Customs side by reducing their manual verification and resources required to validate declarations. This would lead to faster Customs declaration processing and reduced end to end lead time.

- Inter-agency cooperation: exchange of information

There are several challenges in receiving advance electronic information and sharing it with other government agencies. There could be issues with data quality, data not being submitted in time and potential inadvertent or deliberate mistakes in data due to its changing multiple hands.

Blockchains can help overcome some of these challenges. Data sharing through “permissioned” blockchains (a distributed architecture) in a trusted and secure manner can help realize the vision of end-to-end “data pipeline”. Such a blockchain can be operated by supply-chain consortia, accessed and updated by all participants. Customs and other government agencies can get accurate data, right from the source. However, one must also consider that not all supply chains are linear, which brings greater complexity to this concept.

Given the global security environment and the renewed focus on trade facilitation with WTO Agreement on Trade Facilitation (TFA) being implemented, there is greater need for different government agencies to cooperate more effectively. The blockchain may open up new possibilities for these different agencies, including Customs, to share information and resources by using a common distributed technical platform, especially in a Single Window environment, and for cross-border data exchange. This could be a good use case for blockchain if all participants had an identifier code throughout the transactions, bearing in mind the common associated challenges is that the entities are often named differently by different agencies.

In a growing digital economy, this technology can also support enhancing cooperation between Customs and Tax authorities and the exchange of information between them for a more harmonized approach on revenue collection, audit, risk management, as well as on the issue of Customs valuation and transfer pricing.

- Electronic certification/verification of regulatory requirements

Traders are required to comply with several requirements such as non-tariff requirements. There are increasing requirements for product certification in view of growing concerns about product quality and safety. Various licenses, permits, certificates, and other authorizations
(LPCO) may be required for Customs clearance depending on the nature of goods and related national regulatory requirements.

Several pieces of data including for example data concerning the certification of inputs to products (e.g. intellectual property rights (IPR) of products, IPR of inputs/constituents) are needed. Furthermore, several associated activities are carried out by various stakeholders like certifiers, laboratories, producers, regulators and consumers. But, often this information is not shared between all concerned, leading to an iterative process of collation of information and carrying out necessary certification and verification.

Blockchains can help overcome some of these challenges through a holistic product lifecycle data management. The community of producers, laboratories, logistics players, regulators, and consumers can all join hands on a blockchain, providing a shared provenance, testing, certification, licensing, etc. with all relevant actors having full access to all related information.

Furthermore, the blockchain can enable the implementation of electronic certification of LPCO, such as e-Phyto certificates and e-Certificates of Origin (e-CoO) in a more efficient, secure and trusted manner. It could ensure that a certificate is appropriately issued, and properly and digitally signed by a valid regulatory/issuing agency, and at the same time could also prevent any alteration/manipulation of the content or misuse of an e-certificate by a third party.

- **Identity Management**

The blockchain technology can be very useful in identity management of multiple stakeholders and customers in a supply chain (particularly in the E-Commerce environment), thus enhancing security and improving service delivery. It would eliminate the need for an intermediary to certify the identity of business or individuals and perhaps help in unifying several identities with multiple numbers to make it one unique identity (e.g., unique personal identity, unique trader identification number) which would be recognized across the whole government-business ecosystem, for example in a Single Window environment.

- **Revenue Collection**

The blockchain technology could enable any intermediary in the supply chain to collect revenue on behalf of governments, potentially allowing duties and taxes to be automatically transferred to respective authorities using smart contracts. This could be useful while implementing new models of revenue collection on low-value and small shipments (e.g., vendor collection or intermediary collection) in the E-Commerce environment.

Lack of transparency along the supply chain causes various concerns, including that the prices paid might be an inaccurate reflection of the true value having implication on revenue. The issue of undervaluation and misdeclaration can potentially be tackled in a more transparent manner in a blockchain.

- **Compliance Management**

The blockchain could provide provenance of data; reduce frauds; and enhance visibility in the supply chain, for example by accessing the commercial documents starting with the initial purchase order between the parties.

The blockchain can help in mitigating and eliminating risks around food security, conflict minerals, counterfeit goods, forced and child labor, corruption and so forth. Furthermore, the blockchain can assist in IPR management, providing transparent processes in the rights registration, associated authorizations, enforcement, and taxation issues.

- **Post Clearance Audit**

22.
Another potential use case of the blockchain is in the audit of Customs declarations and associated transactions and documents, in particular system based holistic audit with an opportunity to look into each and every (as needed) transactional trails.

Prerequisites to take into consideration

For future use of this technology by Customs, including associated requirements in terms of investments, resources and capabilities, there is a need to become familiarized with the technology as a first step, and then to explore whether and for what purposes it could be used together with the identification of minimum data needed for various regulatory processes. In order to access data, a dashboard is needed that could be connected to the blockchain platform through the application programming interface (API) to pull required data by Customs and other agencies. This could offer unparalleled certainty about the provenance of data and enhanced visibility in the supply chain, for example by accessing the commercial documents starting from the initial purchase order.

The WCO will continue monitoring related developments on how industry is going to use blockchain, and accordingly provide guidance to Members who could prepare themselves, depending on their strategic imperatives and priorities.

Concerning the use of blockchain as an alternative payment solution, there are various blockchain-enabled payment solutions (the most well-known being Bitcoin). These solutions were designed to be equivalent to cash - completely decentralized and anonymous monetary exchanges. These features could be easily exploited by criminals to move money around. In this context, understanding these unregulated currencies such as Bitcoin and how they work is important from a risk management point of view. But at the same time, there are other electronic payment solutions being built on blockchain that are not completely anonymous. Various banks and money transfer organizations are looking at using blockchain technology to create electronic payment solutions with a robust regulatory framework, in which the identity of an individual is well established. This entails several benefits: for example, the blockchain could facilitate, in a couple of minutes, the negotiation of credit which currently takes about 2 to 3 days.

c. Concerns raised

Many issues need to be discussed in view of the challenges in bringing the blockchain technology into practice. These issues will still need to be looked into as part of the many ongoing pilots. Questions around security and privacy, for example. Each ledger is cryptographically secured so that people are prevented from tampering with current and past transactions. Such a tamper-proof record of transaction has become a source of trust in all the data on transaction history embedded in a certain computerized network. Unlike cryptocurrencies (represented by Bitcoin), whose owners do not behave as individuals within the network, other kinds of blockchain applications are not immune to the possible outflow of personal or confidential information. In the words of a Deloitte report, many such applications “require smart transactions and contracts to be indisputably linked to known identities, and thus raise important questions about privacy and the security of the data stored and accessible on the shared ledger”. In theory, blockchains have a notable security flaw: if more than half of the computers working as nodes to serve the network tell a lie, the lie will become the truth. This is called a ‘51% attack’ – the potential defect of blockchains, inter alia,

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7 Deloitte (2016), 12.
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of Bitcoin – that could occur particularly in the process of “mining”. More specifically, the majority of the network’s computing power that has been taken over by a (group of) attacker(s) prevents it from spotting and rejecting a fraudulent version of public ledger.

Another concern relates to the decentralized nature of blockchain; the network lacks its centralized oversight function and it thus has no effective trouble-shooter that should work in the event of contingency, thus reducing the resilience of the entire system. In other words, each participant could suffer directly from some external shocks.

The problem of scalability is also a point of discussion with regard to the challenges of blockchain. By doing away with centralized processing, blockchain-driven networks make transactions happen in a highly efficient manner. This nonetheless means that individual nodes – computers collected to the network – always and simultaneously perform the common tasks of validating and relaying transactions, without having or relying on the host computer. The creation of a new industry-wide ecosystem making the most of the distributed ledger technology represents nothing but the expansion of the given network with an increasing number of (new) participants – nodes and their users, which will place further stress on that network when it processes transactions. This may cause delays in transactions, reduced performance and increased fees and charges (associated with the ‘usability’ for processing). In a nutshell, such a duplication of effort as reflected in the ‘usability’ of networks casts a shadow over the potential for blockchain applications to be developed for use at large scale prevents it from spotting and rejecting a fraudulent version of public ledger.

2. Internet of Things (IoT)

a. What is IoT

IoT is the inter-networking of physical devices (also referred to as “connected devices” and “smart devices”), vehicles, buildings and other items embedded with electronics, software, sensors, actuators, and network connectivity which enable these objects to collect and exchange data. Simply put, the IoT transforms physical objects into smart devices to communicate, as well as to interpret information from the surroundings. It is used to make our lives more comfortable, and our businesses more efficient and less costly.

Use of IoT today is very broad. Connected things, such as ATMs and airline check-in machines, have been in use for many years now. But, new and novel devices, and many ordinary objects, are now being reinvented by means of digital sensing, computing and communications capabilities. IoT has incorporated many kinds of physical goods (e.g. home appliances, security cameras and garbage containers) into big data applications.

The IoT has become a powerful force for business transformation, and its disruptive impact will be felt across all industries and all areas of society. This sudden expansion will boost the economic impact of the IoT as consumers, businesses, city authorities, hospitals and many other entities find new ways in which to exploit the technology. Gartner forecasts that by 2020, 25 billion connected things will be in use and that IoT will support total services spending of $263 billion.

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8 This concern was highlighted by Satoshi Nakamoto when he launched Bitcoin.
Total of connected devices, billions of units (installed base)

Source: Gartner (November 2013)\(^{11}\)

Smart devices for household applications may be the main focus of IoT which will offer a smart home where all electronic devices are connected, capable of communicating with each other and sending information whenever it is necessary.

For example, sensors in the walls will be able to detect your presence in the room and control the air conditioner's temperature. Smart sensors attached to the door will help to open and close the door once someone reaches its vicinity. It can also trigger some events like turn on or off the lights in the room or adjust the airflow to the room. Smart water level sensors can monitor the use of water and control the flow of water in a proper manner etc.

A smart city uses technology to improve the efficiency of its services. IoT allows city officials to interact directly with the community and the city infrastructure and to monitor what is happening in the city, how the city is evolving and how to enable a better quality of life. Through the use of sensors integrated with real-time monitoring systems, data are collected from citizens and devices – then processed and analyzed.

Ultimately, the objective of smart cities is to increase efficiency and reduce costs and consumption. Furthermore, smart city applications are developed to manage urban flows and allow for real-time responses. A smart city may therefore be more prepared to respond to challenges.

A smart city can include energy and water management, smart lighting, predictive life maintenance for i.e. elevators, traffic monitoring etc. Examples of Smart City technologies and programs have been implemented in Milton Keynes, Southampton, Amsterdam, Barcelona, Madrid, Stockholm and in China. In Singapore, a Smart Nation Sensor Platform will be implemented to improve municipal services, city-level operations, planning and security, for a smarter, greener and more livable city.

Now we are able to connect our cars with smartphones and specially designed applications can be used to perform certain tasks. Many sensors in the car collect information and send it to a service team or manufacturer’s database. These data will help the manufactures to track and monitor how individual units perform. It will also help the design team to continuously improve their product.

IoT can also be used in other areas such as healthcare, smart farming and agriculture, wearable technology (smart watches) etc.

However, there are risks. Each device which is connected to the IoT increases privacy and security concerns. These concerns range from hackers stealing our data and even threatening our lives to how corporations can easily uncover private data we provide them with. Hackers could potentially remotely control cars and remotely accelerate or decelerate the car, control baby monitors, other home appliances etc.

The fundamental security weakness of the IoT is that it increases the number of devices behind the network’s firewall. Ten years ago, most of us had to worry only about protecting our computers. Five years ago, we had to worry about protecting our smartphones as well. Now we have to worry about protecting our car, our home appliances, our wearables, and many other IoT devices.

Companies pressured to get their devices out in the market quickly end up compromising on security. Even if they may offer firmware upgrades for a time, they often stop when they focus on constructing the next device, leaving customers with slightly outdated hardware that can become a security risk, or bring forth compatibility issues. Furthermore, connecting large numbers of new devices to the internet can create serious bottlenecks in telecommunication systems.

b. Links between IoT and other technologies

There is a very logical link between the different disruptive technologies which needs to be kept in mind when considering how one or more can be used to support a certain business. Latest technologies are rarely unrelated and most of the time support each other in one way or another. For example: mobile technologies are incorporating more and more artificial intelligence (AI) and machine learning to improve client service; AI is an important part of robotics; IoT relies to a large extent on internet and cloud computing etc. Some interesting examples are provided below.

- IoT and Robotics

IoT can prove to be very advantageous in supporting robotics. For example, Asea Brown Boveri (ABB) has been finding ways to integrate all of the sensors and devices on a manufacturing shop floor to improve all areas of their operations, including reducing the downtime of robots, improving the reliability of systems and optimizing processes.

There are great benefits when every robot is able to store and analyze its own usage data, then is able to communicate that data smartly to other connected devices. For example, it means that ABB doesn’t have to schedule the maintenance of a robot by a simple, old-fashioned "after 10,000 hours of uptime", which might be overly conservative. Instead, the robot itself can monitor its own actual usage and report on its performance. ABB can schedule maintenance of the robot at the perfect time to avoid interfering with its operations, by looking at when the robot is actually used most. It can also mean that potential problems are addressed in a timely manner.

In 2014, KUKA integrated with Microsoft's Azure IoT platform to create a "connected factory" of 60,000 devices and 259 robots. This 24-hour automated factory is able to manufacture
automobiles very flexibly thanks to the IoT approach. This application shows that IoT concepts can be well and truly integrated into industrial robotics.

- IoT and Biometrics

With the growth of IoT and biometric technology, authentication is being completely reimagined in smart homes, smart cars etc. Passwords and PINs are easily forgotten or guessed, but no two people have the same biometric indicators. Enterprises across sectors are looking to biometrics for their authentication needs. The fingerprint, face or iris are always with a person. The latest Apple and Samsung mobile phones, as well as many new desktop and laptop computers, already contain embedded biometric sensors.

However, biometric authentication brings in a major concern for companies: protecting biometric data. Traditionally, biometric data is stored in one location and if someone wants to authenticate to a system, they provide their unique info, which is then compared to the database. There’s a core defect with this, however; it creates a central repository of sensitive data that is a valuable target for malicious activity. There are, however, solutions for such issues. For example biometric tokenization operates similarly to the commonly known form of encryption used to secure payment card numbers and other sensitive information. When implemented properly, biometric authentication can be used for a connected home, connected car, and smart lock.

- IoT and Virtual Reality

Virtual Reality (VR) and IoT share a similar basic philosophy and purpose. Both are about the merging of the physical and the digital world. By combining VR and IoT two innovators have created what could be the next step how we communicate with each other over long distances. The two products, Empathy VR and the OdenVR Telepresence Robot pair a virtual reality head-mounted display with a highly mobile remote-controlled robot. The ability to both look and move freely within a real-world space creates a very strong illusion of actually being present.

One of the most dramatic confluences of VR and IoT has been the technologies used in the healthcare field. Robotic-assisted surgery is already in use across the world using innovations like the da Vinci Surgical System. Using a tiny camera and precision surgical tools, the da Vinci allows a surgeon to perform minimally invasive surgery from a control console that looks like something out of Star Trek. By inserting the camera and tools through a comparatively small opening in the body, the surgeon can gain a full view of the operating area without subjecting the patient to the trauma of a large incision.

- IoT and Artificial Intelligence & Machine Learning

IoT relies on sensors across assets and goods, which transmit signals to core systems. This results in a massive amount of data being recorded and analyzed every millisecond, and businesses need the right systems to understand it. The smartest businesses use this information in combination with AI and machine learning to enable evidence-based prediction of what will be needed, when and where.

The fusion of IoT and AI includes smart sensors (or intelligent sensors) which provide real-time data and feedback information fulfilling a number of different capabilities:

Predictive: Real-time data can be analysed to determine when a large piece of machinery or equipment will break down, enabling the failure to be prevented through proactive intervention.

Prescriptive: Intelligent sensors can suggest immediate action sometimes in remote areas, thus avoiding outages and even disasters. For example, sensors on railway tracks can warn the control centre of any track failures.
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Adaptive/autonomous: Continuous data feeds from sensors can enable systems to learn the right actions to take autonomously. For example, in a healthcare context, blood glucose sensors can automatically change the level of insulin delivered in response to patient needs. Similarly, monorail systems in many airports and cities run autonomously without any human drivers.

- IoT and blockchain technology

One of the key links in this case is that blockchain technology can help security of information in the IoT and reduce costs. Namely, with blockchain technology, IoT data can be managed without setting up a complex and expensive centralized IT infrastructure where devices rely on a central cloud server to identify and authenticate individual devices. With every legitimate node being registered on the blockchain, devices will easily be able to identify and authenticate each other without the need for central brokers or certification authorities, and the network will be scalable to support billions of devices without the need for additional resources. IoT devices will interconnect in a reliable way while avoiding threats such as device spoofing and impersonation.

c. Current use in logistics and supply chain management

Where trade in goods is concerned, stakeholders such as manufacturers, shippers and logistics operators have focused on ensuring that the vast array of data ranging from personal transaction history to the location of containerized goods can be put to practical use, with a view to providing quality service and enhancing the connectivity to be reflected in the supply chain. A recent survey by GT Nexus and Capgemini found that 70% of retail and manufacturing companies have already started a digital transformation project in their supply chain and logistics operations.

Asset tracking has become so important for supply chain management. It gives companies a way to make better decisions and save time and money. IoT is used for monitoring the movement of goods in real time. This includes monitoring the position of the container, which can help in voyage optimization. For instance, if there are blockages on a certain road, the lorry could be rerouted to save time and money.

Fresh vegetables might last a week with no variation of temperature, but not if they warm up for a few hours. According to the Food and Agriculture Organisation of the United Nations, up to one third of food perishes in transit every year. Refrigerated containers (reefer containers) carrying perishable goods are equipped with sensors measuring temperature, light and humidity, for example, which will contribute to food safety and prevent/reduce spoilage. The changes in temperature can trigger alerts that will be followed by mitigation action.

Special apps can also help the customer receiving the goods verify whether the arriving parcel is correct, by using a bar code reader.

IoT has contributed to the growth of E-Commerce. It has transformed how people buy – through Omni channel sales and superfast shipments. Companies such as Amazon and Alibaba are able to deliver in one hour of order, and rely on the technology to move every item with accuracy and on time. Amazon warehouse robots show just how much technology and devices/equipment connected through the internet can contribute to the speedy delivery of goods. Profit driven companies are taking the most from the technologies to ensure even more profit. Some postal services use smart mailboxes in remote areas to see whether they are empty and avoid a wasted journey before collection.

Asset tracking is not new by any means. Freight and shipping companies have used barcode scanners to track and manage their inventory. But new developments are making these scanners obsolete, as they can only collect data on broad types of items, rather than the
location or condition of specific items. Newer asset tracking solutions offer much more vital and usable data, especially when paired with other IoT technologies.

There are several new pieces of technology that are already changing how logistics companies work. First are RFID tags, which provide data on items to which they are attached. Internet-connected trackers use long-range networks or Low Power Wide Area Networks (LPWANs) to let companies track specific items throughout their delivery journeys. In the same vein, satellite trackers provide location data on an item almost anywhere on the planet, even in areas that do not have cellular coverage.

Bluetooth, ZigBee and Wi-Fi are adequate for consumer-level IoT implementations. The need for a technology such as LPWAN is much greater in industrial IoT, civic and commercial applications. In these environments, the huge numbers of connected devices can only be supported if communications are efficient and power costs low.

Bluetooth tags and beacons offer tracking data in smaller, more confined areas, and companies most often use them in retail stores to monitor customer traffic and offer marketing messages to said customers.

Finally, near-field communication (NFC) tags, based on RFID standards, allow workers to use their mobile devices as readers for the NFC tags, which provides an advantage over RFID tags and readers.

d. Potential use in Customs and border management

Suppliers and consumers are digitally connecting in real time. Big companies are using IoT to track their goods and improve customer service. The question is how can Customs and other border agencies plug into this network and benefit from this information, based on integrated supply chain management principles, to ensure that trade facilitation and security requirements in the movements across borders are met.

Disruptive technologies could make it possible to accomplish these two goals, but in order to succeed, the innovations must benefit both the private sector and governments in several different ways. Political leadership must see a match to public policy goals and developers must see profit opportunity in the development of tools. On the other hand, the suppliers must see a benefit from their side, and improved client service would be an important one. In September 2018, Singapore Customs launched the Networked Trade Platform (NTP), to give traders a one-stop interface that will enable traders to interact with all business partners, stakeholders and regulators on trade related transactions. Being an open digital platform, it allows service providers to develop new applications and foster innovation within the trade ecosystem.

Customs administrations would not be expected to monitor movements of cargo/shipments in real time. However, what would provide an added value would be strengthening cooperation with certain stakeholders (shippers, carriers, forwarders etc.) that have employed IoT applications, with a view to promptly obtaining any information that corresponds to certain risk factors. Customs administrations would be able to focus on using analytical tools to identify high-risk and low-risk shipments and supply chains based on information collected through IoT technology.

However, it should be mentioned that, bearing in mind the fact that all that is connected to the internet or interacting with internet can be geo-located is now an important new parameter which may also provide new opportunities to Customs.

As IoT is in particular used for monitoring the movement of perishable goods to avoid spoilage and loss, this information would help Customs and other relevant border agencies understand which shipments are more urgent for release and clearance, and give them priority in the release/clearance procedure. This would also help Customs ensure that health
safety concerns have been met, as information on the temperature readings throughout the supply chain would be available.

With the IoT, a lot more is being ordered through the internet and is therefore contributing to E-Commerce growth. The IoT can provide information on the goods, where they are and when they can be delivered. If Customs and other border agencies have this information available in advance, they can provide feedback on when the goods could be released and estimate the costs of duties and taxes, for example.

IoT is the underlying technology of so-called Smart Port Logistics which is operational for example in the port of Hamburg. Due to lack of space, the port operator has to increase efficiency and make sure that containers are moving swiftly in and out of the port. This means informing lorry drivers (or the railways) of the exact time of arrival of containers, for example, so that they would be spending the least time possible in the port. Consequently, IoT can inform Customs which shipments would need to be cleared more urgently and allow for a certain order based on priority identified by both Customs and the port.

Logistics operators could prove to be very important partners in both trade facilitation and control and inform the authorities of any suspicious occurrences in the supply chain. Using companies’ track and trace solutions for Customs purposes could be a huge advantage.

IoT can help inform on the amount of parcels arriving for clearance to a certain Customs post and potential delays. Artificial intelligence could help identify, based on the number of staff, how long potential delays at the Customs post will be. It can also track down individual parcels and boxes in the shipment marked with serial numbers which could speed up the process of singling out those which have been selected for physical inspection based on risk assessment.

Customs will also be able to react to the incidences of any irregularity in a timely manner, while preventing them from leading to serious offences being committed within the Customs territory.

3. Artificial intelligence (AI) and machine learning (ML)
a. What is Artificial Intelligence?

Artificial Intelligence (AI) is an area of computer science that focusses on the creation of intelligent machines that work and react more like humans. AI refers to systems that change behaviors without being explicitly programmed, based upon data that is observed, collected and analyzed. AI is a broader term that includes different technologies such as machine learning, deep learning, computer vision, natural language processing that taken individually or in combination, adds intelligence to applications. AI is the next big technological development where information systems are patterned on biological systems, giving computers human like abilities of hearing, seeing, reasoning and learning.

AI is not new; however, it has only more recently received prominence and attention due to a combination of technological developments and events. The accessibility of cloud computing and the large-scale availability of processing power, combined with the exponential increase in data, has brought AI into focus more than ever before.

IoT, or the Internet of Things, is one of the newer sources of data that has helped fuel the tremendous growth of AI. IoT is an enabling technology. By connecting sensors and devices to the internet and managing this centrally through the cloud, allows for new opportunities that provide greater insight, allowing for quicker decision making and response times to occur.

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As computer power continues to grow, algorithms and AI models have become more sophisticated and many different use capabilities have arisen. AI and machine learning are frequently used interchangeably, however, they are not the same thing. Machine learning can be looked at as a type or sub-set of AI or rather the “application” of AI where machines access data and learn for themselves.

AI is currently being used in a variety of ways around the world. Voice directed personal assistants and chatbots such as Siri, Alexa and Xiaoice have transformed how people communicate with machines and with technology. Utility companies use AI to forecast electricity demands which allows greater accuracy in planning for high and low periods of demand. Behavioral algorithms are used in thermostats allowing for room temperatures to be adjusted automatically based upon who is in the room. Robots powered by AI run warehouses and automatically replenish stock. AI is being used in weather forecasting, in areas of livestock management and in food safety. The automotive sector has invested heavily in the use of AI in semi-autonomous and autonomous vehicles. The healthcare sector is using AI in medical diagnosis and in-patient data processing. Supply Chain and Logistics usage is seen in supply and demand forecasting, in manufacturing and in transportation.

Source: Tata consultancy services survey of 835 companies, 2017.¹²

b. How can AI be used in Customs and Border Management?

Use of AI in Customs and Border Management presents a tremendous opportunity in the cross-border movement of people and on the commercial side. As huge volumes of data are generated by people and goods moving across borders, AI provides the ability to make sense of this huge and ever-increasing amount of data. AI technologies can be used to ingest all this data, detect and predict patterns more accurately than humans can. Visual search and facial recognition, behavioral and predictive analytics that is being used already in other sectors can also be further tailored for use in Customs and Border Management.

AI can be used for the following purposes:
- Revenue collection models, ensuring that the appropriate duties and taxes are collected at the border;
- Classification of products under the Harmonized System (HS), simplifying things for the user and enabling greater compliance and certainty for both Customs and the private sector;
- As part of Customs audits to identify anomalies much quicker and thereby enable the Customs auditor to focus on areas of non-compliance;
- To improve risk-based targeting of commercial shipments, as well as to provide and analyze data during shipment inspections using augmented/mixed reality glasses in detecting contraband and counterfeit goods;
- Analyzing container image made by X-Ray scanners to improve efficiency of cargo inspection;
- Logistics monitoring and control in the Customs warehouses and bonded areas;
- Identifying high risk passengers and vehicles by using facial recognition and visual search at the border. This can be further expanded to create intelligent analytics to predict future outcomes enabling better risk management and preparedness;
- Providing better service by placing enquiring robots for passengers at the border;
- Providing Customs duty self-payment service by developing mobile apps at the border, etc.

IoT devices can further enhance existing technologies already in place at border crossings by supplying additional data that can be used by AI for rapid decision-making purposes by the Customs officer. Time series data gathered can be analyzed to see what patterns and trends emerge, providing greater insight. The advantage of Customs is that it already has at hand a large amount of data that can further be processed for accelerating smart decision making at the border.

The vision of Globally Networked Customs (GNC) can be realized through leveraging technologies such as blockchain and by applying AI in the end to end intelligent monitoring of the entire supply chain. AI can manage the process of who gets access to what data and when, ensuring that the appropriate levels of control are in place.

c. Benefits and Risks

We are entering a new era where AI will enable us to overcome the limitations of capital and labour. AI provides the potential to significantly increase economic growth and generate significant opportunities for countries.
Significant benefits can be gained through the use of AI that will create new jobs, will extend people's capabilities to perform tasks more accurately and efficiently, providing better services, enabling even faster innovation to occur along with putting customers in control to protect their data. Along with benefits, come certain risks though, if not managed properly. There is a need for strong ethical principles combined with robust compliance and legal frameworks within which AI operates to ensure that AI is not misused. There is a need for clear and authoritative guidance on how AI can be used, especially in the context of communication using chatbots. As use of AI increases, labor market reforms will be needed along with job skills training to meet the new human resource needs as the nature of work changes. In the use of AI there is the need for a shared responsibility between the public and private sectors. AI needs to be transparent so that there is awareness of how the technology works and what the rules around its use are.

AI risks also include the use of AI for malicious purposes and could also create uncertainty and distrust in the accuracy of data. Data security can be easily threatened by malefactor using AI technology. Fake content can be more readily created using AI and introduced into business streams. Exploitation of AI systems could occur thereby skewing the results. The integrity of the underlying data and information will be paramount. Additionally, provisions for appeal of AI-based information and determinations, such as HS classification tools, are needed to ensure effective compliance. Access to robust and transparent redress mechanisms will be required to ensure the integrity and ongoing improvement of AI processes.

We are entering a new era where AI will enable us to overcome the limitations of capital and labor. AI provides the potential to significantly increase economic growth and generate significant opportunities for countries.

d. Potential Future Use

AI can greatly assist almost every function in government. Implementation of chatbots in government agencies can greatly enhance the communication between the government, companies and citizens. Chatbots are interactive applications that are powered by AI and interact with users through natural language. A chatbot could serve as a channel of access to Customs in situations where certain services could be delivered more efficiently and cost effectively. Chatbots can rapidly capture and manage large volumes of user requests and sort through information and databases to deliver results to the user. Routine communication can be automated, questions answered, recommendations made, which would free up officers to focus on higher-value work. The types of government services provided could be transformed and government operations optimized. Predictive analytics for management of services and management of assets can be used for forecasting demand and measuring levels of usage. More effective compliance in reporting and in collection of taxes and duties can be attained.

Use of AI with augmented or mixed reality glasses could be used by Customs for training purposes as well as for shipment inspections and in the detection of counterfeit and contraband goods. Data would be available in real time, enabling the officer to make quicker determinations thereby increasing the number of inspections, accuracy and volume of goods that could be reviewed.

e. Frequently Asked Questions

1. What is AI?
   - AI is not one type of technology but rather a broader term covering multiple technologies which includes machine learning, deep learning,
computer vision, natural language processing and other technologies, used individually or in combination, to add intelligence to applications.

2. **What is Machine Learning?**
   - Machine learning is a subset of AI that provides computers the ability to learn without being explicitly programmed.

3. **What is Deep Learning?**
   - Deep learning is a subset of machine learning algorithms that learns by using a large, many-layered collection of connected processes and exposes them to large sets of examples. This layered structure of algorithms is called artificial neural networks and is inspired by biological neural networks that the human brain uses. Deep Learning helps enable computers to hear, see, speak and even understand natural language commands.

4. **What is Quantum Computing?**
   - Quantum computing applies the properties of quantum physics to process information. This enables the processing of information in a fraction of the time that it would take normal computers to perform. Quantum Computing is still in its early stages and will take several years to fully develop and implement outside of the lab environment.

5. **What is Cloud Computing?**
   - A computing model for storing and accessing data and programs over the internet instead of on a computer’s hard drive.

6. **What is IoT?**
   - IoT, or the Internet of Things, is a system which connects sensors and devices to the internet which enables the collection of data and the analysis of that information to create new insights and enhance decision making.

7. **Is AI a new field of technology?**
   - No. The technology has been developed over several decades. However, due to the greater accessibility of cloud computing, increasing computer processing power and an exponential increase in data, AI usage and development has received greater visibility and usage.

8. **What can AI do?**
   - AI can take in more data, detect and predict patterns more accurately than humans can. Use of AI can lower costs and mitigate risks.

9. **Will jobs be lost due to AI?**
   - Some jobs will be lost while new ones will be created. Workers will need to gain skills that are relevant in the changing workplace as new skillsets will be required for new markets.

10. **What risks does AI pose?**
• Workforce inequality could arise through increased automation and use of AI making certain jobs redundant. There could also be privacy and ethical concerns arising through the misuse of AI. Bad data could be intentionally introduced into the ecosystem.

11. How can Customs implement AI?
• AI can be implemented in different areas and stages based upon Customs’ need. This can be through software or combinations of software and hardware. Specific use cases would need to be created based upon priorities and returns on investment. Initial implementation is usually in areas of IT (Information Technology) and in data analytics.

12. What are the prerequisites to AI implementation?
• To implement or integrate AI, intelligent software applications and tools need to be built for Customs use. Software developers and data scientists need to understand what the objectives are and build them for Customs’ use. Pre-built software services such as vision, speech, language, knowledge and search can be leveraged and tailored for specific use or custom software applications and algorithms can be built for specialised use.

13. Is AI a stand-alone application/technology?
• AI is not one technology or stand-alone application but rather an umbrella term that includes multiple technologies and applications.

14. What other technologies does AI support and how?
• AI is a broad term and is composed of a number of other technologies. AI can be integrated with legacy systems as well as with newer cloud applications. AI algorithms can be tailored to meet different Customs needs and types of software applications to perform basic tasks up to advanced decision making. AI can drive advanced analytics, operate virtual assistants or chatbots, from computer systems to advanced robotics.

15. In which areas of Customs management can AI be introduced?
• AI can be used in almost every area where data and decision making is involved. AI can analyse huge volumes of data faster than humans can, enabling faster and more accurate decisions to be taken. AI can be introduced in automated kiosks at borders where virtual assistants or chatbots aid in screening of passengers. AI can provide information or self-help tools to traders in a 24/7 environment.

16. What kind of changes will AI bring to Customs in the future?
• AI will put more information and data intelligence at the disposal of Customs which will enable faster decision making in areas of risk management to occur both in the cross-border movement of people and goods. Through increased automation, certain repetitive tasks can be automated through AI allowing Customs officers to focus on more value-added activities.

17. What can Customs do to mitigate the risks raised by AI?
Customs can act as “guardians” in a sense, creating and defining the proper regulatory frameworks around how AI is used for Customs purposes and how the data is gathered and shared with other regulatory agencies, other countries, businesses and citizens that it interacts with. Customs can develop robust and transparent redress mechanisms to ensure the integrity and ongoing improvement of AI processes. Customs can work with the private sector to establish the framework around privacy and the pace and adoption of digital tools.

4. Biometrics
a. What is Biometrics

Biometrics is the measurement and statistical analysis of an individual’s physical and behavioral characteristics. The basic premise of this field is that every individual person is demonstratively unique and therefore identifiable via his or her physical or behavioral traits.

To understand biometrics, we first need to distinguish between biographic data and biometric data. Typically, governments and other actors seeking to verify identity use biographic data. For example, an individual’s date of birth is biographic; this information is specific and permanent about an individual, but is not readily observable from the individuals themselves without their self-reporting it or its recordation and reporting from another source. Thus, there must be an act to link the recordation of the individual’s date of birth with the individual. Biographic data includes text data commonly found on the data page of a traveler’s passport, such as name, date of birth, and country of citizenship. Biographic data is not unique to the individual. For example, many people share the same date of birth. As biographic data must be transmittable into text, it is also susceptible to error and easy to misuse.

A biometric system, on the other hand, features the use and recordation of a physical component of an individual that is unique to that specific individual and does not need to be translated into a textual recordation; i.e. the information can be collected and identified in its original source (the individual), and does not need to be transitioned to another medium (i.e. textual). In the past, due to nascent technology, the only biometric information available to law enforcement and other actors seeking to verify identity was fingerprints. For many years, even this was an inexact science, based more on the assessment of trained professionals than upon the automated identification via computer. This biometric identifier was also subject to human error, poor recordation/capturing of the fingerprint, and technological limitations in reproducing the recorded print. However, technology increasingly allows governments and other actors to identify and confirm fingerprints automatically via computer. Technology has also produced significant developments of facial recognition technology, DNA, and iris imaging, allowing new sources of information to verify an individual’s identity. Besides the aforementioned sources of biometric data, other examples can include palm veins, palm print, hand geometry, and odor/scent. Behavioral characteristics can also serve to biometrically identify an individual. Such behavioral identifiers include typing rhythm, gait, and voice recognition.

There are a number of examples of how government and private actors are utilizing biometrics to identify individuals. For example, Walt Disney theme parks are now utilizing the biometric measurements (fingerprints) of theme park guests to ensure that issued tickets are being used by the same person over multiple days of attendance. A much larger example is Aadhaar, India’s national identity program, now the largest biometric database in the world. Aadhaar is a 12 digit unique-identity number issued to all Indian residents based on their biometric and biographic data. Aadhaar is designed to enable Indian government agencies to deliver public services securely based on both biometric data (including
fingerprint, iris scans, and facial photograph), along with biographic data (name, age, gender, address, parent/spouse name, mobile phone number) of an individual. The data is transmitted in encrypted form over the Internet for authentication. As of 15 February 2018, Aadhaar had 1.17 billion enrolled members, out of India’s population of 1.31 billion.

b. Current use in Customs and border management

Customs professionals may ask why biometrics, which is focused on the identification of individuals, is relevant to the core, traditional mission of Customs, which focuses primarily on the movement of physical goods. It is true that biometrics presents a great opportunity for immigration and border security enforcement; however, looking to the future, Customs agencies will likely find many opportunities in the development of biometrics.

Customs administrations enforce laws/regulations relating to the movement of goods across borders; this inherently includes investigations of individuals associated with the subject goods, up to and including inspections, and/or investigations, prosecutions, and civil remedies against those individuals. Access to biometric data of individuals who are engaged in crimes related to trade (goods) can facilitate Customs’ efforts to identify, investigate, apprehend, and prosecute these wrong-doers. False identities could be more quickly identified via biometrics’ unfalsifiable recordation. Biometrics thus can be a force maximizer for all law enforcement entities, including Customs. Individuals identified by Customs agencies using biometric information may also alert Customs agencies to existing warrants or other information that may require additional action.

In addition, Customs administrations are uniquely situated to demonstrate useful methods for interagency coordination, which biometrics requires. Customs administrations have a long history of coordination and interagency work, as we enforce laws and regulations for partner government agencies. We are often co-located with immigration agencies, and can work to promote the adoption of and facilitation of implementation of these efforts. Customs, as a leader in coordinated border management, is uniquely positioned to bring partners together to leverage the tool of biometric data. In order to close information gaps, Customs and immigration agencies should seek to partner with one another to improve data collection, enhance existing systems, and implement automated technology, which will support the identification and targeting of persons of interest seeking to depart our countries, as well as enhance the capability to identify immigration violators.

Biometrics enhance identity verification in a border management and homeland security context. DNA is an emerging biometric in this area.
c. Potential Future use

Given that biometrics technology is still in its infancy, additional innovations and uses will likely arise as technology improves and becomes more ubiquitous. Customs agencies, other government partners, and private actors should monitor this field closely to identify additional uses. Some potential uses we can speculate include:

Biometrics can be used to verify identities and control access of Customs operators. Customs agencies frequently operate in or utilize restricted areas and facilities, including Ports of Entry, secure areas of airports, land ports, and seaports, storage spaces for weapons, vehicles, uniforms, working animals, equipment, and evidence lockers. Customs agencies also often utilize protected computer and other information systems for the storage and access to protected information. Current methods of protection utilize identify cards, passwords, and other information created by or assigned to the individual user. Biometrics allows the opportunity for the creation of a unique operator signature. An operator signature is a biometric mode where the manner in which a person seeking access to a restricted device/system or controlled area must first submit biometric information (for example, a fingerprint or iris scan) to a verification template. Thus, access would be dependent upon the biometric data that only that user possesses, as opposed to a password or biographic data which can be used by any person including non-authorized users of that information, so long as they possess it. This would greatly enhance current protections of protected locations and systems when coupled with current use of password/identification processes. This would increase not only the personal security of the Customs officers, but also the security of the information, systems, and locations.

Biometrics could likewise be utilized to prevent crime in the international supply chain. Biometrics could potentially be utilized to ensure the identity of Customs actors, including

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Customs brokers and other licensed freight-forwarders and logistics operators, ship/airplane and other conveyance crews, and other actors in the international supply chain. Technologies utilizing webcams, finger print readers, and retinal scanners could conceivably be incorporated into the work stations, entry points, and other portals of restricted access to ensure security/verification of identity. This would provide greater security and significantly decrease identity theft and other security breaches in the Customs environment. This will become increasingly important as many professions, including Customs brokers and other actors in the international supply chain, shift increasingly online.

Biometrics may also reduce the ability of shadow companies to exploit the international supply chain for illegal gains. For example, the submission of biometric identifiers could be required for registered agents for corporations and other importers/exporters. Shell corporations could be more easily investigated for alleged criminal/civil wrong-doing if governments move towards requiring biometric data of officers/agents during incorporation. Individuals performing the work of such corporations under investigation for alleged violations would be more easily detectable. Unlike biographic data recorded in fraudulent documents, biometric data is not easily substitutable/switchable.

Biometrics' greater reliability and security can be leveraged to strengthen existing security systems/ regimes. For example, biometrics could become an additional factor of consideration for assessment of authorized economic operator programs (AEO) and other supply chain security regimes. Actors in the international supply chain may seek to use biometric data to verify their drivers, crew members, and individuals with licenses or other certifications, etc. Biometrics may become commonplace in security systems the world over, and eventually become a part of the consideration of AEO certification and mutual recognition.

In the United States, U.S. Customs and Border Protection currently is building upon efforts to achieve a biometric entry/exit system, and to begin implementing biometric exit starting at the highest volume airports in 2018. CBP currently maintains an entry/exit system for foreign nationals based on biographic data. Further, CBP collects biometric data on almost all foreign nationals when entering the United States, regardless of port of entry. Through a variety of programmatic activities, U.S. Customs and Border Protection is now undertaking to develop and implement the remaining piece of the comprehensive entry/exit system by integrating biometrics into the existing biographic entry/exit system.

d. Considerations for Establishing a Biometrics Program

As Customs agencies and other actors in the international supply chain move toward the wider implementation of biometrics, there are several considerations that administrations must take into account:

- Realities of biometric data gathering/use may guide implementation: Individuals' habits and technological considerations will guide implementation. For example, in the immigration context, U.S. Customs and Border Protection is currently working on several different methods for Biometric Exit (for individuals departing the United States), including fingerprint and iris-based systems — but as the tests have wound down, facial recognition has become the most useful and easily implementable method for gathering biometrics. Unlike iris prints, the United States already has visa holders' faces on file. Unlike fingerprints, human faces are much easier and faster to record during boarding at the gate. The general public knows how to participate in taking a photo as opposed to iris or fingerprint recordation; the former is the fastest, least disruptive, and least stressful for the individuals being recorded. Indeed, properly designed systems installed in airports and other public places can identify individuals among the crowd, without passers-by
even being aware of the system. Other biometrics like fingerprints, iris scans, and speech recognition cannot perform this kind of mass identification at this time.

Performance of biometrics will also require additional technological developments to ensure reliability. The quality of biometrics recordation can vary depending upon many factors, including seemingly benign factors like (in the context of facial recognition) the presence of natural light, the type of lighting fixtures, and the height of the ceiling in recordation locations. Secondly, governments are already discovering performance differences between travellers from different countries. This includes issues with varying quality of the images in issued ePassports. In addition, false rejection rates can vary depending on individuals’ age and gender. Significant work remains to perfect this technology.

- **Legal authorities/barriers:** Customs authorities need to ensure that they have the legal ability and required protections in place to collect, share, and utilize biometric data. This can create barriers to advancing work between bilateral partners as these legal barriers are identified and potential methods to update legislation, ensure compliance with existing regulations, or mitigate risks are weighed.

- **Non-compatibility of information-sharing systems between agencies:** Information collected by immigration and other law enforcement entities may not be readily connectible to Customs systems, or useable under Customs authorities/legislation. There can be significant technological, legal, and financial barriers in addressing these barriers.

- **Physical barriers to implementation:** Airports, seaports, land ports of entry, and other facilities where Customs agencies operate may not be built in a way conducive to collecting biometric information, i.e. their construction was concerned largely with the immigration aspect of travelers and not Customs. Hardware would need to be updated or replaced to ensure efficient and safe use of this new technology; the greater security offered by biometrics and its perhaps eventual ubiquitousness may justify these significant resource needs.

- **Expectations and business practices of the trade and travelling public:** Airlines, maritime shippers, and other participants in the international supply chain will need to be involved closely in the development/implementation of biometric information collection and analysis by any government actor. Public education, and clear on-site guidance will be necessary in order to ensure the participation and compliance by participants in the international supply chain and Customs processes. Any insertion of new information checks like biometrics will also need to ensure it is implemented in a way that makes sense for existing business processes, and the value-added is greater than the additional burden of installation, maintenance, and related training.

- **Sufficient IT and personnel resources:** Implementing agencies will need to ensure sufficient IT resources, including software, hardware, privacy protections, bandwidth, etc. Administrations will need to ensure nimbleness to determine flaws in processes identified by the current testing, and determine reliable and cost-effective enterprise biometric solutions.

- **Political will:** All of these challenges require significant time and resources to address. None of this can be accomplished without the support of leadership. The value of biometrics must be demonstrated to ensure buy-in from Customs agencies and other users. There exists significant political will for automation/simplification of Customs processes. As biometrics becomes more common, it may actually piggy-back onto this process as ubiquitous technology as opposed to a separate effort of adoption.
Concerns About Security and Use of Biometrics Data:

There are significant concerns by many about the use of biometrics, in particular that its use may not be limited to mere identity verification. Biometrics can be used to keep airports and seaports secure, but can also be used to identify individuals participating in public protests, as well as remove anonymity of movement in a world already replete with security cameras and access chokepoints. However, many users have already willingly surrendered significant privacy due to the benefits of convenience, access, and security it has provided (examples: cellular phones and location technology, credit cards, security cameras).

A new restriction on access to a location or system inherently creates an incentive to falsify information in order to gain access; care will need to be taken that biometric information originally submitted is accurate, and work put into the ongoing monitoring of the integrity of these systems. Any system must contain protection of information susceptible to security breaches/hacking. We must not become overly confident that biometrics will eliminate identity theft and other forms of fraud in Customs enforcement.

- **Cancelable biometrics**: One advantage of a password or other assigned identifier system over biometrics is that password-based identifiers can be re-issued. If a token or a password is compromised, system administrators can cancel and replace this identifier by a replacement. This ability is not naturally available in biometrics. If the recordation of an individual's face, iris, or other biometric data is compromised through technologic error or deliberate sabotage, the individual cannot cancel or be reissued a new verifier; instead, the system has to be updated to clarify that the individual's original biometric data is valid.

- **Burdens of hardware**: Where previous systems and locations access was obtainable via biographic or password identifiers, biometric data requires physical presence and participation by the individual from whom the biometric data has been gathered. This can require the installation of hardware in multiple locations to enable the recordation and verification of biometric identifiers for individuals seeking to gain access to systems from remote or disparately located work stations. For example, a Customs broker could be required to submit biometric data to confirm their identity, and have to purchase an iris scanner in order to submit this data from their office. This creates a new burden of procurement, and integrity of hardware, for governments and other actors in the international supply chain, and could present an unfair burden on small businesses and individuals over larger companies.

- **New danger to individuals**: When individuals seeking to compromise security cannot get access to secure systems/locations, the limitations of biometrics increase the chance of physical danger to possessors of biometric information that can access said systems/locations. If the item is secured with a biometric device, the damage to the owner could be irreversible, and potentially cost more than the secured property. In a particularly gruesome example, in 2005, Malaysian car thieves cut off the finger of a Mercedes-Benz S-Class owner when attempting to steal the car which required a fingerprint scan to function. This creates a new threat to Customs officers and actors in the international supply chain.

- **Merely stop gap in information/location security**: Creating a new method/system to secure a system or a location inherently creates the incentive to hack or otherwise overcome that method/system. There are innumerable examples of secured communications and systems by wealthy and powerful government and private entities being compromised by criminal organizations and entities seeking to harm or destabilize these system users (examples: WikiLeaks, Panama Papers) as well as terrorist
organizations and their supporters. It is not unforeseeable that the widespread adoption of identity verification technology utilizing biometric data will beget technology which can overcome these checks (for example, distortion technology to make a face appear to look like another; contacts or other inserts which allow retinas to mimic another person’s; or technology to alter or create false records on the otherwise legitimate biometric data collected on individuals). This is the perpetual challenge of law enforcement attempting to stay ahead of bad actors.

Biometrics can offer innovative opportunities for law enforcement; but it also requires more of the basics that Customs agencies are always seeking to achieve, i.e. coordination, information sharing, and mutual support and trust. International forums like the WCO will be important forums for sharing success stories and cautionary tales on biometrics, and the determination of needed international standards, for fostering cooperation, mutual assistance, and information sharing.

5. Drones
   a. What are drones

According to Webster’s dictionary, drone is an unmanned aircraft or ship guided by remote control or onboard computers. Unmanned aerial vehicles (UAVs) are a component of an unmanned aircraft system (UAS); which include a UAV, a ground-based controller, and a system of communications between the two. The flight of UAVs may operate with various degrees of autonomy: either under remote control by a human operator or autonomously by onboard computers. Compared to manned aircraft, UAVs were originally used for missions too “dull, dirty or dangerous” for humans. While they originated mostly in military applications, their use is rapidly expanding to commercial, scientific, recreational, agricultural, and other applications, such as policing, peacekeeping, and surveillance, product deliveries, aerial photography, agriculture, smuggling, and drone racing. Civilian UAVs now vastly outnumber military UAVs. The market for UAVs, is expected to reach some 13 billion U.S. dollars by 2025. Commercial UAV production for mini-UAVs is currently valued at 58.4 million U.S. dollars, so they can be seen as an early commercial application of autonomous things, to be followed by the autonomous car and home robots.
In the trade environment, modes of physical delivery of goods are being continually re-defined. The latest entrant are drones, which are being tested not only for domestic deliveries, for instance within a town, but even for cross-border deliveries. Some express service providers and postal operators are already testing/piloting the use of drones for parcel deliveries at local level in nearby areas. For example, Swiss Post had a trial drone-borne parcel service for packages weighing up to 1kg, and many others, including Amazon, UPS and Google, are looking at similar ideas to use drones for delivery in the not-too-distant future. Wal-Mart trialed the use of drones for grocery and retail deliveries at some of their rural big-box stores in the US.

DHL tested its "Parcelcopter" in an experiment that ran between mainland Germany and the island of Juist in the North Sea, a distance of 12 kilometers, from September to December 2014. The Drone, weighing about 11 pounds, could reach a speed of up to 65 kilometers per hour at an altitude of 50 meters above the sea. It made 40 flights to and from the Island, carrying urgently needed pharmaceuticals in its waterproof payload compartment.

b. Use of Drones for Cross-Border Delivery of Goods

Drone technology allows a high level of autonomy. Using GPS signals for navigation and Wi-Fi for communication, some models require human operators to guide the vehicle manually by remote radio control, using on-board cameras that can act as digital eyes over several

Source: Geospatial World

miles, depending on battery life. Other, more sophisticated vehicles can follow entirely pre-programmed takeoff, flight, delivery and landing routines without human intervention.

Further technical benefits that trigger assumptions of increased use of those new delivery modes are related to less weight of unpressurized drones leading to big drops in fuel consumption, less noise and faster turnaround time in comparison for instance to conventional aircrafts. The Delft University of Technology designed an unmanned containerized cargo freighter that can reduce the cost of shipping by air and the time required for inter-modal transfers and transport on the ground, called ATLAS. The lift generating body of the design helps to make it more fuel-efficient compared to a conventional design.

Prototypes are being developed of drones capable of 10 to 30 tons of cargo that could fly from China to Europe in 12 hours with optimal fuel consumption, and which could serve airports that freighters or cargo-friendly wide body passenger aircrafts do not serve at present.

With these developments, the potential for the use of more developed generations of drones for commercial delivery of consignments within a country and across borders at a marginal cost is not too farfetched. Drones can play a very important role when it comes to making an urgent and efficient delivery to a remote place - be it medicines for a critical patient or an urgent spare part to a shut-down oil rig. Drones could equally be useful in first and last mile delivery and thus, improve and supplement the overall efficiency of the supply chain. The use of drones can also be expected to appear in cross-border deliveries in neighboring countries, notably in regions which lack adequate road transport infrastructure.

c. Regulatory Issues

Before the commercial use of drones in international trade supply chain becomes a reality, several issues/concerns relating to safety, security and privacy as well as regulatory issues including managing airspaces need to be addressed/resolved by concerned authorities together with all stakeholders involved. There is a need to review, potentially update and/or develop global standards on safety, privacy and data protection. Equally, thoughts need to be given to developing an aeronautical data exchange, processing, and synchronization network that accounts for unique requirements of drones, while at the same time internationally harmonizing drones regulations, potential certification standards, and operational procedures.

Some civil aviation authorities, for example in the US, the EU, China and the UAE have already initiated developing a new set of rules and regulations related to the movement of drones. In one such proposal, a drone that weighs less than 25 kilograms and flies at an altitude of lower than 150 meters will be exempt from an airworthiness certification but will still need to register with the respective civil aviation authority. Those weighing from 25 to 150 kg will have to go through airworthiness certification before they are allowed to operate. All flights performed by drones will be required to submit a flight plan before an aircraft takes off.

Another thought under discussion is to create an airspace between 200 to 400 feet above the ground for high-speed drones to operate out of line-of-sight, while smaller, slower drones would be restricted to flying below 200 feet. A 100-foot airspace between 400 and 500 feet would be a “no-fly-zone”, which would serve as a buffer between drones and conventional aircrafts. All drones would be connected to the internet, so they could be tracked and receive warnings if they are in danger. Further, to avoid mid-air collisions, drones must be able to communicate with each other and should have the capability like traditional aircrafts to “sense-and-avoid” another object in the air.

The International Civil Aviation Organization (ICAO) is working on new safety standards for 2018 on large drones/ Remotely Piloted Aircraft Systems (RPAS). The IACO’s Aviation
Security (AVSEC) Task Force on RPAS recently identified numerous security challenges (including the issue of cross-border operations) that would need to be addressed in the near future. These issues will be discussed at future ICAO AVSEC Panel meetings. The December 2018 Gatwick Airport drone crisis that lasted for 38 hours with 120,000 passengers’ flights being disrupted, showed some of the challenges posed by this new technology.

d. Potential Impact on Customs

The use of drones’ in the Customs environment does no longer belong to the "generation next". It is already being used by a few Customs administrations (for instance in the US and Dubai/UAE) for surveillance and monitoring purposes.

On the other hand, there is an emerging opportunity as well as challenges regarding the use of drones as a mode of delivery. Clearly, Customs need to monitor, analyze and comprehend emerging developments concerning the use of drones and related regulatory developments and come up with an appropriate policy response, together with potential adjustments of Customs procedures and requirements, where needed.

Customs can delve into these developments mainly from two perspectives – as a user and as a regulator. In the law enforcement area, drones are seen as the next logical technological evolution. As already mentioned, Customs may potentially use drones for surveillance in inaccessible and hazardous terrains, filling up the gap, if any, in border surveillance in those areas. Equipped with infrared and high-resolution imaging, drones can be effective in border and maritime surveillance, in particular for monitoring suspects; curbing cross-border smuggling and drug trafficking; nuclear, biological and chemical sensing and tracking.

Another area to explore is the Customs regulatory perspective to meet the current and emerging challenges, especially in the context of the use of drones for cross-border delivery of illegal and legal goods. In the context of threats and/or illegal deliveries, drones themselves could potentially be used for air attacks from across the border. In addition to security concerns, another emerging threat is the use of drones for cross-border delivery of drugs and smuggling. In 2015, in the US, 28 pounds of heroin were found to be smuggled across the border by using drones. There are a number of other examples. For instance, Customs officers in southern China’s technology hub Shenzhen discovered a group of criminals using drones to smuggle 500 million yuan ($79.8 million) worth of smartphones from Hong Kong to Shenzhen. The smugglers usually operated after midnight and only needed seconds to transport small bags holding more than 10 phones using the drones. The gang could smuggle as many as 15,000 phones across the border in one night. Regulating the use of drones has become an important task for China, the world’s largest manufacturer of consumer drones. Acting on tips, law enforcement officers from both sides discovered the operation in February 2018 after months of investigation. It was confirmed that the captured gang operated since 2016.

Drug cartels are using unmanned drones to carry drugs across the southern border, challenging the U.S. technological ability to stop the advance. Border Patrol agents are increasingly worried about the threat from drug-cartel-flown drones, after agents spotted 13 drones suspected of carrying drugs across one section of the U.S.-Mexico border in just one

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16 The Washington Times - Tuesday, January 2, 2018
four-day period in November, 2017. Cartels all along the border are using drones, though the San Diego sector has been among the most active in reporting on the traffic. In August 2017, US government arrested a 25-year-old American citizen who admitted he was the pickup person. Police seized 13 pounds of methamphetamine, worth an estimated $46,000, and also seized the drone, a Matrice 600 Pro, which sells for about $5,000, can take off with a 13-pound load and can fly at 40 mph.

Heroin smugglers from Pakistan have been using drones to drop contraband into Indian villages along the Punjab border. Smugglers were recently found using drones in Punjab's Gurdaspur. The report cited that a plastic bag consisting of narcotic substances was found flying at a height of 200 meters. The drone flew back to Pakistan without dropping the package after it was noticed by the police. According to the report, the drug smugglers have been adopting newer methods for ensuring delivering narcotic substances across the borders.

It is a well-known fact that untaxed cigarettes have been one of the biggest issues in the daily life of European Union’s customs officers. Recently, smugglers are using drones to breach the border between Ukraine and Slovakia, supplying EU black markets with contraband cigarettes. Drones, flying almost silently at low altitude, cannot be picked up by the radar. Smugglers manage to have 20 flights in one hour working with drones, carrying 10 boxes of cigarettes (around $4000) each time.

The above facts are a serious warning signs, and Customs must think about how to prevent smuggling performed with the use of drones.

Being futuristic, while the prototype drones may still take some time before their industrialization and use for cross-border deliveries of (legal) goods, several regulatory concerns from a Customs’ perspective including but not limited to the following need to explored and deliberated –

1. Customs is the responsible agency for all cross-border movements of people, goods and conveyances (means of transport). What kind of control measures do Customs need to develop to monitor the cross-border movement of drones?
2. Who will be responsible for the landing of drones carrying cargo at the designated Customs stations e.g. air cargo terminals and how to ensure that?
3. How and by whom data including advance cargo information will be submitted to Customs?
4. Who will have the liability for accounting of the cargo – potential excess/shortage?
5. How to regulate and deal with new class of actors in the supply chain – operators/owners of drones?

The above and other related issues were discussed at the March 2016 PTC. Regarding challenges and threats stemming from the misuse of drones, smuggling of drugs and other contraband items, and potential use for a terrorist attack by criminal syndicates, were given as examples. It was mentioned that such enforcement related issues could potentially be

18 Retrieved from [https://www.rferl.org/a/ukraine-slovakia-smuggling/29009982.html](https://www.rferl.org/a/ukraine-slovakia-smuggling/29009982.html) December 3, 2018
discussed by the Enforcement Committee, while policy and procedural issues should continue to be discussed by the PTC.

Noting that with technological advancements and sophistication, drones could soon be used for cross-border deliveries of goods, delegates recognized that Customs was the responsible agency for cross-border movement of conveyances which included drones. In this context, some delegates opined that in addition to issues raised above, some other regulatory issues related to the use of drones for cross-border e-commerce delivery to buyers/consumers directly instead of airport-to-airport services, and control of cross-border movement of unmanned drones (as some of the existing regulatory requirements are designed for conveyances with drivers/pilots), needed to be further explored in harmony with existing regulations, and in close cooperation with civil aviation, other relevant government agencies and private sector stakeholders.

In conclusion, the PTC agreed that there was a need for carrying out further research on the topic, especially exploring more practical experiences and related policy developments, as well as monitoring and coordinating the work being done in this area by other international organizations (e.g. ICAO).

6. Virtual, Augmented and Mixed Reality

a. What are Virtual, Augmented and Mixed Reality

Virtual, augmented and mixed reality are technologies that either create a fully simulated world or add digital artifacts to the physical world\(^{19}\). Virtual reality is on one end of the spectrum, being a fully immersive technology. On the other end of that spectrum is augmented reality, where digital artifacts are added to the physical world. With mixed reality, digital artifacts are projected in the physical world\(^{20}\). Those artifacts can interact with and exist alongside physical objects. This allows the merger of both the physical and digital world. The following gives further clarity to the differences between the different (immersive) technologies:

- Virtual reality truly immerses the user in a virtual world;
- Augmented reality projects digital objects in the physical world;
- Mixed reality is the same as augmented reality with the addition that the user can manipulate and interact with digital objects.

Different large organizations are developing products using this technology. Those products are largely focused on the game industry. This is especially the case with regards to virtual reality. Examples of such products are the Oculus Rift and the Xiaomi Oculus Go.

Augmented reality and mixed reality products are also being developed with the intent of use in business-like settings. Examples of products are Google Glass and Microsoft HoloLens.

\(^{19}\) [https://en.wikipedia.org/wiki/Immersive_technology](https://en.wikipedia.org/wiki/Immersive_technology)

b. Existing Practices

Within the Customs domain there are not a lot of existing practices using virtual, augmented and mixed reality. In other industries and domains this technology is used in different ways, the oldest and most common is the use of virtual reality in a learning environment.

The Dutch Ministry of Defense uses virtual reality to simulate environments where soldiers can train specific capabilities, e.g. shooting practice. When using this technology, the costs of training can be decreased while enhancing the effectiveness.22

DHL has used augmented reality to help employees to find the right products when order picking23. Boeing has used the same technology to give instructions to employees that are assembling airplanes.24

NASA uses a prototype mixed reality headset to transport people virtually to the Moon and to Mars.25 Furthermore, the technology is used to view objects in the places that they will be used, e.g. a Moon lander or Mars rover.

c. Potential Future use in Customs and Border Management

There are different potential future uses in Customs and border management for virtual, augmented and mixed reality. Augmented and mixed reality can be used to project visual assistance in the physical world, e.g. when doing a physical inspection. This assistance can be in two forms. The first is general assistance that is provided in advance to all employees.

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22 https://magazines.defensie.nl/landmacht/2017/10/10_op-missie-in-virtuele-wereld (in Dutch)
24 https://www.theverge.com/2016/7/14/12189574/boeing-google-glass-ar-building-airplane-parts

48.
The second is the possibility that the assistance is provided by a human that can see what the Customs officer sees, in real time.

Another potential use is the visualization of big data sets. Big data is hard to visualize and manipulate for a layman. When using mixed reality, data can be projected in the physical world as digital artifacts that can be manipulated as real objects.

Last but not least, virtual reality can be used in training Customs officers. Different kinds of training environments can be created that are difficult to recreate in the physical world. For example the machine room of a large container vessel.

Since the most valuable use cases are in the learning domain the risk for Customs when using this technology is limited. Furthermore, the impact on Customs organizations of the use of technology of this kind by the general public is limited, because it is mainly used in the game industry.

7. 3D printing
   a. What is 3D printing

3D printing or additive manufacturing is a process of making three-dimensional solid objects from a digital file, using a 3D printing machine with raw materials such as plastic, metal, nylon, or other.

3D printing is widely used for industrial, medical, construction, and consumer goods. The technology is also at the early stages of adoption within the automotive and aerospace sectors, along with some applications in the consumer electronics sector for the manufacture of cases and covers for smart phones, tablets and other portable devices.

The 3D printing market has seen sustained rapid growth in recent years. Approximately 133,000 sets of 3D printers were shipped around the world in 2014, an increase of up to 68% compared with 2013. Total global sales in the 3D printing market, including printers, materials and services, reached $3.3 billion in 2014, up 34% compared to 2013. The figure was also estimated to climb to $5.2 billion in 2015 and $20.2 billion in 2020, with an average rate increase of over 30%. By the end of 2018, annual revenues from the global 3D printing market were estimated at 14 billion U.S. dollars. 3D printers and materials were expected to represent almost half the total revenues over the next four years, but it is estimated that software and related services will also experience significant growth. Computer-aided design (CAD) software and the market for on-demand parts services are expected to almost triple. Discrete Manufacturing is seen as the dominant industry for 3D printing.
Traditionally, material objects (ranging from computer chips to sweaters to automobiles) have been built in factories controlled by a single corporate entity that designs the product, manages its supply chain, produces it and sells it, directly or indirectly. 3D printing is about to kick off an era of digital transformation that will redefine such classic models.

3D printing is a new technology that could upend manufacturing modes, supply chains, business models, customer relationships and even entrepreneurship itself. 3D printing could do to physical goods what cloud computing is now doing to digital services; what the PC, internet and smart mobility have done to computing; what outsourcing has done to software development and business processing. That is, take mass distribution and innovation to the next level, while realigning the very geography of work and trade.

Technology has brought dramatic increases in industrial productivity since the dawn of the Industrial Revolution with the use of steam engines and water power, and then followed by the application of electricity, assembly lines, electronics and automation. Today, we are in the midst of a fourth wave of technological advancement - the digital industrial technology known as Industry 4.0. presents a transition from a centralized to a decentralized, highly flexible, personalized and digital smart mode of production and services.

Source: Statista\(^{26}\)

In time, 3D printing could lead to a shift towards more digital and localized supply chains and lower energy use, resource demands and related CO₂ emissions over the product life cycle. However, full realization of the potential of 3D printing depends on overcoming a number of obstacles. The necessary material technology is still nascent and building complex objects is slow. There are also regulatory issues that need to be addressed before 3D printing can be widely adopted in the consumer market. Finally, although declining in recent years, the cost of printers, materials and scans is still relatively high, especially for deployment in micro, small and medium-sized enterprises (MSMEs)\(^2\).

There are nine pillars of Industry 4.0: big data and analytics, autonomous robots, simulation, horizontal and vertical system integration, the industrial internet of things, cyber-physical systems, the cloud, additive manufacturing (3D printing), and augmented reality. Among these, 3D printing has a crucial role.

b. Potential impact on Customs and border management

3D printing is one of those technologies where there is no evident benefit of use by Customs. On the other hand, there are estimations of a potentially important impact on the work of Customs in the future.

The discussions on the growing area of 3D printing were launched by the Virtual Working Group on the Future of Customs at the October 2015 PTC Meeting. China, as the initiator of the topic, submitted a paper which formed the basis of a very intense and fruitful discussion.

Some of the questions which were brought up included:

- is Customs the proper/legally responsible government agency in the area of 3D printed products that are not imported/exported goods but printed at national level (sometimes designed by an overseas company and/or software instructions come from abroad);
- how to deal with the growing number of new economic operators: the owners of the 3D printers;
- how to safeguard IPR for 3D printing;
- how to ensure security etc.

Delegates felt that the topic of 3D printing fitted very well into the task of the PTC and the VWG FC to explore what could have a significant impact on the role and responsibilities of Customs in the future.

Some delegates felt that the enhanced use of 3D printing would probably have more impact on movements on the domestic market rather than across borders and that based on current legislation that might mean 3D printing could have more implications on other governmental agencies than on Customs (e.g. tax administrations, national police, etc.). Questions were raised whether Customs would nevertheless be involved in monitoring the virtual supply chain, and if so, how this could be achieved, including whether existing legal instruments were sufficient to cover such responsibilities. In general, cooperation of Customs with tax and other relevant agencies, maybe a new dimension of Coordinated Border Management, was seen as important in the area.

Several delegates also stressed the possible implications of 3D printing on origin, valuation, IPR and security, while a Member underlined that it should not be posing new restrictions in

cross-border trade. Other delegates indicated that there might be revenue, especially VAT implications expected and in addition to legal issues already addressed, there might be a need to redefine the term “goods” in the future - which he thought relevant for Customs responsibilities in 3D printing overall.

Delegates felt that this topic required more research including looking into the existing legal frameworks and tapping into what already exists, i.e. are there comparable experiences already in place, e.g. related to music downloads, that could assist further.

In conclusion, the PTC agreed that there was a need for more research on the topic, especially regarding the legal implications, including by exploring the coverage of existing legal frameworks (such as those regarding music downloads), as well as by exploring what other international organizations are doing in this regard (OECD, WTO etc.). It further agreed that research on 3D printing within the VWG FC would continue in the intersession and report to the PTC at its next meeting in March 2016.

In the intersession, members of the VWG FC shared a number of relevant materials available in open source, including papers provided to the Secretariat by a number of partner organizations such as the OECD, WTO and UN OCHA. Two members of the VWG FC volunteered to develop research papers based on the available material. (These research papers are available in Annexes I and II of PTC document PC0444E1a.)

The results of the research in principle bring forth a number of relevant conclusions:

Mr. Shao Wejian (China) in his research concludes that 3D printing will subvert global trade flows and accelerate the transforming role of Customs from duty collection to social protection, mainly IPR, public safety and security. He emphasizes the reduction of the movement of physical goods across borders and the increase in the movement of raw materials as opposed to finished products, as key elements to consider.

Dr. Edward Kafeero (University of Münster) in his study, that focuses more on the legal implications, suggests that 3D printing does not present anything essentially new to current Customs rules and procedures. Instead, according to him, most of the legal issues about 3D printing concern intellectual property rights such as copyrights, patents, industrial designs and trademarks. Nevertheless, he underlines that Customs is advised to keep abreast with all the new developments (technical, legal or otherwise) in the 3D printing industry. And if there is political will, Customs should also discuss how the scope of Customs legislation could eventually be widened.

The results of the research did not intend to conclude the discussions on the implications of 3D printing on Customs; they confirm that the answer to this question is not straightforward and it is still early to identify how 3D printing will progress and impact Customs business in the future. However, there are a few main themes emanating from the two research papers.

An important element relating to the cross-border exchange of digital files for 3D printing, referenced by both research papers, is the WTO Ministerial Decision of December 2017 on the Work Programme on Electronic Commerce which states that WTO Members will maintain the current practice of not imposing Customs duties on electronic transmissions until the next Ministerial Conference in 2019. This means that increased exchange of digital files for 3D printing purposes across borders will not have revenue implications, at least not for the time being.

Both authors agree that the increase in 3D printing will accelerate the movement of raw materials and reduce the movement of finished products across borders which, on the other hand, will have revenue implications.
IPR implications have been stressed by both authors as an important element to bear in mind. However, how this will impact Customs work has not been clearly defined.

In terms of legal implications, Dr. Kafeero mentions that the envisaged decrease in Customs revenue would not seem to be a strong reason to cause an overhaul of Customs legislation. Instead, digital blueprints could become taxable items, which would not necessarily impact Customs, but possibly (also) tax administrations. His view is that other national agencies such as the police, anti-drugs and standards agencies would be well suited to deal with security issues relating to 3D printing.

Finally, apart from national laws, Dr. Kafeero mentions that there are many international conventions and treaties particularly those signed under the auspices of the WIPO and WTO that can contribute to orderly management of 3D printing across the globe, e.g. the WTO’s TRIPS Agreement and the Dispute Settlement Understanding, the WIPO’s Copyrights Treaty, Patent Law Treaty, Trademark Law Treaty, Washington Treaty, Paris Convention and others.

During the discussions at the March 2016 PTC, diverse views on the 3D printing topic were shared. Some of the delegates argued that Customs deals only with tangible goods and therefore digital transmissions should have no implications on Customs work, even though it was important to still keep a close eye on the developments in the future.

On the other hand, there were views that Customs needed to monitor the cross-border movements of intangible goods too or to at least look into this new manufacturing mode and identify whether the same rules would apply, for instance, in determining the origin of goods. Some delegates felt that Customs still had an important role to play in monitoring cross-border movement of intangible goods.

A Member shared its experience on import of 3D printers which was restricted and required registration with the responsible government agency.

In conclusion, the PTC agreed that even though for the time being no duties were being imposed on intangible goods, this did not mean Customs had no role to play. Furthermore, it was agreed that the topic of 3D printing and its implications on Customs was not to be closed at that point in time, but was to be revisited in the light of any relevant future developments.

Furthermore, at the December 2018 Policy Commission, an item regarding the role of Customs in taxation of intangible goods was placed on the agenda. The objective was to discuss the issue of the imposition of Customs duties on intangible goods and provide policy orientation, given the ongoing WTO moratorium on the imposition of duties on electronic transmissions, to consider possible approaches and associated legislative and operational requirements for the collection of Customs duties on intangible goods, to examine Customs’ role in non-fiscal areas such as security, admissibility, IPR and illicit trade in the context of growing digital trade, and to provide guidance on the way forward. At the request of several delegates, it was decided not to take up this item for the time being. However, the Chairperson, as well as a number of delegates, expressed their disagreement with this decision. Several delegates considered that a future discussion could be useful in order to have a better understanding of the role of Customs with regard to intangible goods, from a wider perspective. The outcomes of such a discussion would also have implications on the role of Customs in cross-border transfers of 3D printing digital files.
III. Strategy Behind Technology

a. Developing and Implementing New Technology

There is a need to harness latest technologies as traveler and trade growth, including e-Commerce, has significantly outpaced the typical Public Service rate of evolution, challenging our conventional operations, program policies and legislation. Drivers for technological change in Customs organizations include the following:

- **Global Environment:** Becoming a leader in trade facilitation and customs services in the marketplace
- **Accountability:** Enhancing accounting capabilities and internal controls
- **Efficiency and Service Delivery:** Making it easier for client and business interaction
- **Business Simplification:** Reducing barriers to trade and lowering costs for importers
- **Technology:** Increasing productivity and improving decision-making capabilities while supporting trade fraud and evasion detection.

Technologies such as blockchain, biometrics and artificial intelligence are more than business enablers, they set expectations for our clients and change how we work. It is essential, however, to focus technological changes on those key to an organization’s mandate or risk over committing.

Innovation is key to developing and implementing new technology and can include:

- Reviews of latest technologies
- Establishing partnerships with the private sector, between countries and with academia
- Considering the global ecosystem
- Keeping people, processes and change management at the forefront

Innovation initiatives require a clear funnel and gating process to properly review and assess the ideas. Some initial ideas will be of low value, unfeasible or already in the works. The process must allow for the appropriate gating and filtering of ideas to allow the “right ones” through to pilot and potentially full production/implementation.

Options for emerging technology implementations must be evaluated based on the services required and the needs of the organization. Commercial-off-the-shelf services on hosted platforms may be the right solution for one line of business within an organization while a purchased platform with services built internally may be the right solution for another.

Organizations must also evaluate the potential time to market, security requirements, the need for product customization as well as the size and knowledge of their development team when determining the technological right fit. There is also a need to continuously re-evaluate technology strategies and plans over the course of projects as new technologies may be more relevant and cost effective.

The high rate of failure in large, multi-year IT-enabled projects has resulted in organizations moving aware from large IT system development and instead selecting technologies that can easily migrate to new hardware in the future. Organizations are looking to aggressively standardize on key platforms by buying the software once and using it multiple times. Furthermore, system dependencies are being decoupled and large monoliths broken down in small sub-systems to allow for scaling, enhancement and re-use of individual components.
Where possible, organizations have moved or are moving away from waterfall approaches to project management and towards more rapid prototyping and design thinking. These iterative approaches are focused on understanding the problem from the point of view of all stakeholders, going through many iterations of ideate, build and test.

In order to allow for iterative project management approaches to lead to success, key performance indicators need to be defined at the onset and assessed as prototyping unfolds. This include having quantifiable measures of system performance, effectiveness and suitability to document whether what is being delivered offers the expected quantifiable outcomes. If so, documenting the extent at which it does allows for small adjustments to deliver more capabilities in the long run. Positive qualifiable outcomes are obtained through iteration, where incremental changes hone more and more on user expectations.

Key to these methodologies is the principle of failing fast and recovering quickly. The fidelity of the solution increases with each iteration as what worked is kept and what failed is reworked in the next iteration. Ideas are tested through a phased approach to gain insight while managing immediate pressures, as outlined by a sample timeline below:

- **Phase 1 - Proof of Concept (1-3 months):** Doing mini experiments of the individual pieces to see what might work
- **Phase 2 - Prototype (3-6 months):** Putting the pieces that worked from the Proof of Concept together; Framing the end to end solution/response; Understanding the glue that frames the response (i.e., policy, new class of employees, training, infrastructure, technology…); Multiple iterations that increase in fidelity each time
- **Phase 3 – Minimum Viable Pilot to Production (1-2 years):** Real life in the field and addresses immediate pressure; Opportunity to see what works and what doesn’t in a real life context; Fix what doesn’t work while the pilot is running (iterate the pilot fidelity); Informs the implementation of a national product

Regardless of the size of the project, test-driven system development is crucial to gain agility, boost product quality, reduce delays between releases as well as errors during handoffs. This is achieved by developing tests before their associated features, thus inherently increasing test coverage. Doing so ensures that each feature meets the intended use before it is fielded, new features being developed by disparate team are tested against the existing and that all features function as expected before being fielded. The concept of continuous integration enabled through automation, including automated testing, ensure that the tooling is in place to orchestrate testing and deployment, reducing manual intervention, delays and human errors. These pieces are essential to boost design thinking and improve velocity between iterations.

**b. Potential Future use in Customs and Border Management**

Customs organizations are using new methodologies to implement the disruptive technologies outlined in this report. The Canada Border Services Agency is developing prototypes using Design Thinking, one of which was deployed at the Ambassador Bridge in September, to remotely process commercial vehicles as part of the Secure Corridor Concept - Trusted Trader pilot. The pilot is testing the technologies’ ability to reduce processing times of trusted, low-risk commercial trucks at the Primary Inspection Line by up to 50%, increase truck volume throughput at the Port of Entry, and a reduced administrative burden on BSOs by removing manual processes. This would contribute to an overall reduction in average border wait times for commercial carriers leading to reduced costs to industry partners.

Highlights of this initiative include:

- Design thinking approach that was taken from concept to prototype to pilot, introducing technology quickly
Annex to
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- Key performance indicators identified to measure up new technology against existing processes

- A combination of technologies used to automate the **capture** and **input** of commercial passage information into CBSA systems, removing the **administrative** burden from the BSO allowing for greater decision-making focus.

- Mounted on installations around the **PIL lane**, technologies to be evaluated include:
  - RFID – collecting and authenticating passage information
  - Licence Plate Readers – collecting plate information
  - CCTV – monitoring driver
  - VoIP – two way audio interaction
IV. Recommendations

At its meeting in October 2017, the PTC extensively discussed disruptive technologies, their possible impact, benefits and risks for the future and provided a set of mainly general, but also some specific recommendations for consideration by policy makers. They aspire to serve as key guiding principles for the future:

- **There are tangible benefits for embracing technology.** However, there is also a need to gauge and evaluate these technologies, ascertain whether they have been fully developed and test their functionality before investing a great deal of energy, time and public resources into them.

- **It is not a matter of choice for Customs to embrace and fully exploit the potential of disruptive technologies and keep abreast with their everyday progress and improvements.** Otherwise, Customs is faced with the risk of “losing the war” against fraud and criminal activities.

- **There is a need to establish a common understanding of the scope of disruptive technologies in the Customs context.** Not all aspects of, for instance, robotics would be relevant in the Customs environment. Furthermore, some of the technologies, such as 3D printing might impact Customs and its work, but would not present a benefit for its improved functioning, and Customs would probably not find any particular opportunity for using 3D printing in its work. On the other hand, artificial intelligence could present an extraordinary opportunity in risk management and in identifying potential trade trends and patterns.

- **Technology can help Customs complete its work more efficiently and manage trade flows and controls.** It should not erode the human element needed to ensure progressive engagement between trade and Customs. Disruptive technologies need to be utilised and deployed in an optimal manner. They can be used to build Smart Customs and virtual borders and can boost interconnectivity with business operators. They should be geared towards enhancing efficiencies, focusing on trade facilitation, optimal use and deployment of resources, and ensuring a secure supply chain.

- **One of the greatest benefits is that technology generates a pool of data (big data) that could be used for better decision making.** With the appropriate use of artificial intelligence and data mining, the effectiveness of the availability of data can be brought to a higher level.

- **The use of technology in Customs should be needs-driven, rather than driven by its availability.** Technology could help embed the modernisation of Customs processes, including revised Customs tools and instruments such as the SAFE Framework of Standards (FoS) and Integrated Supply Chain Management Guidelines (no need for physical inspections if technology could help provide credible levels of accurate information in supply chain processes).

- **There is a need to ensure regular engagement between Customs and Trade on emerging trends or technologies and their impact on the Customs environment.** Customs should strengthen cooperation with the business sector through, for example, on-the-job training for special Customs experts on disruptive technologies.

- **Using latest technologies requires a cultural shift within the administration, not only at management level, but also by other staff.** A change management action plan should be developed and a new recruitment strategy put in place, as new skills would be required for deploying these technologies. Specialized training and creating
a new study or academic centres which could develop analyses, reports and forecasts for the use of disruptive technologies in Customs, could be useful.

- **A new legal framework should be drawn up for the use of new technologies**, bearing in mind that they might change the philosophy and working methods of Customs.

- In addition, there are **many potential specific benefits**, such as:
  - **moving away from mass physical interventions** to more highly automated controls,
  - better, more responsible and consistent decision-making for management purposes - “smart decision-making”,
  - **improving data quality** in general and, as a result, making risk analysis more efficient,
  - **replacing human resources** in those areas where they were not efficient or unable to produce satisfactory results, due to risk or otherwise (e.g. X-ray analysis or inspection of radioactive materials),
  - **monitoring the daily work of Customs officers to make them more productive and innovative**, as well as improving monitoring and management functions at the highest level in Customs,
  - **supporting Customs investigation and enforcement activities** (data cannot be erased, data and records are easily available),
  - **securing revenue collection** and state budgets,
  - providing an **enhanced service for travellers** and cross-border traffic,
  - **automated Customs procedures and controls** (through the use of robots, for example),
  - **faster release** of goods and trade facilitation,
  - **improving Authorize Economic Operator and Single Window models**, etc.

In addition, the annual dialogue held between the Private Sector Consultative Group and the Policy Commission in June 2018 discussed, through a break-out session, a number of questions relating to disruptive technologies and sought guidance on how Customs and the private sector can cooperate on the path of making best use of them for the purpose of facilitating and securing trade. A number of recommendations, were brought up, including:

- **Need for more involvement of the private sector** in terms of inviting private sector solution providers to share their findings in the WCO, but also having the WCO going out to the private sector and seeing how things work on the ground;
- Carrying out **individual country assessments and cost/benefit analysis, as well as pilots**, and sharing results;
- Developing a **strategy** to keep up with the speed in which information technologies are developing;
- Holding **joint IT conferences**;
- Carrying out **joint research, pilot projects and jointly developing standards**;
- **Using the WCO working groups** as effectively as possible;
- Developing **best practices and compendiums**;
- Developing **expertise** on the new and emerging trends and developing **capacity** in this area;
- Enhancing **information sharing** between Customs and the private sector;
- **Engaging more with start-up companies**;
- Involving more **academia** into the process.
V. Conclusion

The Study Report brings together lessons learnt and recommendations stemming from the research, pilot projects and discussions taking place under the PTC and other WCO fora. It is evident that bringing forth specific conclusions and recommendations in this domain is to a large extent a moving target as, on one hand, advances in latest technologies are usually faster than the ability of Customs and governments to follow, and on the other, experiences in their use are not as sufficient and wide-spread as one would expect or desire.

Nevertheless, there is a general understanding around the need of keeping abreast of the developments in this field and continuously seeking to understand the challenges and opportunities that latest technologies can bring to Customs and border management.

The Study Report will continue to be updated with latest insights and information on pilots that could further enrich the knowledge within the Customs community and contribute to well-informed decision-making in this domain.
ANNEX - The Use Cases

1: The Blockchain Technology experiences

The use of blockchains in supply chain management can help manage and track goods and associated information by digitizing the supply chain process. It can enhance transparency and secure sharing of information among supply chain stakeholders – shippers, freight forwarders, ocean carriers, Customs authorities, and ports.

There are a number of ongoing pilots and initiatives in this domain; some of which are briefly mentioned below:

- Maersk and IBM

Maersk and IBM are testing a blockchain that enables its customers to keep a tab on their cargo as it moves from one end to another, while enabling regulatory authorities including Customs (Dutch Customs and US Homeland Security) to monitor, carry out risk assessment, and perform regulatory processing and clearance (as required). Blockchain technology's reliance on cryptographic signatures makes it harder for anyone to mislay goods or tamper with labels while cargo is on the move, and reduce the time goods spend in transit.

This pilot supported by IBM blockchain based on Hyperledger Fabric with permissioned access, called GTD, aims at the digitalization of an entire supply chain process, as an alternative to the traditional paper-based records of the shipment process. For example, goods from Schneider Electric were transported on a Maersk Line container vessel from the Port of Rotterdam to the Port of Newark in a pilot with the Customs Administration of the Netherlands. The U.S. Department of Homeland Security Science and Technology Directorate, and U.S. Customs and Border Protection are also participating in this pilot.

The international shipment of flowers to Royal FloraHolland from Kenya, Mandarin oranges from California, and pineapples from Colombia were also used to validate the solution for shipments coming into the Port of Rotterdam.

- DP World, DB Schenker, and Hamburg Sud

Another comprehensive trial of blockchain technology for global supply chains has been successfully carried out with a new Australian-developed blockchain security architecture from TBSx3 which has the potential to raise global supply chain security to a military grade.

The new TBSx3 benchmark was successfully used on an 8,100 km global road-and-sea supply chain stretching from the wine-growing Coonawarra region of rural South Australia to the port of Qingdao in north-eastern China. Partners included DP World Australia, DB Schenker, Hamburg Sud and Australian wine producer IUS.

- Korean Port Authorities, Hyundai Merchant Marine (HMM), and IBM Korea

A blockchain consortium has been launched for shipping and logistics, involving public organizations and private enterprises - Korea Customs Service (KCS), Ministry of Maritime Affairs and Fisheries, the Korea Maritime Institute (KMI), Busan Port Authority, Hyundai Merchant Marine (HMM), Korea Marine Transport and IBM Korea.

The consortium will provide a blockchain security platform to participating enterprises and organizations alongside technological consulting for them. This platform is designed to verify trade information by distributing encoded data to each participant through the network. This
project is expected to streamline import and export processes regarding Customs as well as speed up shipping businesses, thus facilitating logistics flow and reducing costs.

- Walmart

Walmart and a group of food companies are partnering with IBM to explore the use of blockchain technology in their food supply chains. The blockchain is being used to track food shipments – potentially allowing it to identify every stop a product makes on its journey to a store shelf, which could be a game-changer in the event of an outbreak of foodborne illness.

Food shipments are tracked and digitally recorded via blockchain from the start of the journey at the farm, pallets of mangoes were tagged with numeric identifiers; each time they crossed another checkpoint - from farm to broker to distributor to store – their status is signed and logged. In this scenario, it takes mere seconds to identify whether a given food package was at risk. This could provide an easy-to-use interface for the company management to keep a tab on the flow of shipments as well as regulators like Customs to look into the associated information including the provenance of the shipment, when necessary, for carrying out its risk assessment and timely mitigation.

- Global Trade Connectivity Network

In November 2017, the Monetary Authority of Singapore signed a Memorandum of Understanding with its Hong Kong counterpart to jointly develop a cross-border DLT-based infrastructure, known as the Global Trade Connectivity Network (GTCN) that aims to link up digital trade platforms and the growing number of trade-related DLT platforms and communities around the world.

The GTCN is envisioned as an industry-neutral, service-agnostic, cross-border utility infrastructure that does not aim to control or dominate partner networks. It will connect to Singapore’s Networked Trade Platform (NTP), a new one-stop trade information management platform that connects digital islands across the entire trade ecosystem, to support both DLT and non-DLT based connectivity and exchanges of digital data.

For a start, GTCN will provide a common view for trade finance applications between Singapore and Hong Kong, empowering participating banks to share information across the border using DLT that is immutable and auditable. This allows the various stakeholders to retain control of their own information.

- Others

There are some other pilots/initiatives with regard to the use of blockchains in the supply chain.

Diamond traders are investigating a blockchain version to verify the provenance (origin and authenticity) of precious stones to curb the problem of counterfeits and ‘conflict diamonds’. A London-based company called Everledger has placed more than 1.6 million diamonds on a blockchain. Entries on digital records on a blockchain include dozens of attributes for each diamond, including the colour, carat, and certificate number, which can be inscribed by laser on the crown or girdle of the stone.

Food fraud is one of the biggest issues facing the global food industry, because of the potential health risks associated with adulteration and loss of trust from consumers and governments. Alibaba, Australia Post, and vitamin company Blackmores are working on a pilot programme to prevent food fraud by using blockchains. The project will explore the use of blockchain, which could obtain crucial details from suppliers about where and how their food was grown and map its journey across the supply chain.

Aircraft makers are exploring how a blockchain might track disparate parts of their jets as they make their way from machining shops to the tarmac.
SITA, an IT solution provider for 90 percent of airlines, partnered with ShoCard to develop a passenger identity management app for airlines. The app combines facial recognition technology and blockchain-based data to streamline passengers processing at airports.

Barclays reported the first blockchain-based trade-finance deal in September 2016. The process, from issuance to the approval of the letter of credit, usually takes between seven and ten days, but could be reduced to less than four hours.

Some regulatory authorities in the Netherlands are already exploring the use of blockchain technology to replace traditional certificates with alternative secure electronic solutions.
2: Blockchain-based Smart Contracts and the Customs Administration of Georgia

Being one of the leading e-governance agencies in Georgia, a service oriented policy, based on recent technologies, has been identified as one of the priorities for the Georgia Revenue Service. This particular approach aims at further development of seamless and trust based procedures for business. With this in mind, Georgia Revenue Service has been actively cooperating with leading universities and companies in Georgia and abroad.

One of the target areas for study outlines blockchain-based smart contracts. In cooperation with Georgian universities, a pilot project aiming at the digitization of the issuance and management process of Certificates of Origin based on smart contracts is underway.

A prototype of the system was presented in December 2018. The model is able to track and control the issuance of Certificates of Origin with the use of smart contracts on the Ethereum Blockchain.

The findings of the pilot project will create the basis for deep and comprehensive analysis of risk and opportunities in regards to the development of smart contracts while supporting the effective implementation of blockchain-based technology solutions in e-services.
3: EU: The use of the blockchain technology to bring trust in the digitization of a customs procedure: the ATA Blockchain proof-of-concept

Given its role in shaping policies and developing operational systems for the EU Customs Union together in collaboration with the Member States, DG TAXUD has embarked on an exploratory activity since early 2017 to study the applicability of the blockchain technology in both the customs and taxation domains. In the fields of customs, the exploration of the potential of the blockchain technology has focused on the so-called notarisation service where a blockchain platform could be used as a third-party holder of the truth on the information generated by the stakeholders active in the supply chain. Such an approach entails that only a hash of the actual data is stored on the blockchain guaranteeing the true version of a document at any given time. In this context, the hash function is a fundamental part of blockchain technologies, also known as the digital fingerprint of a document. Obtained by an algorithm which doesn’t permit reverse engineering of the original document from the fingerprint, the hash ensures that even a single comma change in a document would result in a totally different fingerprint.

At the heart of the supply chain complexity lies an inherent lack of trust between the supply chain participants (e.g. shipper, freight forwarder, importer, etc.) and public authorities. The blockchain notarisation service could contribute towards achieving a proper balance of trade facilitation and border security by creating additional trust between the different stakeholders involved. In this context, the notarisation feature has the potential to offer a multitude of applications and DG TAXUD is just setting off on its exploratory journey of discovery. To this end, the EU Customs authorities are assessing the technology with a business mindset: beyond the hype, studies are ongoing to assess practical cases where this technology can contribute to reduce complexity in the supply chain and improve business to government interactions for the benefit of economic operators, citizens and public authorities.

The ATA goods passport ("Admission Temporaire" / Temporary Admission) is an international customs paper document that mainly permits the duty-free temporary admission of goods for up to one year.

ATA goods passport have been issued and accepted in more than 71 countries. The eATA project aims to digitize the temporary admission process by providing worldwide electronic data exchange between countries or customs unions (ATA partners).
In June 2017, a partnership between DG TAXUD and the International Chamber of Commerce (ICC) was established whereby DG TAXUD launched a proof-of-concept (PoC) using blockchain technology to interface with the ICC Mercury II pilot solution. The business objective of the PoC was to bring an extra layer of trust.

Therefore, on top of the architecture proposed by ICC, an additional, independent layer of trust was studied in the PoC.

The PoC has concluded successfully by mid-2018 and has demonstrated that the distributed ledger technology (Ethereum test network in this case) could be used to ensure integrity and traceability of carnets and transactions through an anchoring mechanism on a private blockchain platform combined with periodic anchoring on a public blockchain (effectively achieving independent notarization).

The information stored on the blockchain test network is only the hash of the carnets or transactions and a few metadata thus allowing to perform carnets movements automated consistency checks, which is also another learning from the PoC, i.e. to use the Blockchain Ethereum Smart Contract technology in such business context.

DG TAXUD doesn't envisage making the PoC operational but sees that the learnings can benefit the stakeholders who are active in the digitization of the ATA carnets procedure.
For more information on Blockchain@TAXUD activities, please contact: zahouani.saadaoui@ec.europa.eu.
Annex to
doc. PC0541E1

4: Peruvian experience in using the Blockchain technology for mutual recognition of AEOs – the CADENA tool

Authorized Economic Operator (AEO) programs are extending all around the world and along with them the signing of more AEO Mutual Recognition Agreements (MRAs).

When only two countries exchange a short list of AEO companies to be reciprocally recognized by each other, it is not a difficult task. However, it can become quite complex if the agreements involve multiple countries with thousands of companies.

Recently, Peru, together with Costa Rica and Mexico, has participated in a pilot project named CADENA, which uses blockchain as a possible solution for the challenges described. CADENA is a platform developed by Microsoft with the sponsorship of the Interamerican Developed Bank.

The overall goals of the CADENA are to solve the challenge of exchanging data on AEO companies under the MRA and to gain experience with the new technology in the Customs environment. Blockchain enables users to share a single view of the status of an AEO certificate in real time, and it is designed to allow, all users access to company information depending on [permissions. Transactions are validated and shared among nodes which operate in a cloud environment.

Each Customs administration inputs the information of its AEO program, according to predetermined parameters. As soon as a new AEO is registered into the CADENA platform, every user can access the information, via a web application.

Under the current (non-blockchain) procedure, Peruvian Customs informs other Customs administrations about a new AEO company on a monthly basis, so there can be up to 30 days delay for a newly certified AEO company to obtain the benefit from an MRA.

It is expected that this pilot will eventually allow the CADENA platform to integrate with the IT systems of each Customs administration to ensure that benefits can be accessible in real time.

Currently, this tool is only being tested by three countries. The advantages increase as more countries use it.

Some considerations to take into account include the legal restrictions that any particular Customs administration may have regarding sharing of information. Peru publishes a list of its AEO companies, (unless otherwise instructed) so that there is no legal restriction to the use of CADENA.

The CADENA project is now in its validation phase. With the help of AEO Customs officers, it took approximately 6 months to work on the business functionalities and the technological architecture to successfully develop the blockchain enabled solution. The main activities included: validating the technology and the solution, assessing the benefits of the solution through several indicators, identifying the improvements to the solution for a potential
production phase, planning and implementing the integration with risk management systems and discussing the future governance model.

ROAD AHEAD:

The use of blockchain to exchange information and granting of benefits in real time in MRAs, is a very potential solution.
5. Canada: Blockchain technology trial
(October 2018)

OVERVIEW

The Canada Border Services Agency (CBSA) will participate in a pilot project, led by IBM and Maersk, to evaluate the capacity of TradeLens, a blockchain-based trade digitization solution designed to improve data quality and facilitate the movement of goods. The pilot project will allow the CBSA to determine what role, if any, the TradeLens platform could play in its business processes. The desired outcome for the Agency is to benefit from the advantages that blockchain can offer – specifically, improved data quality and security, transaction transparency, and increased availability of information.

IBM and Maersk are introducing the TradeLens global shipping digitization platform. Announced in January 2018 through a collaboration between Maersk and IBM, TradeLens demonstrates strong acceptance and viability of the concept of a blockchain-based ecosystem for digitizing global shipping, built on open standards. More than 90 participants from around the world and from multiple points in the supply chain have agreed to pilot the platform as of mid-November 2018. TradeLens is an open solution built with feedback from the network participants and designed to modernize the industry for the better – benefitting participants across the global trade ecosystem.

While IBM will do most of the publicity, from the CBSA’s perspective, this is an opportunity to showcase how the Agency is engaging with technology. This platform is based on blockchain technology that allows participants to securely write and access information on a shared ledger instead of exchanging documents. The intent is to reduce costs of shipping across the industry and speed up the availability of information.

The CBSA continues to modernize its border management processes by introducing new technologies to enhance security and to expedite the flow of legitimate goods and people across the border. The Agency has made tremendous progress in recent years to facilitate trade and promote efficiency by mandating paperless processes at all stages of the movement of goods. The CBSA is pleased to see the industry investing towards the same goal within its operation. Piloting technology, such as this blockchain technology, is something that the CBSA has a strong interest in, given its capacity to secure data.

QUESTIONS AND ANSWERS

Q1. How much has the CBSA invested to participate in this pilot project?

A1. The CBSA has not provided any funding to the pilot project. Maersk and IBM are providing the bulk of the support to their project, having already invested in the development of the TradeLens Solution and are providing it free of charge to the CBSA for the duration of the pilot.

From an operational perspective, the Agency’s participation in the pilot will not demand any additional resources.

Q2. How will the CBSA weigh the success of the pilot project?
A2. The pilot will be a success for the CBSA if improvements in data quality and better responsiveness from the trade chain to requests for information can be observed.

The CBSA will then assess the advantages offered by the Global Trade Digitization (GTD) Solution and consider including it as part of its business processes.

Q3. What, if any, training will be required on the part of the Agency to participate in this pilot?

A3. No special training will be required. The solution is deemed to be intuitive enough to allow a CBSA officer to approach and use it with confidence. Reference material will be provided by IBM.

Q4. How is this blockchain-based solution different than the system currently used by CBSA?

A4. Current systems receive electronic messages sent by the industry’s system (system to system exchange). A blockchain solution is a shared record system (a ledger) that allows participants to enter and review information on the same system, without exchanges of electronic messages in the traditional way. It allows to record transactions (changes in property, responsibility, etc.) faster and at less cost than traditional systems.

Q5. What are the advantages of a blockchain solution compared to the systems currently in place?

A5. As the technology theoretically allows a managed access to the ledger, its distribution, and its encryption, a platform based on blockchain technology, like the one used for this pilot, is expected to add a level of security, from a holistic perspective (i.e., taking into account all of the players in the trade chain continuum). Transactions on the ledger are also unalterable.

For the CBSA specifically, a ledger shared between participants could improve data quality by allowing data to be entered within the blockchain only once by a participant instead of being transcribed multiple times in different systems. This is closer to the concept of “data pipeline” promoted by the World Customs Organization, in which the data is provided by its original owner, and then pushed, unaltered, down the trade chain to other parties.

Q6. Upon completion of the project, what are the next steps for the CBSA and its use of blockchain technology?

A6. The pilot will allow the CBSA to determine what role, if any, it could play in its business processes. Upon completion of the pilot, the Agency will undertake a thorough assessment of the advantages offered by the Global Trade Digitization (GTD) Solution and, as a next step, may consider including it as part of its business processes.

Q7. How long is the pilot project expected to run?

A7. The pilot is expected to last no more than a few months. The objective is to prove the effectiveness of TradeLens within the shortest time span possible to allow the CBSA to assess the viability and advantages of the platform.
6: Hong Kong Customs Applied Big Data Technology in Combatting Online Intellectual Property Crime

Hong Kong Customs launched an IT system in December 2017, called the “Big Data Analytics System”, which is the first of its kind that applies big data technology for Hong Kong Customs to analyze and monitor the changing trends of online intellectual property (IP) crimes, including counterfeiting and piracy activities.

The purpose of the system is to strengthen the capability in detecting online IP crimes in an efficient manner. The system helps to keep investigators abreast of the latest internet jargons, hot topics, popular gimmicks and trendy gadgets on the internet. It also helps identify platforms and messages that have a higher risk of being associated with IP crimes such as the selling of counterfeit goods, movies, music etc.

The system collects huge volumes of public domain information from various online platforms. The system uses machine learning to analyze and collate the collected data to yield meaningful results. The technology is particularly helpful in analyzing Chinese language messages, which are more challenging than those of Latin-based languages. The system enables Hong Kong Customs to stay vigilant of the prevailing trends of online IP crimes, to detect them more effectively, and to combat them in a more targeted manner.
Given the rapid growth of online platforms and the flourishing of e-commerce, Hong Kong Customs has taken into account the scalability and expandability of the system to be ready for future operational needs. The computation capacity of the system, including processing speed and storage capacity can be expanded easily in a modular manner.

With the assistance of the system, Hong Kong Customs will be able to protect against online IP crimes effectively despite the increased challenges that come with the ever-changing infringing activities.
7. Dutch Customs Real Time Information System (CRIS) uses machine learning and cognitive data mining

Introduction
The Dutch Customs Administration (DCA) participated in the European Commission (EC) funded CORE project. During the CORE project the Data Pipeline concept was tested in demonstrators. The demonstrators have shown that shipping documents in global trade (B2B) and logistical event information can be shared through the Data Pipeline concept and can be made available to government inspection parties by participating companies. The DCA can use this information, in combination with the readily available declaration information, to enhance the risk management process and for de-risking shipments in the targeting process. The goal from a government perspective is to secure and further facilitate global trade, mainly by increasing efficiency and effectiveness in the inspection processes, without the need to request additional information on a case-by-case basis while goods are held.

CORE Dashboard
The DCA has been using a dashboard created by Intrasoft under the CORE project. This dashboard aggregates the information that was sent to the Data Pipelines and provides secure access to the information based on several unique identifiers, for example, a container number. During the CORE project the DCA found that the Data Pipeline information was of added value in the targeting process, but that further integration with internal and external data sources was necessary to optimize the workflow from a targeting officers' perspective.

CRIS
In the second half of 2017 DCA management decided to invest in a Proof of Concept for a national implementation of the CORE dashboard. This system is called CRIS (Customs Real time Information System). CRIS incorporates all the information that is provided by the CORE Dashboard and supplies the targeting officers with targeting information found in other data sources. The DCA developed CRIS internally by using Watson Explorer Technology, based on machine learning and cognitive data mining, to filter the enormous amount of data and to present it in a workable format to the verifying officer. Amongst others, the aforementioned targeting information includes: Data about parties in the logistical chain as registered in the Dutch national register of commerce, container status messages (Contraffic), internal Master Data Management (MDM) sources, historical compliance figures, declaration and targeting information. By providing a single 360 degree view to the targeting officers with all relevant information, targeting has been made more efficient and consistent and has been significantly improved over manual collection.

Production
Because of the successful Proof of Concept, the wish to make continued use of the Data Pipeline after the CORE project ends and other external data enrich targeting, DCA decided to invest in a production system of CRIS. Preparations are being made to start the production development. The DCA expects to have a production version of CRIS available in mid-2019. The first stage is operationalization of the current CRIS data in a visual interface. Stage two will be adding more data sources and stage three will involves a study to link the online system to the current targeting tools of the DCA.
8: Dutch Customs: PROFILE project – Customs risk management project based on data analytics and artificial intelligence

E-commerce in international trade today plays an important role, as the Internet has become an effective intermediary between merchants around the world. International operations with goods and services have been transformed throughout the supply chain. The integration of information and communication technologies (ICT) into international commercial operations provides new opportunities and of course new challenges for businesses, governments, consumers and international organizations.

In this light, the European Commission co-funded a new customs risk management project named PROFILE. The project develops modern data analytics and artificial intelligence (AI) to leverage Big Data and additional open data sources for effective and efficient Customs risk management.

Challenges faced in E-Commerce risk assessment processes brought together the Netherlands and Belgium seeking the common interest in increasing the hit rate of inspections and their capacity to cope with transnational crime, terrorism, and the E-Commerce-driven growth of Customs declarations.

Beginning on August 1, 2018, the PROFILE project will last for 3 years, with the total EU contribution of approximately 5 million EUR.

Dutch Customs is always looking for new ways of conducting its supervision and reducing the inspection burden for trade and industry. For this purpose Dutch Customs is testing groundbreaking technologies, working methods and partnerships. By way of example, studies are currently conducted to find out to what extent AI can make the organization smarter.

As a part of this project, the Dutch Customs Administration and IBM Corporation came up with a concept of a web-crawling system. They are creating AI capable of comparing the information of the goods from declarations with the same items from E-Commerce platforms. The system compares and matches values of the same items with the values declared in the declarations, ultimately, indicating the under/over-valuation risk level to customs. Web-crawling is the most specific part of a search engine that scans the Internet for the most high-quality and relevant information. Each crawler has a specific schedule for crawling web pages, for re-indexing and checking content for updates and relevance; on the basis of such rounds, sites are ranked in respective order. Making repeated visits to sites that have already been indexed, they find links to previously unknown resources and visit them. The web-crawler also adds newly discovered sites to the index of their search engine. The idea is for the web-crawler not to analyze discovered content, but only to transfer it to the search engine server, where it is being processed.

PROFILE solutions will be built on machine learning, graph-based analytics and natural language processing technologies. The solutions use Industry Big Data in three main ways:
1. Comparison of historic data against Customs control results. Customs can discover new risk patterns that predict illegal activities in the cross-border traffic.

2. Near real-time data feeds of key data elements to Customs, this way allowing operational application of the new risk indicators and profiles.

3. Requests of data and documents when Customs officers need to examine the validity of declaration data.

PROFILE tests solutions in operational settings in Belgium, the Netherlands, Sweden and Norway. These real world experiments called Living Labs (table 1), among other objectives, seek to:

- Customize and test web crawlers that collect valuation-relevant information about imported goods from E-Commerce web sites.

- Create more accurate risk indicators and profiles by applying machine learning models to historic datasets.

- Explore opportunities for exchange of export and import declarations between EU Customs and non-EU Customs.

- Design and test Risk Data Sharing Architecture for safe and secure Customs-to-Customs sharing of risk-related information.

<table>
<thead>
<tr>
<th>Dutch Living Lab (WP3)</th>
<th>Belgian Living Lab (WP4)</th>
<th>Sweden – Norway Living Lab (WP5)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Enhance the work of a risk targeter in the incoming e-commerce workflow</td>
<td>ENS and Import declarations</td>
<td>Exchange of export declarations between EU and non-EU country</td>
</tr>
<tr>
<td>Design of web crawlers that collect valuation-relevant data from e-commerce sites</td>
<td>Create more accurate risk indicators and profiles through applying machine learning techniques to historic datasets</td>
<td>For fraud detection, it would be useful to check whether the exporter declares the same information as the importer</td>
</tr>
<tr>
<td>---</td>
<td>---</td>
<td>---</td>
</tr>
<tr>
<td>Comparison of online pricing data against relevant databases</td>
<td>Use of external data sources to improve the precision of the models.</td>
<td>Import-export cross-checking is not possible today because customs do not share export and import declarations</td>
</tr>
<tr>
<td>Targeting interface for reviewing average prices for certain products</td>
<td>Establish collaborative data analytics development between Customs</td>
<td>Exploring methods within data analytics to be able to compare risks</td>
</tr>
<tr>
<td>Create more accurate risk indicators and profiles by applying machine learning models to historic datasets and by using datamining techniques.</td>
<td>Develop tools to improve the “explainability” of analytics based risk rules.</td>
<td>Living Lab proposes a path forward for automatic cross-checking of import and export declarations</td>
</tr>
</tbody>
</table>

Table 1 – Living Labs under the PROFILE
9: Chinese Customs on the way of digitalization: new solutions for new challenges

With limited resources, China turned to technology to improve efficiency and save human resources, thus bringing about technology-driven changes. China Customs has already made some progress over the last five years. Some of them are presented below.

Cases of Deployment of Artificial Intelligence in Customs by China Customs

1. Customs Intelligent Image Review System

The intelligent image review system is a system which bases on the experience of manual review, using artificial intelligence technology to learn the information of goods and articles corresponding to the massive historical machine inspection images, and forms an automatic recognition algorithm for the machine inspection images of H986 (Large scale container X-ray scanner), CT(Computed Tomography) and other equipment. The system, combining the relevant information of goods, articles and transportation tools, can automatically review the corresponding machine inspection scan images, and help Customs officers to carry out manual image discrimination. It can continuously optimize its algorithm, and then realize the final goal of replacing human review in the field of machine inspection in the end.

The General Administration of Customs of China collected more than 7 million inspection images from vehicle scanners and more than 0.8 million CT images, and worked hard together to mark nearly 0.8 million images among them the use of deep learning. Based on this, the intelligent review algorithm models for machine inspection images were established, including dozens of algorithms.

For example, the customs declaration comparison algorithm has covered 5,934 product names (10-digit HS code) and is constantly expanding. The vehicle TPS (Thin Plate Spline) image warping algorithm and Image & Declaration comparison algorithm piloted in a regional Customs was applied to the vehicle scanner and CT sites respectively: The vehicle TPS image warping algorithm is based on the situation that the vehicle body structure of the road port is relatively stable. The historical image of the same vehicle in the same time from the same inspecting device is used as a reference for intelligent comparison, and the abnormal situation is prompted to the reviewer. The Image & Declaration comparison algorithm can effectively compare the image and declaration for single-item and the double-items Express: to compare whether the name of the declaration matches, and to compare whether the quantity or weight of the declaration matches, and it can automatically alarm if it doesn't match.

During the pilot period, the algorithms were further optimized, and good results were obtained in the detection of small weight ivory, guns and their components, and control tools, and the drug identification and luggage compartment finding were greatly improved. At present, the system has been smoothly integrated into the customs machine inspection operation process, the coverage rate has been gradually improved, and a large number of
cases have been seized, which has effectively strengthened supervision. The system makes the machine inspection process more intelligent and the efficiency has greatly improved.

2. Pilot Intelligent Passenger Face Recognition System

The pilot system applies face recognition technology, installs face recognition cameras in various customs control areas, integrates the low temperature detection system of the quarantine inspection, and forms the 3 operation lines: front line (warning zone), middle line (main battlefield), and back line (review). The 3 operation lines can identify and alert key passengers (mainly including blacklisted passengers, multiple inbound passengers and high-risk passengers for inspection and quarantine). It is equipped with mobile individual equipment and face recognition terminal, prompting customs officers of inspection and selection to intercept and catch key passengers. It can gradually establish and expand the basic information base of passengers, and screen and analyze unstructured data such as pictures and videos to realize business functions such as risk analysis, risk control, and query statistics.

At present, the average number of high-risk passengers in the system exceeds 1,000, and the alarm accuracy rate exceeds 99%. A number of smuggling gangs have been seized, and the role of fighting against “high risk frequently travel passengers” has been very obvious, effectively strengthening the supervision of passengers’ inspection. At the same time, it helps ensuring the "concealed and non-invasive" regulatory services, and the speed of customs clearance for passengers at ports has increased significantly. The system makes the passenger inspection and supervision process more intelligent and humanized, and the passengers have better experience in Customs.

*          *

*          *

China Customs believes that, to improve control mechanisms, IT environment must reach international standards and evolve continuously. The exploration and implementation of new technologies is an ongoing process that will never end. Customs resources are now being focused on exploring how blockchain technology can help to develop trusted, safe and efficient trade chains by collecting and sharing data covering all stages of domestic and overseas production, processing, storage and usage.

Last but not least, China is also looking at Virtual Reality and the possibility of using it to train officers to handle terrorist attacks, deliver epidemic control or manage vessel inspections. Pilot projects in this regard are currently being promoted at various Customs units.
10: Artificial Intelligence in Brazil’s Customs

By Jorge Eduardo de Schoucair Jambeiro Filho, Head of Artificial Intelligence for Customs Systems, Department of Federal Revenue of Brazil

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Since 1997, all Brazilian import declarations are registered in Brazil’s Integrated International Trade System (Siscomex). If any errors are found when an import declaration is inspected by a customs officer, a rectified version of the declaration is registered and both versions are kept indefinitely. Since 2014, an artificial intelligence called SISAM (a Portuguese acronym for “Customs Selection System through Machine Learning) learns from the huge Siscomex database and analyzes every new import declaration that is registered in the country.

For every item in an import declaration, SISAM estimates the probability of about 30 types of errors. These errors include false descriptions of goods, errors in harmonized system (HS) codes, errors in the declared countries of origin, missing import licenses, non-applicable tax regimes, wrong preferential tariff and “ex-tariff” claims, the use of wrong rates for the calculation of import duty, the tax on manufactured products, social contributions and anti-dumping duties.

Most importantly, SISAM has the ability to explain, in natural language, how it calculated the error probabilities. For example, suppose SISAM says “The declared HS code has a 90% probability of being wrong because the description of the goods is incompatible with it”. The officer may read the description and conclude that, for a subtle reason that escaped the system's analysis, the description is actually compatible with the HS code and could ignore the suspicion. On the other hand, if SISAM says “The declared HS code has 90% probability of being wrong because this importer has been caught committing this error several times and, in those times, the description of the goods were also wrong”, the officer will certainly want to inspect the goods physically. So, the same probability causes completely different effects depending on the explanation.

Errors are found in more than 75% of the import declarations that are selected by customs officers to be physically inspected following a suggestion from SISAM. However, this result has the influence of the natural intelligence of the officers. To evaluate SISAM without human influence, we ran the system over a dataset containing 624517 items which had all been inspected by officers in the past and compared system's predictions to actually observed results.

To save space, in Table 1, we only show recall rates for errors in HS codes, which is the most important and difficult of the errors that are currently handled by SISAM. Recall rates for other types of errors are all similar or better. More results can be found online [1].

<table>
<thead>
<tr>
<th>Selection Rate</th>
<th>1%</th>
<th>2%</th>
<th>5%</th>
<th>10%</th>
<th>20%</th>
<th>50%</th>
<th>75%</th>
</tr>
</thead>
<tbody>
<tr>
<td>Recall</td>
<td>22%</td>
<td>34%</td>
<td>52%</td>
<td>66%</td>
<td>81%</td>
<td>96%</td>
<td>99%</td>
</tr>
</tbody>
</table>

Table 1: Recall Rates for Errors in HS Codes
In Table 1, we can see that selecting the one percent of goods with the greatest error probabilities, we can capture 22% of all existent errors in HS codes, which represents more than a twenty-fold gain in relation to random selection. Coherently with international standards, in Brazil, more than 95% of all import declarations are cleared without being stopped for inspection. SISAM's suggestions are only one of the criteria used to select the remaining 5% [3]. Thus, recall rates for selection rates below 2% are the ones that matter for deciding if an import declaration will be cleared automatically or assigned to a customs officer for verification. In the latter case, the officer in charge of the declaration still has to choose which items will actually be inspected. This officer also counts on the help of SISAM. For him, depending on his workload, actually inspecting 5% to 100% of the items in an import declaration can be reasonable. So, the fact that SISAM offers significant advantages for any selection rate is very convenient.

Customs officers can use any criterion to select an import declaration for inspection. The most common reason for selections appears in Table 2. The fact that customs officers choose to perform more than 30% of all their work based on the information produced by SISAM really shows its usefulness.

<table>
<thead>
<tr>
<th>SISAM</th>
<th>HS Code</th>
<th>Weight</th>
<th>Incomplete description</th>
<th>Undeclared link</th>
<th>READ subsequent to shipment</th>
<th>Foreign Exchange coverage</th>
<th>Other</th>
</tr>
</thead>
<tbody>
<tr>
<td>31.62%</td>
<td>16.78%</td>
<td>12.80%</td>
<td>5.93%</td>
<td>5.46%</td>
<td>2.49%</td>
<td>0.97%</td>
<td>23.96%</td>
</tr>
</tbody>
</table>

**Table 2: Reason for selection**

We consider spontaneous comments of customs officers who use SISAM very important. They are generally positive and point particularities of the benefits of the system: “With this system, we catch errors that would certainly escape among the thousands daily imported goods”; “With SISAM I can analyze more import declarations”, “The explanations appear to have been written by a person”, “SISAM is particularly good when I have to inspect big import declarations”, “With SISAM novice officers become productive much faster”, “I cannot conceive working without it again”.

SISAM has been running for four years and recently we received some reports that it is not as easy to catch errors using it as it once was. This effect was predicted in the beginning of the project since importers whose errors are regularly being caught have incentive to change their behavior. Reports from another of our initiatives confirm that this change is actually happening.

The Customs Mesh is a project that currently does not use SISAM. Instead, a team of customs officers use data warehouse queries in the attempt to find errors that have passed undetected during customs clearance. The first problem tackled by the Customs Mesh were the errors in HS Codes. After two years, we received the following report: “In consonance with which had been reported in several occasions, one reason for us having so much difficulty in finding ‘raw material’ for the Customs Mesh in what regards to the tax classification of goods is a change in the behavior of some tax payers due to SISAM”. Making it difficult to find errors after customs clearance is a good effect of the use of SISAM before and during clearance. Such effect is not a problem for the Customs Mesh team, which will just move its focus to more complex errors.
We are aware that the errors that are most difficult to detect are probably still there and that some importers probably have learned to become more deceptive. To counteract this, we plan to use more information originated from our internal revenue service about importers and their associates and to integrate SISAM with other artificial intelligence initiatives that will be mentioned ahead.

SISAM is not a simple application of available Artificial Intelligence techniques. Its central technology is Bayesian Networks with Smoothing Hierarchies [2], which were, from their origin, developed to circumvent difficulties in the application of machine learning to Brazil Customs’ problems. Since then the technology was extended to

- handle combinations of nominal attributes, quantitative attributes, free text and time in the same problem;
- apply supervised and unsupervised learning at the same time and
- adapt to legislation changes without invalidating old knowledge and even without requiring retraining.

SISAM is implemented in Java and uses no machine learning tools or libraries. To handle a knowledge base of 8.5 billion patterns, extracted from 150 million imported items, SISAM has load balancing and distributed learning capacities. This allows it to be updated automatically each day without stopping. Recently, SISAM's test version gained the ability to detect under and over invoicing, which is relevant for its use in the fight against illicit financial flows [4]. The initial results are very promising.

In recent years, concerns about the ethics in the use of artificial intelligence [5] have become common. The greatest concern is the so-called black box problem, which is the impossibility of understanding how and why an artificial agent achieved a conclusion. To mitigate this problem and improve transparency, SISAM generates summarized explanations for its users as part of its normal work. SISAM has also the ability to produce logs representing its full reasoning process, which makes the system completely auditable.

In addition to SISAM, Brazilian customs officers count on ANIITA [3,6], which is a tool that include expert systems that highlight risk factors in import declarations, export declarations, express couriers, postal consignments, and export declarations. Expert systems are based on rules created by humans. They are simpler to implement, easier to execute and immediately scale up the application of human knowledge. They are an indispensable resource in every fraud detection domain. In our experience, the key points for successful expert systems are the flexibility of the rules, the provision of the ability of creating rules both for regional and national experts under an adequate privilege control scheme and a sharing mechanism that allows good rules to be propagated from region to region and possibly become national.

Brazil's customs has two other artificial intelligence initiatives, both related to computer vision. The first, called BATDOC [10], looks for mismatches between import declarations and auxiliary documents like invoices and bills of lading, which become available as digital images, after an import declaration is selected for inspection. It detects divergences in
company names, addresses, prices, quantities, HS codes, incoterm codes and others. It applies optical character recognition to the auxiliary documents, identifies relevant fields and performs comparisons. Currently, the auxiliary documents are not made available before the selection of import declarations for inspection. Consequently, SISAM cannot use BATDOC's results in its suggestions. We expect that rules will change and that the presentation of auxiliary documents becomes required for all import declarations.

The second initiative, called AJNA [7], is focused on the analysis of scanned images from containers. AJNA is in its infancy, but all containers leaving or entering the country through Brazil's largest port (Port of Santos) are already being scanned and all images are being transferred to a single server for later analysis. Using the Python SciKit-Learn library [8] and TensorFlow [9], we built models to detect cargo inside allegedly empty containers and applied them to our dataset. This led to the immediate detection of several instances of containers with undeclared cargo. The suspicions could easily be confirmed by simply examining the images. However, the images were examined post-release, and therefore no action could be taken. We are also using random forest regressors [12] to predict the total weight of the cargo inside a container from the images and convolutional auto encoders [11] to measure the divergence between the image of a container and the images of similar ones containing the same type of goods. We believe that both tasks will be important in a future version of AJNA and SISAM that will lead to the use of all available information in the detection of divergences of imported and exported goods.

There are current plans for using SISAM to analyze export declarations and also to detect errors in domestic trade transactions. In Brazil, the customs service and the internal revenue service are both under the Secretariat of the Federal Revenue of Brazil (RFB), which facilitates the latter.

Artificial intelligence already provides important tools for our risk management environment. Some of these tools have been in extensive use for several years and they have influenced human behavior for the better, for Brazil's customs staff and tax payers. Others systems are under development and complement the abilities of the more mature ones. None of the AI models or algorithms are anywhere near the capabilities of human intelligence, however, they can be added as an important tool to ensure compliance.

References


11. Japan Customs: Study on the image identification and risk assessment with AI

Japan Customs has been facing an ever changing environment. There has been a dramatic increase in the number of foreign tourists due to recent government measures to encourage tourism. Japan has also experienced a surge of import declarations from online purchases due to e-commerce development. At the same time, seizures of methamphetamine exceeded a ton in two consecutive years from 2016 to 2017. As Japan will be hosting major international events such as the Tokyo Olympic and Paralympic Games in 2020, the role of Japan Customs has increased despite limited resources for additional personnel.

In order to cope with these challenges, Japan Customs is required to operate more efficiently and effectively by using technologies such as Artificial Intelligence (AI).

Japan Customs initiated research with a view to introducing AI in the Customs field in 2016. Gathering opinions from experts and manufacturers with AI technologies, Japan Customs acknowledged the effectiveness of the use of AI on image analysis done by X-ray inspection equipment.

In 2017, Japan Customs set out to study image identification and risk assessment with AI in the international postal stream. For the study, a number of images were collected from the X-ray inspection equipment and then processed using machine learning. Based on the selected and processed images, an algorithm for image analysis was developed. Japan Customs has been working on improving the method of selection, the processing of images, and the algorithm.

Japan Customs is continuing the study with the goal of having AI automatically select cargo for physical inspection. It is expected that AI equipped inspection equipment will be deployed for frontline Customs offices in the near future.
12. Korean Customs boosting its data analysis capacity with data mining

With the exponential growth in e-commerce, the number of small parcels cleared by customs has skyrocketed, stretching the limits of customs enforcement capacities. Korea has a tax-exemption system and simplified customs procedures in place for “low-value goods,” and there is reason to believe, for example, that criminals sneak in smaller quantities of goods in separate consignments to avoid reaching the de minimis thresholds, above which duties and/or taxes become payable.

To address this challenge, the Korean Customs Service (KCS) decided to boost its data analysis capacity by bringing together customs officers trained in data mining and customs experts dealing with the clearance of express cargo and postal items. Based on the outcomes of their discussions, IT experts from the private sector who have been working with customs’ IT systems for years then reviewed the actual analysis tools and methods, and trained officers conducted a two month long project.

Based on their experience, the hypothesis formulated by risk analysts was that operators (in an effort to avoid paying duties/taxes) were importing items in multiple small parcels, using a number of different addresses and contact numbers. In other words, compliant importers use one name, one phone number, and one address for all their operations, while non-compliant importers use a series of names, phone numbers, and addresses. To confirm the hypothesis, records of importations that were transported via express and postal services were extracted for a three-year period. Then, search tools were used to mine the data in order to identify specific information such as phone numbers and addresses. Datasets containing the refined data, including the consignee’s name, address and phone number, were then created for analysis purposes.

Among the suspicious cases that came out of the analysis was an importer who had reported 123 different phone numbers and 127 different addresses. To facilitate data-reading, the analysis team converted the addresses into geographic coordinates. Several visualization techniques were used. For example, the datasets were analyzed using ORA, a network analysis tool, to examine correlations and relationships.

By inputting information such as phone numbers, descriptions of goods and the exporting country into the visualization program, analysts were able to identify importers’ different addresses. Data on seven suspicious importers showed that they were using a specific region of Seoul, Korea’s capital, as their address, which indicated that they might be importing items in multiple of small parcels with false destination addresses across this region.

“Garbage in, garbage out” is a well-known maxim relating to the need for “good” information for meaningful data analysis. The expression emphasizes that the quality of output is determined by the quality of input. The KCS has learned through experience that Customs officers tend to be nonchalant to the importance of the quality of data in customs as much as
to the quantity of it. In light of this, the KCS plans to conduct automatic data cleansing at the time when data is recorded in its database by adopting artificial intelligence technologies.

Another lesson learned is the importance of “domain knowledge.” During the project, one IT expert from the private sector said that a task which took one week to complete by customs officials would have taken one month by a layperson. In other words, domain knowledge matters a lot when analyzing data. Therefore, Big Data analysis of customs related topics should remain within the purview of customs.

This project was a short-term pilot project aimed at testing how data analytics could enhance risk analysis. It was applied to express cargo and postal items to identify commercial fraud, but the KCS believes that the same methodology could be applied to other areas. For example, criminals trying to import high-risk cargo, such as narcotics and weaponry, tend to file an import declaration with a false address in order to hide their identity. The KCS plans to invite a larger number of IT experts to enhance the tools used during the project in order to make them fit the Service’s analytical needs. The KCS will continue to conduct a yearly project to train Customs officers in data mining and invite a larger number of IT experts to make them fit the KCS’s analytical needs. These solutions will be integrated into KCS’s system for utilization in actual investigations.

More information kcsmd@korea.kr
13. Heathrow airport application of artificial intelligence on a daily basis to predict and plan passenger volumes across its terminals

Heathrow Airport is using a range of data and analytics tools and machine learning models to better predict passenger flows through its terminals to improve operations and make passenger journeys smoother.

The reason behind this innovative approach was aspiration to get past paper-based manual model and to go over to machine learning model capable to forecast and engineer future events.

In 2016 Heathrow adopted Power BI as a frontend analytics tool to liberate data out of Azure cloud services, including Data Lake Analytics, Stream Analytics, and Azure SQL Database, to extract, clean, and prepare real-time data about flight movement, passenger transfers, security queues, and immigration queues.

The concept of this mechanism can be described as pulling data out of back-end business systems and pushing it to Power BI for further real-time passenger traffic observation by staff.

In the past, immigration, customs, baggage handling, and food services staff would normally find out about an increase of passengers volume at the very last moment. With the use of these technologies, airport employees receive notification on passenger increase one to two hours beforehand, which allows them to manage allocation of additional resources when and where needed.

Furthermore, in the nearest future it is planned to deliver real-time operational data directly to passengers via special application for smartphones, where they can find connecting gates, favorite shops and restaurants, etc.

In 2017 Heathrow publicly announced implementation of a machine learning model running to predict accurately the passenger flows by 15-minute increments into each terminal. Power BI reports and dashboards are already available to security officers, transfers and customer services staff. The next stage of the rollout will see border force given access to dynamic information relating to arrivals and baggage volumes throughout the day.
14. Deep learning and other avenues for innovation in Dutch Customs

The Customs Administration of the Netherlands (CAN) participates in European research and development projects to address mid to long term challenges. Together with other Member States these challenges are brought to the attention of the European Commission. For the use of non-intrusive inspection technology, key challenges exist in the automated signal interpretation of existing technology, the design of a flexible architecture of non-intrusive inspection technologies addressing each threat scenario appropriately and the development of novel non-intrusive inspection technologies to make-up for current lacks of capabilities.

In 2013 the ACXIS project (see www.acxis.eu) started its work on automated X-ray image comparison for cargo. The work led to the world's first container X-ray interpretation algorithms. The added value of the use of the algorithms was validated in a controlled study incorporating the effect of learning by doing. The project resulted in the wish of the Dutch Administration to further develop algorithms with, amongst others, its key suppliers, something that is visible in the current tender documents. In the meantime more Customs administrations have taken up the challenge of developing deep learning algorithms. The need for accessible databases of image material in a unified file format (under development with the WCO), declaration data and inspection results is a known prerequisite for automated X-ray image interpretation.

Customs administrations are confronted with a plethora of threat scenarios on entry or exit. Since the late nineties, X-ray image interpretation has been the technology of choice to confront these scenarios. As much as X-ray inspection is used, its limitations are known among experienced end-users. The C-BORD project (see www.cbord-h2020.eu/) addresses the need for the X-ray to be accompanied by a suit of technologies that in combination deal with the threats more efficiently and effectively than X-ray alone. Evaporation-based detection, advanced radiation detection, next generation X-ray inspection, tagged neutron inspection and photo fission were all combined in a C-BORD control street set-up to study their added value in September 2018.

But European Customs administrations want to be in the position to choose from a range of applicable products and to devise tailor-made architectures. To that end, the recently started COSMIC project looks into the detection of chemical, biological, radiological and nuclear materials through the use of dedicated sensors and muon interaction, in combination with X-ray inspection. Moreover, under the Horizon 2020 programme a call will open on March 14 focusing on the need for the development of technology to inspect, amongst other, high density cargo without disrupting the flow of goods. All these developments, some well under way, some still at the very start, will make the Customs administrations more able to efficiently and effectively inspect the rising numbers of goods crossing borders.
15. Biometrics - the experience of the New Zealand Customs Service

The New Zealand Customs Service has deployed an automated border control system using facial recognition to process passengers arriving and departing at Auckland, Wellington, Christchurch and Queenstown airports in New Zealand. This system, known as SmartGate New Zealand, was initially deployed in 2009 and consisted of separate kiosks and gates. Since 2009, the system has gone through multiple improvements, with the changes to the facial recognition algorithm, the cameras and, most recently, the gates themselves. The current system has dispensed with separate kiosks and instead uses two stage gates. Each traveller approaches the gate and scans their ePassport at a passport reader in front of the gate. The system then captures their demographic details and facial image from the ePassport chip and records their answers to any Customs declaration questions. After confirming the authenticity of their ePassport, and their eligibility to use the system, the first barrier door opens and the traveller moves forward towards the second barrier. A totem with three cameras at different heights captures multiple images of the traveller as they move towards the second barrier. A facial recognition template is developed from multiple images captured by these cameras and matched against a facial recognition template generated from the chip image of the traveller. If the match score passes the operational threshold for that location then the second barrier opens and the traveller moves on to the rest of the airport. If no facial template of sufficient quality can be generated, or if the match score is below the threshold, then the second barrier will not open and the case is referred to an officer for decision or, if there is still potential for a mismatch, the passenger is referred for manual processing.

At present, the SmartGate New Zealand system is available only to travellers aged 12 years and older who hold ePassports issued by Australia, Canada, China (excluding Hong Kong), France, Germany, Ireland, New Zealand, Netherlands, UK and US. Expansion to other countries is planned in the near future.

Since its initial deployment in 2009, the New Zealand Customs Service has made it a priority to monitor and understand the operational performance of the SmartGate system. A biometric performance tool is used to generate regular reports with full detection error trade off curves and performance separated by appliance, by location, by country of origin and various other factors. Several lessons have been learned over almost 8 years of performance monitoring.

Firstly, performance varies substantially by airport location. Even at the same airport, the performance of the SmartGate system in the arrivals precinct may be quite different from the performance in the departures precinct. A lot of this seems to be related to illumination factors such as the amount of natural light, the type of lighting fixtures and the height of the ceiling in each location. Secondly, there are substantial performance differences between travellers from different countries. Much of this seems to be related to the quality of the images in the ePassports issued by each country and to the rules they enforce to ensure ICAO compliance of these images. Thirdly, younger travellers experience a much higher false reject rate in the facial recognition comparison than older travellers. This is one of the reasons why there is a minimum age to use SmartGate in New Zealand. The rejection rate for travellers younger than 12 is very high. Finally, every algorithm and camera version tried so far shows a consistently higher false reject rate for females than for males. Since all algorithms tested showed this bias, it is at least partially due to females being intrinsically more difficult to match using facial recognition, but since different algorithms showed this to different extents, it is also partially due to the way the algorithms were designed.
16. Biometrics - the experience of the Canada Border Service Agency (CBSA)

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<thead>
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<td>Identity Verification 1:1 match against chip image</td>
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<td>Enrolled Foreign Nationals</td>
<td>3 airports with kiosks (additional 7 by 2019)</td>
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<td>49 Port of entry with biometric equipment and 10 enforcement offices (additional 8 ports of entry by 2018)</td>
<td>Identity Verification 1: many search against criminal and immigration databases</td>
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17. iBorderCtrl – European Union’s smart decision to facilitate and secure border check points with biometrics

More than 700 million people enter the EU every year – a number that is rapidly rising. The huge volume of travelers and vehicles is piling pressure on external borders, making it increasingly difficult for border staff to uphold strict security protocols – checking the travel documents and biometrics of every passenger – whilst keeping disruption to a minimum.

To help, the EU-funded project iBorderCtrl is developing an “intelligent control system” facilitating – making faster – border procedures for bona fide and law-abiding travelers. In this sense, the project is aiming to deliver more efficient and secure land border crossings to facilitate the work of border guards in spotting illegal immigrants, and so contribute to the prevention of crime and terrorism.

iBorderCtrl system will collect data that will move beyond biometrics and on to biomarkers of deceit.

The iBorderCtrl system has been set up so that travelers will use an online application to upload pictures of their passport, visa and proof of funds, then use a webcam to answer questions from a computer-animated border guard, personalized to the traveler’s gender, ethnicity and language. The unique approach to ‘deception detection’ analyses the micro-gestures of travelers to figure out if the interviewee is lying.

This pre-screening step is the first of two stages. Before arrival at the border, it also informs travelers of their rights and travel procedures, as well as providing advice and alerts to discourage illegal activity.

The second stage takes place at the actual border. Travelers who have been flagged as low risk during the pre-screening stage will go through a short re-evaluation of their information for entry, while higher-risk passengers will undergo a more detailed check.

Border officials will use a hand-held device to automatically cross-check information, comparing the facial images captured during the pre-screening stage to passports and photos taken on previous border crossings. After the traveler’s documents have been reassessed, and fingerprinting, palm vein scanning and face matching have been carried out, the potential risk posed by the traveler will be recalculated. Only then does a border guard take over from the automated system.

At the start of the iBorderCtrl project, researchers spent a lot of time learning about border crossings from border officials themselves, through interviews, workshops, site surveys, and by watching them at work.

It is hoped that trials about to start in Hungary, Greece and Latvia will prove that the intelligent portable control system helps border guards reliably identify travelers engaging in criminal activity. The trials will start with lab testing to familiarize border guards with the system, followed by scenarios and tests in realistic conditions along the borders.

As a consequence, the partner organizations of iBorderCtrl are likely to benefit from this growing European security market – a sector predicted to be worth USD 146 billion (EUR 128 bn) in Europe by 2020.
Project details

• Project acronym: iBorderCtrl
• Participants: Luxembourg (Coordinator), Greece, Cyprus, United Kingdom, Poland, Spain, Hungary, Germany, Latvia
• Project №: 700626
• Total costs: € 4 501 877
• EU contribution: € 4 501 877
• Duration: September 2016 to August 2019
18. The Federal Customs Authority (FCA) of the UAE is increasingly using the latest technologies such as drones, 3D CT, scanning devices, and virtual robots.

The FCA vision is to be a leading customs administration to improve community protection and trade facilitation. The FCA strived to become one of the first Customs agencies in the world to use the latest technologies to accomplish their vision.

Over the last few years, new technologies such as drones and AI, have become increasingly used by the UAE government for a range of activities such as customs and security protection. At the Government Summit held in February 2014, the UAE introduced the “Drones for Good” award to encourage the development of drone-related technology. Along with other activities, drones are used in Dubai Customs for surveillance of suspicious activity and inspection of trade vessels in Dubai Creek. Additionally, Dubai Customs has launched a new sophisticated smart inspection device that features 3D CT scanning as part of its ongoing efforts to keep abreast with the latest technologies. The system is used to considerably enhance inspection performance and enables inspection officers to work more efficiently. As a result of the new technology, Dubai Customs inspection officers made 1,628 drug seizures in 2017 compared to 1,347 seizures in 2016.

Another good example is the ‘Smart Refund Initiative’ that was shortlisted for the final stage of the Hamdan Bin Mohammed Program for Smart Government Award. The initiative uses robotic process automation technology that requires no human intervention. Not only does the intelligent system eliminate human errors in data entry, but it also reduces the time needed to refund custom’s insurance from seven to nine minutes to just one minute. Moreover, the initiative has reduced processing costs by 80% which translated into AED 23.5m in savings. The initiative has helped increase customs declarations processed to 702,000 between January and September 2017. Dubai Customs also introduced a Virtual Corridor system which has improved the goods transfer process from port-to-port. The initiative coincided with the Smart Transformation Strategy of Dubai Customs and Smart Dubai. It has eliminated site visits, reduced duty deposits and has resulted in savings of AED 358m.

FCA plans to furnish all entry points with the latest and most advanced scanning and inspection devices. This will require mobile and fixed drug and explosives detection devices that will be used to check containers, vehicles, luggage and people. The package will include the ‘Ionscan 500DT’ which is used by security professionals to detect a wide range of substances and is adaptable as threats and needs change.

FCA will continue implementing the latest practices and innovations to support legitimate trade and enhance customs controls.