Cabinet Office

THE ECOSYSTEM OF TRUST EVALUATION REPORT

AUGUST 2023

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Executive Summary

Context

- The 2025 Border Strategy set out our vision of using data and technology to create the most effective border in the world. It set out our ambition to move processes away from the border where that could facilitate trade while protecting the biosecurity and security of the UK.
- We set out to test whether a new border model based on this principle, called the Ecosystem of Trust, could be implemented across the public and private sector to reduce trade frictions. This model is based on the use of innovative technology capabilities, real time data and trusted relationships to provide border agencies with new ways to assure what is moving across the border.
- We partnered with six industry consortia, made up of technology firms, traders and logistics companies to test this model.
- Together with border agencies these consortia have tested new ways of sharing data and assurances around the border, exploring what benefits these approaches could deliver.

Findings

- Through the pilots we learned that industry can make a broader range of higher quality data available to the government than that available today. This data can be provided in various formats that adapt to border agencies' needs.
- Our findings suggest that supply-chain data can provide 80% of the minimum risking requirements for customs purposes and 60% of trade statistics requirements. Supply chain data improved frontline targeting teams' confidence in their decision-making and our analysis suggests it might be possible to decrease the time taken to make those decisions by 17%.
- But the pilots show us that new models are not yet ready to replace traditional mechanisms of border control. The UK government cannot take full advantage of new data because industry has yet to be incentivised to develop the appropriate technical infrastructure to make it available in the right (machine readable) format at scale, and government has not yet adequately determined the most effective ways to use or collect it.
- The pilots also looked at how augmenting technologies or assurance devices can provide assurance of a goods' integrity and its journey, and how useful that information can be at the border. While these devices cannot be relied upon alone to provide assurance that consignments have not been compromised, they can improve the border by providing new, useful intelligence (e.g. about temperatures) that can help border agencies deliver effective border controls.

- Most importantly, the pilots have shown that industry and government can collaborate quickly and usefully to unlock solutions and overcome interoperability issues around the use of data. There is an appetite on both sides to drive trade digitisation and facilitate the adoption of supply chain data into government for mutual benefit.

Realising the benefits of these models

- There are clear opportunities for government and trade if we can use supply chain data more effectively. Government has a long-term ambition to transform the operation of the border through technology. This ambition is shared by some of our key trade partners, and presents the opportunity of truly digital international trade.
- Initial analysis provides compelling estimates for the "size of the prize" if the EoT models are adopted, including the economic benefits for trade and for government and society as a whole. For example, if the automation of customs declarations using business documentation, when it becomes possible, reduces industry's customs data collection costs by 40%, this could result in an annual average reduction administrative burden of up to £225m depending on the scale of uptake.
- But no new model will be taken up by industry if it isn't attractive. To be truly transformational, government needs to make border facilitations available to supply chains investing in this technology, so there is a return on investment.
- The pilots began the work to explore what assurances would be required to release such benefits, with particular focus on where paperwork requirements for traders might be reduced. Defra's forthcoming Trusted Trader scheme pilots will apply some of these ideas more specifically to the SPS regime.
- To truly harness the potential of the these new technologies there are clear challenges that must be overcome:
    - We need to tackle the interoperability problems uncovered during the pilots by removing the legal barriers to trade document digitisation through the impending Royal Assent of the Electronic Trade Documents Bill.
    - We must encourage the adoption of digital trade document standards, which alongside the process improvements which exploit standardised document data, will incentivise trade and government to accelerate their digitisation efforts.
    - We must create a way for the government to ingest supply chain data through the UK Single Trade Window that encourages industry to innovate and incentivises them to share data.

Recommendations

- The work on this highly transformative technology cannot stop here and our core recommendations are that:

- **Interoperability** is the biggest problem to solve. The logical next step is to integrate industry data into government systems and collectively assess structured upstream trade data against business requirements, including how to scale and automate transfers of data from industry into government. There are other interoperability issues which must also be addressed as supply chain members share data among each other, with the government and between countries. Specifically, adoption of particular standards, data governance and legal issues. International interoperability is key so new models of sharing data can align with that of our trade partners. We have an opportunity to be influential, and to encourage particular models and standards, and digitisation, if we act quickly. The pilots included international partners but ongoing collaboration across international boundaries will allow us to experiment and develop models more effectively.

- **Maximising value to trade** is key to adoption of these technologies. Government must continue identifying ways to incentivise trade so that new information flows between industry and government can be established and adopted. If the government can pinpoint where it needs particular assurances, then industry can start providing them in return for fewer border frictions.

- **Collaboration** between industry and border agencies is at the heart of driving improvements that work for both sides and which are informed by actual trader experience, so it must remain. Other sectors with issues that intersect ours, like trade finance, should be part of our problem solving efforts. We set out the governance for that collaboration to continue, and the priority issues that must be tackled.

- **Building the mechanisms for border agencies to receive and use supply-chain data.** The STW programme should explore how innovative, “lighter touch” ways of receiving data in line with what industry has told us works best for supply chains could meet departments data needs.

1. Strategic context and overview of the pilots

The UK government's vision for the border

Having left the European Union, the UK has an opportunity to redefine how we run the border. We can make key decisions about how we implement border controls and radically redesign processes by looking at advances in data collection and sharing and new technologies.

The UK isn't alone in wanting to improve its border. All governments want to deal with the latest challenges for trade - be they the rise in e-commerce and small packages crossing the border, or new security and biosecurity threats, or the ability to manage the border through crises and supply chain crises caused by geopolitical events. The European Commission has just issued its proposals for an overhaul of customs by 2032, where the main thrust is a move from a declarations-based system to a data-led system. In other words, paperwork and formalities are reduced where data is given transparently and authorities have visibility of whole supply chains. The US has also started the acquisition process for its next generation single window for trade data platform. This will replace their current single trade window, and support the provision of better quality data earlier in the supply chain, more seamlessly and from a wider range of supply chain actors. It will increase supply chain visibility and allow US agencies to make timely, coordinated targeting decisions further in advance, before goods arrive at the border, improving security while speeding entry for legitimate trade.

The UK has big ambitions. Our border transformation projects are not confined to customs but look at all relevant border compliance regimes. But, like every government, the UK government has to balance innovation with a range of responsibilities it must deliver in its implementation of the border: for example, keeping citizens safe, protecting the UK's environment, enforcing trade policy, honouring international obligations and protecting consumers. To do these effectively, we maintain control over what crosses the border. We need to know what – and who – is crossing the border, while assessing the level of risk these movements constitute so that we can carry out appropriate checks. The UK government also wants to promote economic growth and support businesses to trade easily with countries across the world. Effective border processes are crucial to delivering these objectives, by ensuring that we can enforce controls with minimum burden to businesses.

Current processes at the border are transactional and create administrative burdens for traders. Often traders (and those providing data on behalf of the trader) are required to submit the same or similar information to different entities within the government, creating complexity and cost. Physical checks and other border processes can add further costs and delay the release of goods. These can result in an incomplete or disjointed picture of border flow for government agencies, leading to suboptimal risking and inefficient checks.

One of the goals of our 2025 Border Strategy is to reduce the burden on traders and help UK businesses take advantage of new trading relationships with countries across the world,

whilst strengthening our ability to target criminal activity and protect the UK's people, businesses, health, and environment.

The UK government believes that transforming the border means moving physical processes away from the frontier wherever possible. We believe this can be achieved by taking advantage of cutting-edge technologies and real-time data, which can help us better assure the movement of goods across the border and by triangulating this new data, technology and trusted relationships. This automated assurance and reliability can help to build and ensure trust between actors, creating an "Ecosystem of Trust" (EoT) that could allow a great deal of processes to be moved away from the physical frontier.

What the Ecosystem of Trust project set out to test

In 2021 the UK government committed to testing the idea that an EoT - made up of three pillars; technological capabilities, real time data and trusted relationships - could reduce trade frictions without compromising the UK's security or biosecurity.

The vision of the EoT is that, by working with industry to harness innovative technology, we can create a frictionless import/export experience for compliant and Trusted Traders and enable enforcement of controls to be more focused on traders deemed to be of higher risk.

We started with the idea that through new Trusted Trader Schemes we might be able to unlock streamlined border experiences for particular traders in exchange for three things:

- Visibility of their supply chain data, which helps government know the identity of goods and spot anomalies, and;
- Assurances from technology and devices, which helps government trust the integrity of a goods' movement, and;
- Evidence that the trader and their supply chain is responsible and compliant and so could form a trusted relationship with border agencies.

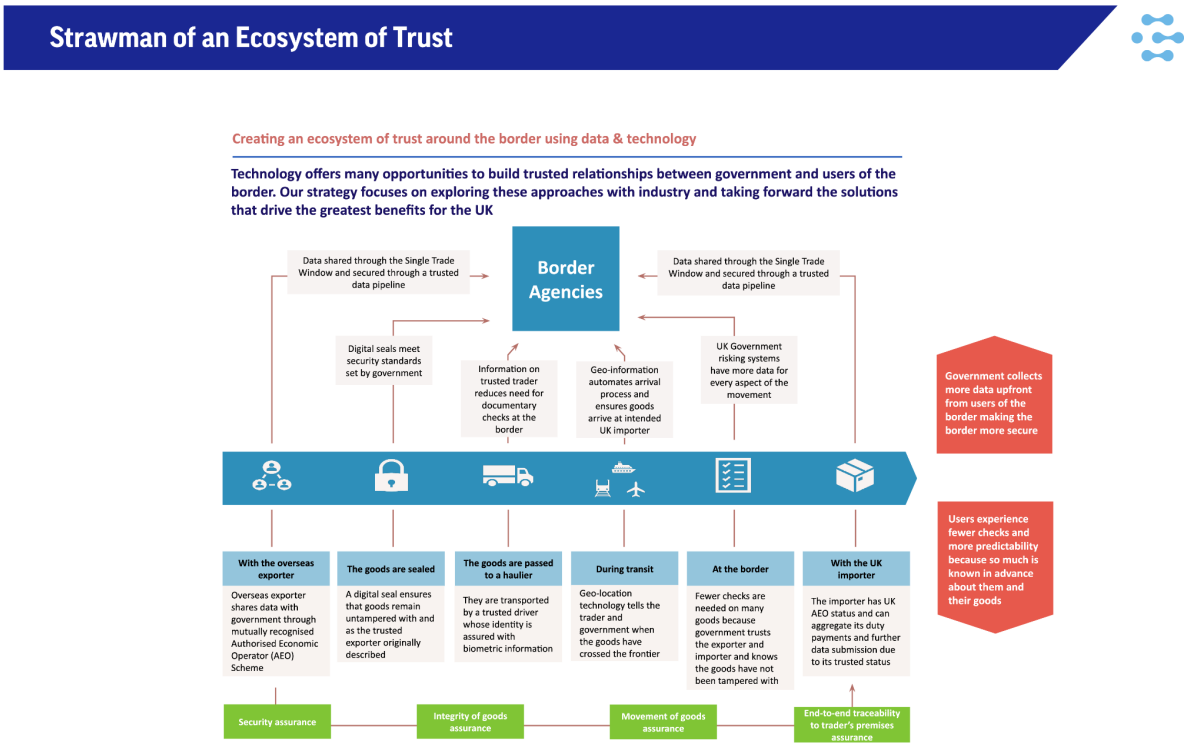
We set out to explore whether the ambitious goal of using better technology and data to enable frictionless trade was feasible and, if so, what level of benefits could realistically be expected. Possible outcomes range from modest time/cost savings for traders due to data automation and movement of checks away from the border, through to the most ambitious benefits, like the reduction of physical inspections and associated paperwork. The government hoped for greater trade facilitation and a more secure border, capable of detecting and deterring hostile actors.

Government wanted to assess: which supply chain visibility and goods movement integrity capabilities are currently available and deployed by industry; the extent to which these could support an EoT approach in practice; and what the benefits of this might be. This would allow the government to better understand which policy, process and system changes would be required for the EoT model, including what open technology standards would be required to allow efficient scale adoption of the model.

The core features that the EoT pilots set out to test are:

- Whether we can create an agreed and defined set of **data requirements**, generated securely by commercial transactions, that trusted traders are required to provide to the government in order to meet its risk and compliance and wider economic management needs.
- Which **technologies** can secure a journey across the border so that the government's agencies can trust the integrity of a load, and understand how technology is practically deployed at the border.
- What **value** can be released to trusted traders as quid pro quo for this assurance.
- What the overall **cost and benefits** would be of a new EoT approach, both for the individual trader and the wider macroeconomic benefits for the UK.
- And how **feasible and scalable** a model would be to implement.

Figure 1: Strawman of an Ecosystem of Trust (as outlined in the 2025 Border Strategy)



Pilot design and delivery

The pilots were based on the principle of collaboration and open innovation between government and Industry, with both working together to co-design trials of technology and processes.

As such the pilots provided an opportunity, in a safe environment, for industry to demonstrate in-practice systems and technologies which have the potential to significantly enhance the way government and industry communicate and share data with each other.

The fact that pilots were “dual running” with standard border controls, and so all normal processes were followed while the pilots were testing new processes in parallel, meant that we could be as experimental in our pilots as possible with no detriment to security or biosecurity.

The pilot process began in December 2021 with a call for expressions of interest. These called for self-organised consortia to pilot proposals in conjunction with border departments and agencies. The scope was that consortia would:

- Operate in a live port environment and include exchanging documents and data relating to real goods movements.
- Deal in almost all types of commodities (except the most high risk such as firearms or live animals) and all modes, subject to discussion around the operational preferences of key agencies.
- Focus on testing the model for trade between the UK and the rest of the world, including the EU. The movement of goods between Great Britain and Northern Ireland was deemed out of the scope of the pilots.

Those companies expressing an interest underwent due diligence checks and then were invited to form consortia. The consortia were required to comprise of at least; a port, a trusted importer with an accredited overseas trade partner, a carrier, a logistics firm and a technology company (though some also included research organisations and universities). A full list of consortia members and participants can be found in **Annex E**.

Industry collaborated in return for an opportunity to shape the future of the border, to test their ideas in a live port setting and to be involved in the development and creation of the standards and requirements needed to deploy technologies at scale.

After a co-design phase where prospective consortia had the opportunity to discuss and shape ideas with the departments who would be piloting them, all consortia proposals were judged by a cross-government panel. The six consortia proposals taken forward to live piloting were announced in July 2022, with pilots then running during the last quarter of 2022 and first quarter of 2023.

Pilot consortia and their proposals

The six consortia each came with a variety of products to be tested on their own traders’ commodities across several modes and routes. A summary of the respective six consortia proposals can be found in Table 1. The government and consortia held a series of design clinics to understand their specific user journeys and the significant supply chain events within those user journeys in order to identify when time-critical information would be made available.

Each individual consortium deployed their own **system of record** (i.e. information storage and retrieval system) and a **dashboard** to visually present the data, with different “views” for

government and industry. One consortium overlaid their dashboard with a **data platform** to enable enhanced data aggregation.

To assist government colleagues with understanding of the data being provided, each consortia produced a **data menu** describing the available data fields. A key distinction between consortia was the status of the data they were able to provide:

- None could provide “1st hand data”, where supply chain actors provide data directly to government without any system of record in place. This approach to data provision was out of pilot scope because timelines and related constraints ruled out full technical integration between industry systems and government systems.
- Some consortia provided “2nd hand data”, which is where supply chain actors enter data into the system of record themselves, and that data is then accessible to all with permission to access the systems of record.
- Some consortia provided “3rd hand data” which is where a third party extracts data entered by others onto the system of record, and provides visibility of the data through another platform or system.

In addition to dashboards and platforms, several consortia took the opportunity to provide both an **historical and operational file export** during the pilot duration. Historic file exports contained data held in systems of record prior to pilots starting with the purpose of demonstrating data properties to officials, whereas operational file exports contained data exported directly from consortia to government once pilots had started and were made available at configurable intervals. Co-design discussions took place with departments to establish suitable formats in which to receive the structured data (namely CSV, XML or JSON). One consortium developed a roadmap for how they could achieve file exports in the future.

Consortia also provided extensive augmenting technologies which we explored and trialled to various degrees (see Chapter 3).

Table 1: Summary of the six consortia proposals

Consortium	Routes	Ports	Commodities	Proposed EoT deployment model
Azarc	EU-UK RoW-UK	1. Harwich 2. London Gateway (RoRo accompanied, LoLo)	(1) Fresh fruit and vegetables; and (2) Charcoal & wood.	Azarc's proposition was to use the Rune Utility Trade Network to establish assurance by permitting supply chain actors to contribute data directly into a shared system of record. Azarc presents data as second hand data via a dashboard and through historical/operational file exports. Rune supports greater efficiency in the clearance process, including increased pre-clearance data and the associated visibility of movement of goods across the border. The system captures information from multiple data sources, such as IoT devices and smart seals. The Azarc proposal enables different forms of real time payment of duty/taxes enabling improvement in processes.
Chainvine	RoW-UK (Americas) UK-EU	1. Dover 2. Liverpool 3. Felixstowe 4. East Midlands Airport (Break Bulk, LoLo, Air)	(1) Melons; (2) Wine; and (3) Cut Flowers.	Chanivine's application acts as a data aggregator between producer/logistics & regulators. It permits direct contribution of supply chain data into a shared system of record. Data is presented second hand via a dashboard (BlueRing) or through historical/operational file export. The dashboard links to IoT technology, e.g. Octosense smart seals which offer intrusion detection by measuring CO2, light and speed monitoring in order to create an event(s) in the dashboard. Chainvine offers digital labelling in the form of a QR Code which is an access and communication point. When scanned, QR codes redirect the user to a dashboard where information on the goods movement is displayed.
Connected Borders (Palantir)	EU-UK	1. Dover 2. Felixstowe (RoRo, Maritime)	(1) Meat & Meat Products; (2) Fish; (3) Egg Products and (4) Shelf stable food products	The Digital Goods Passport Platform allows industry to submit information to government agencies on their consignments and build a digital 'passport' of the trusted status, certifications and history of that consignment and the traders involved in its movement. A single data dashboard provides access to typically third hand data presented in the form of a data platform, enabling enhanced data aggregation and operationally exportable. The data aims to provide assurance that goods are physically secure from packing to arrival at their final destination, that they have a digital seal and that drivers are trusted.
Digital Business Marketplace/African Trade Corridor	EU-UK RoW-UK (Kenya)	1. Immingham 2. Felixstowe 3. Stansted airport	(1) Frozen fish; (2) Coffee; (3) Tea; (4) Animal feed; and (5) Cut flowers.	DBM/ATC's proposition permits supply chain actors to contribute information directly into a shared system of record. This data will be presented second hand via the Trade Logistics Information Platform (TLIP) dashboard, aggregating detailed supply chain documents, events and information in real-time during the consignment journey on one platform. The pilot includes digital seals by SecureTrak, which provide real-time information of geolocation and condition of the goods. In addition, due diligence can be increased

		(RoRo unaccompanied, LoLo, Air)		by leveraging In-market checks (Retail Asset Solutions), enabling a larger number of professionals to observe and potentially intervene over a goods movement.
Fujitsu	EU-UK	1. Eurotunnel 2. Dover (RoRo)	(1). Pet food; (2). Computer, computer components & office equipment; (3) Paper for recycling; (4) Car parts and accessories; (5) Books; (6) Kitchen Appliances	Fujitsu's proposal is to utilise the Fujitsu Atamai Freight platform, permitting supply chain actors to contribute data directly into a shared system of record. The data is operationally exportable. In addition, smart seal technology (reusable seals), providing events sent immediately to the Atamai Freight platform coupled with real-time journey tracking events, provide a level of assurance to help predict potential issues arising during the movement of goods. The proposition permits an increase in due diligence by leveraging in-market checks (Retail Asset Solutions), enabling a larger number of professionals to observe and potentially intervene over a goods movement.
IBM-Maersk	RoW - UK (China, Thailand, Latin America)	1.Felixstowe 2.Southampton (LoLo)	(1) Bananas; (2) Electric Scooters & Parts; (3) Poultry products	The IBM-Maersk proposition aggregates data and collects information from upstream systems. The shared system of record therefore makes second and third hand information available through multiple dashboards. The proposal uses TradeLens, Remote Container Management (Captain Peter) and MyMaersk online surveillance to test this concept. Smart container technology is deployed to enable Global Positioning System (GPS) tracking, notifications of deviations and records in-transit container temperature and humidity. In addition, IBM will provide a presentation on a remote risking system (Quantexa) and how it could be leveraged, using a combination of data sources to provide insight and context to supply chain actor relationships.

2. Findings: supply chain data for border controls

Data sits at the heart of the operation of the border. For businesses, data is key to managing complex international supply chains. For the government, data is vital for keeping the UK secure - underpinning our ability to evaluate the risk associated with goods and to make swift and accurate interventions where needed to combat fraud and disease.

Responses to the 2025 UK Border Strategy consultation consistently emphasised that the government must work with industry to improve the use of data at the border and how it is shared. Specifically, the use of data, technology and relationships between government and users of the border to deliver robust upstream compliance, which would allow processes to be moved away from the frontier.

The pilots have acted as a proof of concept with industry - exploring which data elements could be drawn directly from the supply chain and, broadly, the requirements for the system integration methods to automate ingestion. The pilots, as illustrated in the remainder of this section, have demonstrated that supply chain data can provide additional value to that which is received from discrete declarations.

However, the pilots have also demonstrated that, at present, it is not feasible for supply chain data to replace the traditional declaration process as a result of significant obstacles to provision, adoption, and integration of this data.

The implication is that use of supply chain data, as a form of assurance that can replace particular border requirements for traders, will be a gradual process. Better border processes in aggregate will be driven from incremental improvements which are applied and scaled from specific use cases, as opposed to overhauling the current declaration process outright.

The value of supply chain data held by industry

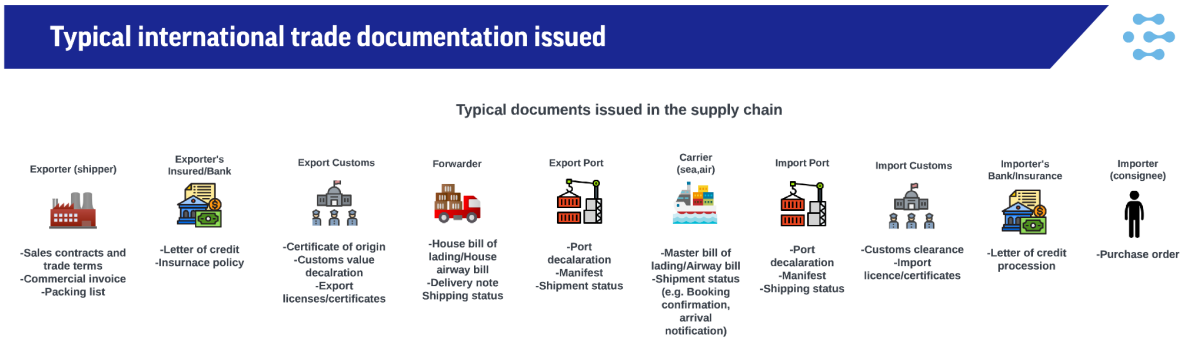
Through the pilots, we explored what data it is possible to generate securely from commercial transactions (such as those shown in figure 1) and pass into government to support border agencies to deliver border control regimes, and fulfil other responsibilities e.g. HMRC's production of trade statistical data.

Below, we include findings from assessments conducted by the Home Office (HO) and Border Force (BF); Department for Environment, Food and Rural Affairs (Defra), Food Standards Agency (FSA) and HM Revenue and Customs (HMRC) respectively.

A core question we tested is whether supply chain data could provide "better quality" data to the government than is currently available through declarations. We used data field analysis to assess whether the minimum risking datasets that departments want for their internal processes could be met by consortia, i.e. testing whether supply chain data could match the

scope of the data currently available through declarations. Our findings are broken down by compliance regime using the following criteria to assess the data we tested.

Figure 2: Typical international trade documentation issued



(source: World Trade Organisation)

Defining supply chain data and measuring its qualities

The key differences between current declarations data and what we call “supply chain data” where it is gathered at source from the supply chain are:

- **Real-time data.** Declarations data is static - it provides a record of a trade movement at a single point in time. There is a time lag between when data is generated commercially and when it is provided to the government as a declaration. Supply chain data is produced in real-time as part of the individual commercial transactions, logistics, and legal process involved in producing and shipping and ensuring the regulatory compliance of the goods.
- **Richer data.** Supply chain data provides extra, fuller data compared to declarations where requirements means that data can be diluted or omitted.
- **Telemetry**. Supply chain data can include a live, physical status of the goods in question which UK government does not have access to through declaration data.
- **Indirect due diligence.** Supply chain data can contain insights resulting from third party operated quality assurance processes - for example laboratory tests and official veterinary sign-offs.

During the pilots we used the following four markers of data quality to assess the data we were seeing from consortia:

- **Availability** of data fields currently available to departments through the declarations and reporting process, and those which are additional. We are looking for whether data met departmental requirements, and whether it helps them with their border objectives.
- **Timeliness** of data fields made available to the government, and at which stage in the border process including whether supply chain data can give government data earlier.

- **Accuracy** of data fields and whether these would have supported departments to make more confident targeting decisions in a real-time operating environment.
- **Accessibility** of data fields; whether departments were able to immediately access a sufficient goods image, for compliance & risking needs, with the data elements made available by the consortia; and whether the data was consistently present in a usable format.

Assessing data for safety and security needs

Border Force targeting teams are responsible for assessing the potential risks of a consignment, and its related entities, so that timely interventions can be made at the border when necessary. To do this, they use several sources of data which vary by mode, including safety and security (S&S) declarations.

We have assessed the usefulness of data for the Home Office (HO) and Border Force (BF) using two methods:

- By running an availability (comparative) data analysis with central HO intelligence teams: HO analysts compared the data from two consortia against the full dataset that is currently used for commodity-based risking in HO & BF.
- By running an operational 'confidence scoring' exercise with three BF targeting teams where some 37 movements were tested (compared to a total 74 million import declarations made in 2022). Three targeting teams operating from key border sites, responsible for risking consignments being imported into the UK for specific modes of transportation, participated in the consortia data analysis: Break Bulk, Accompanied Roll on Roll off (RoRo), Unaccompanied RoRo. Each team used novel data provided by the consortia as part of their day to day risking exercises to see whether it improved confidence in their targeting decisions.

The findings are given below and highlight that industry has access to valuable supply chain data that is not currently available to BF and HO from S&S declarations and other sources. The findings we would most highlight from extensive analysis are:

- **All targeters across the 37 movements** specifically tested during the confidence scoring exercises found that the additional consortia data provided, in addition to the data they currently use, would have helped them make a more confident targeting decision.
- Across all modes, **~28 *new* data elements and whole documents were made available** to assess in a targeting environment albeit with some degree of overlap of the new fields occurring between modes.
- Particular data fields were identified as providing very high levels of confidence - including invoices, journey tracking details and health certificates. For some of these notable data fields, **consortia were capable of providing BF with over 80% consistency.**

- For accompanied RoRo, **70% targeters asserted that the additional consortia data helped them reach a targeting decision with a high level of confidence.**
- The limited testing for unaccompanied RoRo showed that **there is potential for targeters to reach a compliance decision up to 17% faster[1] when using the consortia data, in addition to existing data.** This does not necessarily suggest the saving will be across all movements and other factors could have contributed to this improvement, such as presenting the data in one place rather than multiple systems.

Analysis of the availability of data

The data from the consortia was matched against the data currently used for targeting of each mode. The targeting criteria cannot be shared publicly due to security constraints so we have instead indicated where data was sufficiently matched (noting that multiple consortia data fields could match a single data field used for targeting).

Airfreight, Containers and Unaccompanied RoRo: For the consortia analysed, almost half the available data were strong matches against the BF targeting data set with an additional ~10% of unique matches that were potential matching, bringing the total of strong and potential matches to 59.1%.

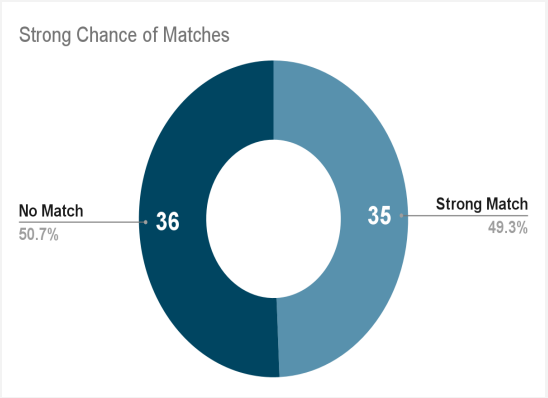


***Chart 1**: Number and % of consortia data fields with strong matches to the data used for targeting by Airfreight, Containers and Unaccompanied RoRo*

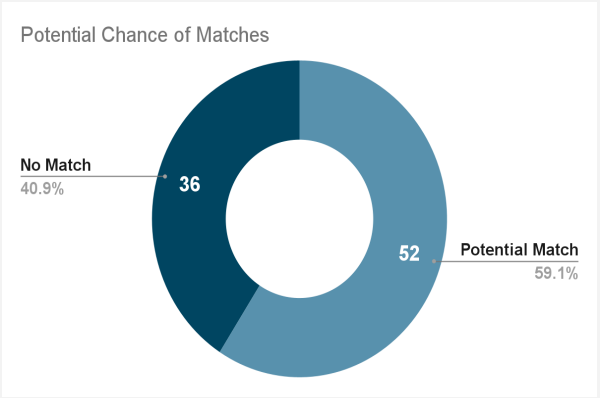


***Chart 2:** Number and % of consortia data fields with potential matches (strong matches + maybe matches) to the targeting data used by Airfreight, Containers, and Unaccompanied RoRo*

Accompanied RoRo: For the consortia analysed, two-thirds of the available data were strong matches against the BF targeting data set, with an additional ~6% of unique matches that were potential matching, so the total of strong and potential matches to 72.6%.

[1] This refers to the initial decision only. When subsequent movements present the same assurances, these would be acted on quickly and consistently regardless of the time taken on the initial decision so this improvement in time may not apply on subsequent movements. This figure is illustrative from limited testing and does not represent a typical value. This should not be used in further analysis without prior consultation.

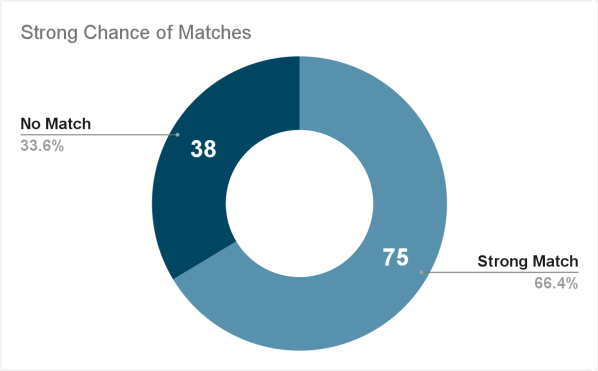


***Chart 3**: Number and % of consortia data fields with strong matches to the data used for targeting by Accompanied RoRo*

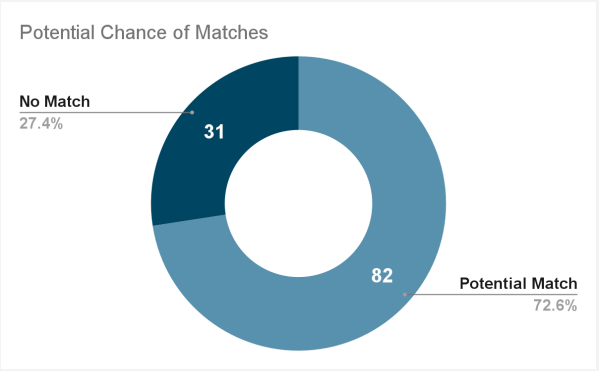


***Chart 4:** Number and % of potential matches (strong matches + maybe matches) between one consortia's data and targeting data used by Accompanied RoRo*

As well as the comparative data analysis, we performed an operational analysis to determine whether novel consortia data improves confidence[2] in targeting decisions. Our rationale was that if the new data boosts confidence when making targeting decisions then the rate of false positive checks and other mistakes will reduce for compliant goods, resulting in fewer delays for compliant traders. The evaluation assessed:

- Consistency: How often a novel data field or document provided by consortia was present on the consignment to be assessed by targeters.
- Confidence: The additional confidence a data field or document gave a targeter making a risking decision, ranging from low to very high.

Accompanied RoRo: 17 consignments were assessed; ranging from books, kitchen appliances, automotive parts and computer related equipment - all within one consortium (Fujitsu).

- All targeters agreed that the set of data fields provided would help them make targeting decisions with greater confidence in a real-time operational environment. In addition, targeters found that without the consortia data they could not make a decision with a high - very high degree of confidence for 70% of the consignments assessed. This is due to time constraints on busier short straits routings and all the data being provided in one system and well in advance of travel.This assertion must also be caveated with the fact that once the current EU waiver has ended S&S declaration data will provide the Accompanied RoRo team with a much greater baseline of targeting data. Therefore if this analysis were repeated the results would be much less pronounced.

[2]For this assessment the consignments tested were from highly compliant traders willing to participate in the EoT and provide additional transparency into their supply chain information at no immediate gain to themselves. As a result a higher level of confidence for a specific data field or supply chain document should not be directly attributed to any measurable or quantitative measure of targeting accuracy, rather it should be considered a proxy for an improvement in positive targeting outcomes such as a reduction in false positives or an increase in the identification of potentially non-compliant consignments.

- However in several cases the novel data lacked a number of key fields that consortia specified would be available (e.g. load description is mostly shown as a reference number or missing data for load weight, number of packages, addresses, country of origin, true buyer/seller data - though the latter appears in PDF invoices)
- The table below highlights the sorts of data fields which most added to government confidence.

Table 2: Accompanied RoRo novel data fields analysis, across 17 consignments

Data field	Consistency	Confidence	Additional notes
Point of First Collection	100% (17/17)	**High**	Useful tracking data, but in some cases was not available late in the consignment journey. In some cases, goods picked up from a consolidated warehouse gave a misleading indication as to where the goods were really from.
Port of Exit	88% (15/17)	**Very High**	-
Port of Entry	88% (15/17)	**Very High**	-
Final Destination	100% (17/17)	**Very High**	For several consignments, warehouse to warehouse details are shown on the structured data but the true destination on the paperwork is different. There is an accessibility issue accessing the true data through the document but it still provides very high confidence and it is consistently provided.
Consignor Details	100% (17/17)	**High**	Useful data field but in many cases this only provides agent to agent details in the structured data. True consignor details were present in the documentation.
Smart Seal	100% (17/17)	**Very High**	-
Haulier Details	25% (2/8)	**Medium**	Only presenting details of the haulier but there was evidence of subcontractors being used who were unnamed.
Journey Tracking Data	100% (9/9)	**Very High**	-
Commercial Invoice	82% (14/17)	**Very High**	Invoices indicate the true origin of the goods where they are not always accurately presented in structured data; Presents true buyer and true seller; In many cases suggests UK as Country of Origin
Packing List	18% (3/17)	**Medium**	Presenting origin of the goods as UK which in consideration of other data points seemed unlikely
Road Consignment Note (CMR)	41% (7/17)	**Medium**	Details presented as agent to agent (Kuehne Nagel) so not true buyer and seller; sub contractor details are not clear on the PDF; sometimes only presenting a limited or part description of the load; lacks clear load description generally.

Transit Document	6% (1/17)	**Very High**	-
Export Accompanying Document	6% (1/17)	**Very High**	-

Unaccompanied RoRo: 18 consignments were assessed ranging from: frozen fish; coffee; tea; animal feed; and cut flowers for the same criteria, related to the one consortium dealing with this mode (DBM-ATC).

- All targeters for all consignments involved in the evaluation for this mode agreed that the set of data fields provided by this dashboard would help them make targeting decisions with greater confidence in a real-time operational environment.
- The availability of commercial invoices gave a lot of useful data to conduct checks against. The following key fields, core to targeting decisions, were all found on the commercial invoice: true consignee, consignor information and origin of the goods.
- Unavailable data fields include driver details. As the mode is unaccompanied usually this is not a concern, however details of the driver picking up the consignment from the port would allow BF to perform credibility checks. While Movement Reference Numbers (MRNs) provide high confidence, it is only the import MRN that is used during targeting and in some consignments the export MRN was provided instead.

Table 3: Unaccompanied RoRo novel data fields analysis, across 18 consignments

Data field	Consistency	Confidence	Additional notes
Trailer number	100% (15/15)	**Very High**	**Mandatory data field:** Required with additional data in order to identify the consignment but does not directly assist in making a targeting decision.
Consignor Name/Address	80% (12/15)	**Very High**	**Mandatory data field:** Required to perform additional credibility checks. Credibility checks against this data are the basis for a targeting decision. On occasion only one 'true' consignor was shown for part of a 10 consignment load. Other consignments in the same load were labelled with a warehouse.
Consignee Name/Address	80% (12/15)	**Very High**	**Mandatory data field:** Required to perform additional credibility checks. Credibility checks against this data are the basis for a targeting decision.
Seal Number	78% (14/18)	**Medium**	Could assist frontline targeting in the case of suspected tampering. Would not directly assist in making a targeting decision.
Import MRN	88% (16/18)	**High**	Availability of the MRN allows for searches to be conducted on other systems for further data if needed.
Unique Consignment Number (UCN)	88% (16/18)	**Low**	Availability of the UCN allows for searches to be conducted on other systems for further data if needed.
Health Certificate	87% (7/8)	**Very High**	*For relevant consignments.* Provides good evidence and goods are accurate and legitimate.

Transport Plan	33% (6/18)	**High**	Allows Border Force to see haulier / driver picking up and the date & time for pickup or delivery. Allows additional credibility checks to be performed on the haulier or driver and assist in clarifying any direct checks with consignees.
Catch Certificate	93% (14/15)	**Very High**	*For relevant consignments.* Presence of official documents adds evidence and credibility to fish importations.
Data fields assessed with a limited sample size			
CMR	*(1/1)*	*Medium*	*Useful additional goods detail.*
Packing List	*(1/1)*	*Medium*	*Useful additional goods details*
Import Declaration	*(1/1)*	*High*	*Included 'true' consignee details missing from structured data*

Analysis of the timeliness of data

The new controls as part of the Targeting Operating Model will end the waiver for S&S declarations for EU imports mandating pre-arrival data from EU (as is currently mandated for non-EU traffic) within specified timescales. In RoRo and short sea containers, declarations are required by a minimum of 2 hours before arrival at the UK border; consortia stated that key data fields required for S&S declarations were made available well in advance of the deadlines – 72 hours after goods left port and 96 hours before arrival (this was not tested).

- For Accompanied and Unaccompanied RoRo: Having the declaration in advance of the minimum timing for each mode is the preferred option. This can allow a deeper level of investigation of the consignment(s) and where goods are enroute to port more details from the carrier can be requested without the need to hold up the goods at ports to await responses. As long as the key transport data is there all work can be completed pre-arrival e.g. vehicle and / or trailer number. Accompanied RoRo targeters are currently able to process and target transit movements which start from beyond the EU. In Unaccompanied RoRo, the IMO vessel identification data will be missing if the declaration is completed early in the journey, and the lack of this information complicates identification of the trailer as the manifested number may differ from the S&S trailer number. Multiple filing suggested for Single Trader Window should allow the early declarations to be cross referenced to the vessel near the time of sailing, if delivered as indicated by HMRC.

- If the S&S declaration is completed prior to the goods sailing and recorded on GVMS, this would assist the ferry company in having the reassurance that the movement is compliant which reduces or removes their liability under the compliance legislation.

- Where an issue could arise is if a company registers several movements for a vehicle / trailer in advance, this could potentially confuse things. This would likely only happen if a vehicle / trailer was on a regular run with a quick turnaround so the issue is less likely to meaningfully impact targeting work.

Analysis of the accuracy of data

Across all modes, targeters found that documents detailing true consignee/consignor details, such as commercial invoices, were a much more reliable and accurate source of data than current declaration data that frequently displays agent to agent details (as shown in Tables 1,2 & 3 where true consignee/consignor details were assessed for improved targeting confidence). however there were issues with how consistently these data fields were provided.

- Accompanied RoRo: Invoices were key to creating higher confidence targeting, and are more likely (compared to current data sources) to present more consistent and accurate true consignee and consignor information and country of origin details. In some cases the invoice was missing in groupage consignments so it was not possible to determine details such as load and weight - this may increase targeting likelihood.

- Air Freight: It was not possible to determine whether the consortia was more or less accurate than the data currently used for targeting in airfreight.

- Unaccompanied RoRo: Consortia documents that provide reliable access to true consignor/consignee details are more useful for risking than documents that display agent to agent details. However there were some accuracy issues, for example, on occasion, different trailer numbers were shown on the structured data than appeared on documentation such as the packing list and CMR leading to confusion as to which trailer number was correct. Similarly, different consignees were presenting differently on separate documents - while this is likely to be attributable to human error, consistency checks across different sources of supply chain data provide useful targeting insights as explained later in this chapter.

Analysis of the accessibility of data

- Accompanied RoRo: The consignment data (e.g. accurate consignment descriptions, consignor names, consignee name and commodity codes) was available in one place on the consortia dashboard (during the confidence scoring) rather than needing to develop the same data image by accessing several different departmental systems. Presenting a clear data image of a consignment in one place is a key benefit that allows targeters to reach a risking decision more quickly. However, some critical data elements to risking (e.g. load description, weight and number of packages) were only present in PDF attachments which are not machine readable and therefore incompatible with government-systems specific risking rules.

- Air Freight: consortia provided access directly to the whole airway bill, which is valuable for targeting. This also permits access to information written in the handling info box which is not a data field that is saved in government systems. Access to phytosanitary certificates and commercial invoices provides valuable pre-arrival risking data. While the Airway bills, phytosanitary certificates and commercial invoice can be made available to the targeting teams they are typically accessed through separate, more time consuming means.

- Unaccompanied RoRo: consortia dashboard provides direct access to useful commodity data such as: consignment description, consignee name, consignor name,

net mass, total packages, commodity code, as well as access to an additional range of valuable data fields such as: Commercial invoice number, Unique Consignment Number (UCN), Seal Number.

A few movements had Customs Declaration Service (CDS) import declarations, but not all of the movements within the same load. These were found to be useful during the targeting process and would save time accessing other systems. Some critical data elements to BoF risking (e.g. load description, weight and number of packages) were only present in PDF attachments which are not machine readable and therefore incompatible with government-systems specific risking rules.

Analysis of the interaction between augmenting technologies and supply chain data

In one consortia, we had the presence of augmenting technology (smart seals, GPS trackers) as well as the dashboard of supply chain data so we were able to look at the interactions and usefulness for BF.

- Journey tracking information provides very high confidence but must be provided consistently and legally in order to be of use. The drivers must be made aware (e.g. in an employment contract) that they will be tracked and their driver details made available to the government, otherwise this is a breach of covert surveillance rules.
- For the assessed consignments, tracking data was incomplete in some cases, which may increase the chance of targeting despite additional data having been provided by the logistics entity. In one example, journey tracking data started at a truck stop on the A10 some 75 miles from initial pick up according to other data points.
- Dashboard data was corroborated by the presence of the journey tracking data collected via smart seals. The tracking on the dashboard provided the journey start and end point for the vehicle, this could be followed live and demonstrated that the vehicle completed the expected journey. The journey as detailed via the tracker was invariably warehouse to warehouse as the participating transport businesses are goods consolidators rather than manufacturers of goods. When the invoices were examined the true origin of the goods was often found to be from a different city or country to those shown on the tracked journey. The structured data provided often showed the warehouse to warehouse information instead of the true origin of the goods and businesses involved in the transaction this impedes effective risking.

Assessing data for biosecurity and traceability needs

Defra, its agency Animal and Plant Health Agency (APHA) and the FSA have specific objectives, systems and processes: FSA around traceability and food health, Defra in Sanitary and Phytosanitary (SPS) and biosecurity controls, and APHA in controlling plant and animal disease. The results from their assessments of data are below

Assessment of how data met biosecurity and traceability needs

Availability:

FSA analysed the three consortia involved in the movement of relevant commodities. These consortia were able to meet 66%, 46%, and 66% of FSA risking data requirements respectively. An exact breakdown of where data was and wasn't available for FSA is below.

Table 4: Consortia data availability analysis against FSA risking data requirements for three consortia

	consortia 1	consortia 2	consortia 3
1. Consignor/Exporter	yes	yes, in a document, not always openable	yes
2. Accompanying Documents	yes	yes, but unviewable	no
3. Establishment of Origin	yes	no	country
4. Description of Consignment	yes	yes	yes
5. BCP/Control point/Control unit	*NA*		
6. Prior Notification	*NA*		
7. Transport Conditions/Temperature	no	no	no
8. Total quantity	yes	yes	only weight
9. Consignee Importer	yes	yes	yes
10. Country of Origin	yes	yes	yes
11. Container/Seal Number	no	no	no
12. Number of Pieces/Volume	yes	yes	total packages in shipment
13. Place of Destination	country	no	no
14. Means of Transport	yes	no	yes
15. Certified as for:	*NA*		
16. Total net/gross weight	no	yes	yes
17. Commodity code (required for risking)	no	no	yes

While import documents and information could be provided as part of the pilots, there was no way to replicate identity and physical checks. Defra notes biosecurity assurance capabilities from consortia are limited and do not provide the same level of information/ assurance as regular import processes. While some of the data provided was of interest (like the availability of the Export Health Certificates (EHCs) or phytosanitary certificate early in the consignment journey), the data provided so far could not replace current import processes or means of providing assurance. Assessing it against current import data/ risking information, the biggest gaps were:

- Lack of transmission data (ie likelihood of a disease hazard surviving on a commodity).

- Lack of mitigations and prohibitions data (ie data on current restrictions, prohibitions or product treatments - like heat treatment of meat products - due to outbreaks or legislation that increase/decrease risk of entry of disease hazard or prevent import of a commodity from a trading partner).
- And Defra were available to identify the additional data points that they most want in order to streamline processes or create more efficient systems, as: recipe product, specific manufacturing data, packing list, commercial invoice, transport plan, MRN number, seal number (and integrity confirmed at location), EHC, early Entry Summary Declaration (ENS) data (I.e. gross weight, descriptions, packages etc.), Import of products, animals, food and feed system (IPAFFS) reference number, timings of transport and the movements of goods and batch number.

For APHA, the plants and plant products team undertook the data analysis in line with the commodities tested. The two consortia that they analysed were able to meet 50% and 30% of the APHA's risking data requirements respectively. APHA found that consortia data was sporadic and difficult to find in dashboards, therefore the comparative analysis in the table below is not entirely representative of the data that was available during the pilots.

Table 5: Analysis of data availability for two consortia against data used by APHA for risking based on four plant based commodities between 12.01.23 - 21.01.23.

Data field	Current Data Source Used by APHA	consortia 1	consortia 2
Commodity Name	Phytosanitary Cert	Yes	Yes
Commodity Latin Name	Phytosanitary Cert	Yes	No
Weight	Phytosanitary Cert	Yes	Yes
Country of Origin	Phytosanitary Cert	Yes	Yes
Exporter	Phytosanitary Cert	Yes	Yes
Importer	Phytosanitary Cert	No	No
Commodity Type	Phytosanitary Cert	No	No
Additional Declarations to Fulfil UK Legislation	Phytosanitary Cert	No	No
Consignment Shipment Details	Airway Bill / Bill of Lading	Yes	No
Container Number	eDomero	No	No
Estimated Date of Arrival	Airway Bill / Bill of Lading	(Not clear)	No
Agent	eDomero	No	No

The plant commodities were low frequency checks e.g. melons 1% random selection and green bananas which did not require a physical inspection due to Green Banana exempted Trader Status for this particular trader.

APHA felt that the consortia were not an improvement in existing IT systems where industry has to notify APHA of all regulated and pre-notifiable imports on a purpose built IT system (PEACH) and IPAFFS which uses automated risk engines, inspection recording facilities and links to HMRC's CDS to enable prompt custom clearance. APHA couldn't reach conclusions

on what assurance the consortia data might provide or how it could improve biosecurity because they didn't have opportunity to test high-risk goods during the pilots.

Timeliness: It was not possible for the FSA, Defra or APHA to make an assessment on the timeliness of data either because timestamps were not present for the consortia that were analysed; or because it was also not possible to receive scheduled historical and operational file transfers due to the lack of suitable environment.

Accuracy: It was difficult for Defra, FSA and APHA to ascertain the reliability or accuracy of data consortia - for example because, although the FSA has access to IPAFFS and HMRC customs data, they do not own those systems. For Defra, making it clear when documents had been uploaded would serve as a reliable method to confirm that certificates pre-dated departure from the country of origin as per Defra requirements. But if documents are not visible in a user-friendly way this reduces the reliability of this form of data availability.

Accessibility*:* Most of the data shared through consortia is available to the FSA via IPAFFS and HMRC (Customs Handling of Import and Export Freight (CHIEF/CDS) in a machine-readable format, with the exception of additional documents, seals and temperature data. Generally the sporadic nature of the data available through the consortia means it has little value to FSA's border processes in its current state.

Assessment of how data met customs compliance needs

Availability: Consortia collectively demonstrated industry's ability to provide data elements necessary to meet over four-fifths of HMRC's minimum risking requirements and three-fifths of trade statistics requirements.

Data required specifically for international trade, but not other commercial functions, was most likely to be missing. However, this was not always the case and commodity codes for example, were found in some of the commercial invoices reviewed as part of the pilots.

Consortia also demonstrated the capability to share additional data beyond what HMRC would typically receive when goods are presented for clearance which could be potentially beneficial for risking, two such examples are:

- True consignee/ consignor – the reality of trading often means that this information is not passed on to HMRC who often receive agents details instead. Critically, this prevents cross-referencing with watchlists that may point to historical infractions and prevents the ability to link the importer view with the consignment view. The pilots demonstrated the capability for this information to be shared with HMRC while protecting potentially commercially sensitive information.
- Licences – currently HMRC typically receives reference to the type of licences held by traders. The pilots demonstrated industry's ability to provide HMRC with unstructured versions of these licences. If industry could provide structured and machine readable

documents and greater detail about the licences they hold, it could potentially be used to enhance HMRC's risking activity.

The capability for industry to share additional data with HMRC that they already possess at potentially negligible cost to traders creates potential opportunities. HMRC would be particularly interested in potentially receiving additional data that increases its confidence in the classification, origin, destination and valuation of the goods as well as understanding what happened to them enroute and who are the responsible stakeholders in the supply chain.

The documentation typically requested as part of a typical post-clearance compliance check are airway bill/ Bill of Lading, licences, preference/ certificates of origin, payment/ financial records and instructions to their agent.

Timeliness: Upfront access and analysis of key documents (outlined above) could re-orientate the form and timelines of checks, and could improve their targeting (subject to HMRC systems being able to process this information).

Timeliness of data largely improved across all pilots as data was made available often by the stakeholder who generated the data. This differs from common commercial practices where HMRC typically receives data shortly before the consignment is dispatched and would allow HMRC to receive the data when it is generated, or shortly after.

Accuracy: HMRC was unable to robustly test the accuracy of data as it did not have access to a counterfactual to confirm if the data held was factually correct. HMRC did confirm for a small sample of consignments that the data accuracy was broadly equivalent to what is currently received. While HMRC could not confirm data quality improvements, consortia proposals and capabilities could logically provide it, for example, by reducing the opportunity of keying errors. While not a guarantee of accuracy, most platforms used cryptographic data security techniques, such as digital ledger technology to create an audit trail of when and who placed data on the platform.

Accessibility: Data was made available to HMRC in two ways - consortia platforms and in some cases via a bulk download of structured data. While HMRC knows industry can meet its current requirements, the main issue is accessibility. Overall the data was insufficiently accessible**:** it was made available on dashboards that required HMRC officials to 'eyeball' the information and it largely consisted of unstructured commercial documents which was not suitable for bulk processing of data. The structured data received in historical and operational file transfers was unsuitable because some data elements were missing and others that were available weren't provided, as had been requested, in the correct format required to be analysed by HMRC systems, below is a non-exhaustive list of examples:

- Customs value provided in USD rather than GBP;
- Consignment weight provided in grams (g), rather than kilograms (kg);
- Dates provided in the US format (mm/dd/yy), rather than in the UK format (dd/mm/yy);
- Country of dispatch, and port of arrival provided by name rather than country code;

- Details of the transport mode not provided in the correct standardised format, or having special characters which cause issues when processed by HMRC systems.

These accessibility challenges must be worked through collaboratively between government, industry and international partners and how to overcome them is further explored in Chapter 6.

Broader assessment

In summary, the first cut of the data provided by consortia did not meet all of departments' current requirements but were able to provide a lot of departments' "ideal" data requirements, including information on good(s) descriptions such as quantities, values, buyer, and seller; and information on logistics such as routes, delivery addresses.

We think this is promising, and that consortia proved that they could improve data provision iteratively once they were made aware of what specific data fields the government wants to receive. Long term, with the right incentives, industry has shown that it can create mechanisms to collect various desirable data fields from supply chain participants. For example, HMRC gave specific requirements to the Chainvine-led consortium who were able to amend their system of record and update their dashboard to include further fields[3].

There were a small number of data elements, specifically required by the government in order to administer control processes but which didn't always appear in commercial documents. These data fields are either used uniquely when submitting data into government or are generated during interactions with government border processes (like reference numbers). Examples are shown in the table below.

Table 6: Data elements required which may not typically appear in commercial documentation:

Control Regime	Missing Data Fields from Commercial Documentation
Safety & Security	Local Reference Numbers
	Reference Number - Customs Office First Entry
	Reference Number - Customs Office of Subsequent Entry
	Reference Number - Lodgement Customs Office
	UN Dangerous Goods Code
	Date and Time of Declaration
	Declaration Place
	Taxpayer Identification Number (TIN)
Biosecurity	Border Control Point / Control Point / Control Unit

[3] Commodity Code, Consignee EORI, Declarant name & EORI, Entry date, Preference, VAT value, Net Mass, Previous Document type, Previous Document reference, Additional procedure code, Customs Procedure code, APC, Entry number, Item number

	Animal Genus / Commodity Latin Name
	IPAFF Reference Number
	Additional Declarations Needed to Fulfil UK Legislation
Customs	Customs Procedure Codes
	Commodity Code
	Customs Valuation
	Origin Statements

We observed a spectrum of coverage for these sorts of data in EoT systems during the pilot: those systems designed to submit customs declarations and SPS pre-notifications generally provided more complete coverage, while the remainder provided support for those data elements relevant to the core functionality of the software. The specialist nature of these data items means there is little scope for full automation, although we noted a number of 'helper' facilities like look-up lists, detailed guidance, or Artificial Intelligence (AI) based initial calculations, for human review, aimed at reducing the effort required in this area.

Potential uses for supply chain data at the border

Improving access to commercial documents offer several advantages beyond the better quality covered above, including:

- Going with the grain of the business processes which trade already uses to buy, sell and ship goods internationally. Novel approaches to managing supply chain data based on their existing and organic data collection processes can help to reduce some of the challenges we see in the current declaration processes, which typically add separate complex and costly collection and processing activities.
- Data is contributed at the point it is created and added to as new information is made available, allowing an incrementally richer picture of the trade to evolve over time
- Data can be loaded once and shared to all supply chain organisations with the appropriate permissions to see the data (including regulatory authorities on both sides of a trade corridor).
- Information is contributed by, and directly traceable to the person or organisation where it originated rather than by a potentially unknown downstream actor or system.
- This will potentially be a more flexible and lower-cost approach to data collection and data sharing compared to current declaration processes.

Long-term, once we have established solutions to accessing industry data and overcoming technical barriers (at Chapter 6), we can see a set of likely steps on a pathway to transforming the border.

Table 7: Pathway to transforming the border

First steps / low ambition	The UK government maintains its requirements for structured, declaration data to meet border requirements, but industry systems are organised to allow the generation of that data with a greater level of automation, and therefore lower level of ongoing costs than at present. This is the least ambitious first step, where EoT systems establish a more efficient mechanism for supplying the existing, entirely unchanged declaration processes and formats. This would require no changes in the government's approach, and this could be pursued by businesses independently of any improvements the government makes at the border.
More ambitious	A hybrid approach is where key documents are fully digitised (e.g. those relevant to pre-arrival notifications) with some essential data elements being submitted, or pushed into government systems. Other elements of government data requirements could be accessed from industry systems if and when needed. The hybrid approach represents a potentially realistic model with scope for realising benefits for industry and government. This approach would involve establishing new data pathways into government that can run alongside the existing declaration processes, while also allowing experimentation on the exploitation of supply chain data to the mutual benefit of trade and government. These facilities will be new, but it is possible to create them with modest amounts of investment and in a progressive manner that will allow us to make progress towards reducing trader burden without creating a lot of disruption or risk.
Most ambitious	Most radically, where systems can make the relevant business documents available to the government then it might be possible to eliminate the need for separate declarations, perhaps in the context of a Trusted Trader scheme. Our assessment is that the most radical vision, where users of EoT systems might be taken entirely out of the existing declarations process, is a long-term vision and extremely difficult to do quickly due to the costs, complexity and disruption involved in establishing the new approach, in addition to resolving all the current blockers described in this report, such as the provision of data fields not exchanged in the commercial process in Table 6. In particular, established, largely automated processes relied on by trade and government to expedite movements across the border (for instance, customs clearance) are based on existing declaration data structures and would need to be redeveloped. Additionally, alternative solutions would be needed to replace those aspects of the S&S and biosecurity controls that rely on structured pre-arrival data.

The impact of international interoperability on supply chain data

During the pilots several consortia used their close ties with international partners to make additional information about goods movements available to the UK government, which was assessed by departments and border agencies. In order to achieve secure frictionless trade, it is critical that data exchange models extend beyond the UK border to include competent authorities and trading partners in other countries. Key benefits to this approach are:

- Access to commercial goods data the moment it is created by the source actor. Commercial data, such as purchase orders, are produced customarily and making

them available to government requires no additional effort from the actor, but leads to improved compliance outcomes.

- Access to administrative documents produced by competent authorities in exporting countries such as the export declaration and health certificates, such as phytosanitary certificates.

- Access to end-to-end event data from the country of export into the UK such as Port of Exit, Port of Entry, Final Destination, and journey tracking data.

Interoperating between Kenya and the UK

The DBM-ATC consortium deployed "TLIP" infrastructure to capture supply chain documentation and events for a number commodities including coffee, tea and flowers. TLIP in Kenya is integrated with the Kenyan Government's 'KenTrade' single window platform which provides access to international trade documentation by 'pointing' to the actual records, such as the original export declaration or e-phyto certificate, avoiding the need for duplicate entry.

The Accompanied RoRo team in BF assessed a subsection of these data elements, including key location events such as arrival and departure from ports that are relevant for targeting and were new to their processes (see table 10). Data elements that were not assessed were either irrelevant for targeting purposes, or were already available to BF targeters through other means.

Table 8: Supply Chain Documents Present in TLIP for Coffee, Tea and Flowers

Coffee	Tea	Flowers
➢ Commercial Invoice ➢ Phytosanitary Certificate ➢ Packing List ➢ Certificate of Origin ➢ Sea Waybill ➢ Export Declaration ➢ Quality and Fumigation Certificate ➢ Rain Forest Alliance Certificate ➢ Audit Report ➢ Landing Account Report ➢ ESG Report ➢ Smart Seals Report	➢ Commercial Invoice ➢ Phytosanitary Certificate ➢ Packing List ➢ Certificate of Quantity and Weight ➢ Export Declaration ➢ Import Declaration ➢ Shipping Instructions ➢ Port Health Inspection Report ➢ Sea Waybill ➢ ESG Report	➢ Commercial Invoice ➢ Phytosanitary Certificate ➢ House Airway Bill ➢ Master Airway Bill ➢ Export Declaration ➢ CMR Note ➢ T1 Documents

The table below shows which administrative documents originate from competent authorities in Kenya. These government documents are made available 3-5 minutes after they're created in government systems and - during pilots - were available 3 weeks in advance of goods arriving at the UK border on the TLIP platform.

Table 9: Documentation shared by Kenyan authorities

Kenyan Government Agency	Responsibility	Administrative Document Issues	How soon it is made available in TLIP
Kenya Revenue Authority	Customs	Certificate of Export, Export Declaration	5 minutes
KEPHIS	Plant Health and Inspection Agency	Phytosanitary Certificate	3 minutes
KenTrade	Single Window System	Consignment Details	N/a

In addition to better quality and timely data, additional assurance such as due diligence, and other corroborating data can be collected and shared from international partners.

- Environmental, social and governance rationings made available against supply chain actors incorporating factors such as labour standards, tax transparency, and sustainability practices.
- Certificates acquired from global conformity bodies to confirm products need international standards (I.e. Conformity, medical device, inspection certificates).
- Digital product passports that record a product's footprint throughout its life cycle.

TLIP provided BF targeters with a 'consistency check' for a number of consignments to highlight where there were critical differences in specific data fields across a number of documents in the consignment journey. For BF the data consistency checks provided key indicators for a movement's legitimacy, specifically where data fields were consistent across all documents, and the type of documents provided offered increased confidence (official documents – Health Certificates etc). Discrepancies across certain data fields may lead to quicker intervention decisions, allowing a much faster assessment. Additionally, consistency checks allow for a much quicker assessment, avoiding the need to access individual documents in order to confirm consignment data, with the ability to check specific documents where appropriate.

TLIP currently collects data from Kenya (tax, customs, SPS, standards agencies) but has planned activities with Tanzania, Rwanda and Uganda (SPS), Port of Rotterdam, Belgium, Dubai and Germany offering further opportunities to scale the evidence-backed value of making available high quality and timely data from a broader range of international jurisdictions.

Given the benefits highlighted in this chapter, it's clear that we need to work with international partners. Recommendations for how we do that are in Chapter 6.

3. Findings: augmenting technologies

We have tested various augmenting technology capabilities during the pilots, although not as many as consortia offered us, given the complexity of defining use cases and operationalising the pilots.

In summary, while all devices aren't by themselves a panacea and tests showed that they could be circumvented by determined criminals with various degrees of effort, the devices are still useful because:

- They all provided some level of additional challenge and therefore might form part of security controls when considered as one aspect in a range of precautions taken by trade; and
- The devices can also provide useful intelligence (e.g. around tampering, unscheduled stops and diversions or changes to environmental conditions) which could help inform government decisions on whether to apply controls at the border, allowing fewer interruptions for compliant trade.

We think augmenting assurance can combine with other capabilities to form an ecosystem of trust which collectively gives the government more confidence in accrediting reliable actors. That model is explored in Chapter 4.

We have assessed a number of technologies with information about the identity and integrity of the goods being moved, testing them in conjunction with new data capabilities. We considered how these technologies might help answer some of the questions considered as part of the controls operating at the border:

Issues around goods' *integrity*:

- Have environmental conditions been maintained so that goods are not damaged, spoiled or contaminated during transit?
- Have the goods been tampered with, unloaded or substituted during transit?
- Do the goods comply with SPS, customs and safety and security regulations?

Issues around goods *identity*:

- Does the data contained in the declaration submitted to the government match the business documents used to arrange the original transaction (commercial invoice, packing list, bill of lading etc)?
- Do the goods supplied match the goods specified in the original invoice & declarations?

We have also assessed the threats, hazards and risks present at the border as well as the mitigations and controls adopted by the responsible departments. The status of the testing done on augmenting technology is shown below in Table 10.

Table 10: Testing status of augmenting technology

Technology	Capability	Route > Mode > Commodity	Status
Octosense (Chainvine)	Intrusion detection (CO2, speed and light sensors)	Rotterdam > Felixstowe Unacc RoRo, Cut Flowers	Completed
QR Code + GPS Seal (Chainvine/ Fujitsu)	Scanning locations/timing events and link between the reference number for the label and data about the goods. Lock tamper evidence,un/unlocking events geolocation .	Spain > Tilbury, Wine	Completed
STC Seal (DBM-ATC)	Geo location,lock tamper evidence.remote control features: remote unlocking; updates to status reporting frequency.	Mombasa > Teesport, Tea	Part completed (the device completed some of its journey but was erroneously removed by Kenyan authorities)
Smart Seal (Fujitsu)	Geo location,lock tamper evidence.remote control features: remote unlocking; updates to status reporting frequency.	EU-UK	Completed
Fleet Management Data (DBM-ATC)	GPS, geolocation and route deviation	Cuxhaven-Imm > Unacc RoRo, Frozen Fish Fingers	Tested as part of tabletop and simulation exercises.
Smart Container (IBM)	Power status of refrigeration unit (on off), controller alarms status, temperature target value, supply/return temperature humidity, atmosphere, cargo Probes	South America > GB, Bananas	Tested as part of tabletop and simulation exercises.
e-Seal (AZARC)	Lock tamper evidence	South Africa > London Gateway, Firewood	Tested as part of tabletop and simulation exercises.

Testing technology to assure the integrity of a load

Many of the EoT deployments use internet-enabled devices (also known as *Internet of Things* or IoT devices) to help secure and track the movement of goods. These IoT devices can be broadly classified into two categories:

- **Smart seals** have features that allow the location of goods and integrity of the load to be tracked. They can typically record opening or tamper events and detect when equipment enters specific locations (“geofencing”). Smart seals are usually attached to the doors of the transportation unit.

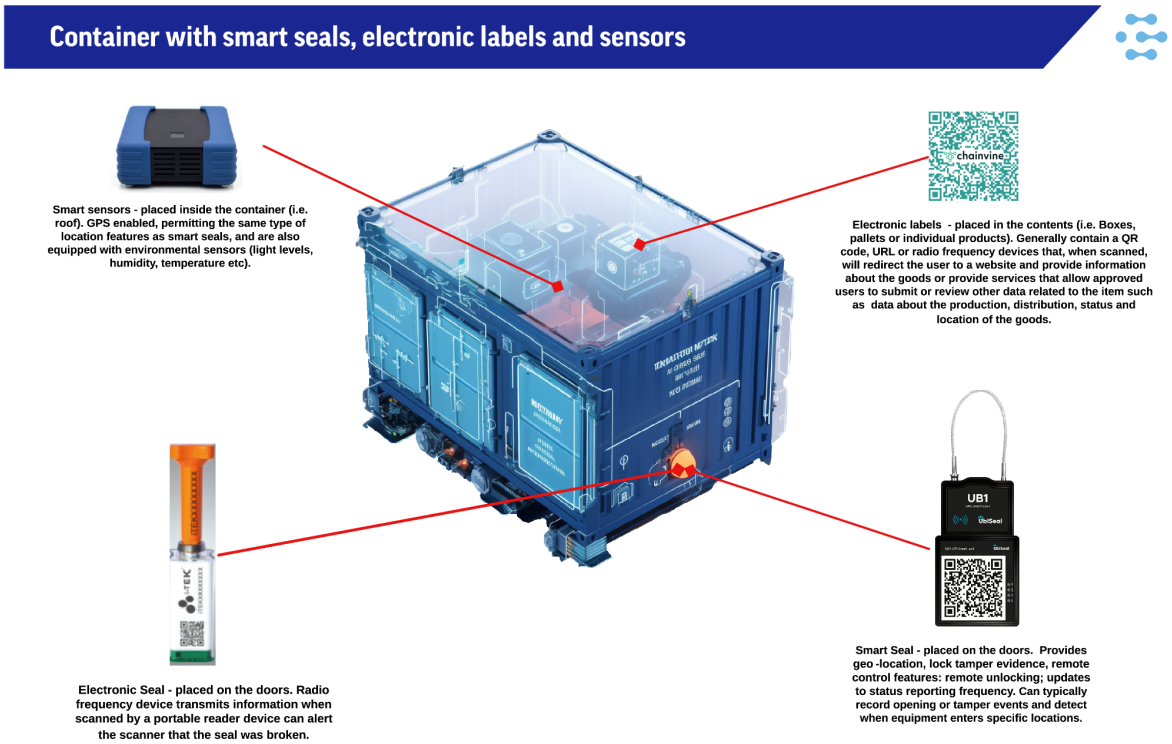
- **Smart sensors** are generally GPS enabled, permitting the same type of location features as smart seals, and are also equipped with environmental sensors (light levels, humidity, temperature etc). The devices are generally inserted with the load and are used commercially to track the integrity of the goods. Correlation of sensor data (for instance a spike in light & CO2 corresponding with a signal that the vehicle is stationary) may indicate the unit has been tampered with. This type of technology can also be permanently built into transportation equipment, and are called “smart containers” or “smart trailers”.

Two types of “passive” devices (i.e. devices that do not require a power source) are used:

- **Electronic labels** generally contain a QR code, URL or radio frequency devices that, when scanned, will redirect the user to a website. The website might provide information about the goods or provide services that allow approved users to submit or review other data related to the item, for instance data about the production, distribution, status and location of the goods.

- **Electronic seals** contain a radio frequency device that transmits information when scanned by a portable reader device. The devices can only be read when closed and undamaged - once opened they will no longer transmit identification information, thus alerting the scanner that the seal was broken. Although these devices are not GPS enabled a rudimentary routing picture can be obtained from scan events which are tied to the location where the scan occurred.

Figure 3: Container with smart seals, electronic labels and sensors



Safety and security

Vulnerabilities at the border can arise where goods are routed through international locations outside of our control or because of criminal activity in the supply chain. Goods moving from Europe, particularly via the Short Straits, can often be ordered, loaded and dispatched on the same day. Therefore timely pre-arrival data about the goods, route, transport equipment and supply chain participants is of critical importance.

Government prioritises risks according to the National Control Strategy, which sets out priority high risk categories (for example, drugs, cigarettes, and weapons). In many of these cases, augmenting technologies could be useful. For example, in tackling smuggling where an organised crime gang might operate part of a supply chain using unaware logistics companies (known as piggybacking or rip on/rip offs); or in tackling an insider threat where staff working in an official capacity, or with responsibility for organising aspects of the supply chain, are compromised and assist with the movement of illicit goods.

Devices may be able to support risking for specific threats. Instances where a ship has been targeted, and where intelligence to say it has been attacked is available, combined with a triggered seal, could help BF narrow down the search for the offending container.

Smart seals devices can also help mitigate against the risk of substitution of goods as this generally requires the doors to be opened. However this does not apply to rip on/offs and piggybacking where they do not disturb the doors for access into the container or do not require container access.

Historical data from devices may help with forensic analysis after a successful intervention to identify possible patterns of behaviour that inform future targeting.

While devices could help, there is limited potential for mitigating these risks due to the ways that determined criminals can circumvent the technology:

- The GPS signal can be tampered with, which causes the vehicles to disappear from the tracking software for periods of time. Although we heard from suppliers that, at an extra cost, devices can be equipped with multiple antennas and other features that make this type of issue more challenging, they also confirmed none of the solutions are guaranteed to prevent determined criminals from disabling tracking.

- The smart seals are attached to the vehicle using cables. These cables are not a physical barrier, since they can be cut or broken, but the circuitry in the devices will automatically trigger an alert in case they are cut without having first unlocked the device. This may deter certain types of criminal activity, however, there are work-arounds which can vary in sophistication (when committed by insiders these work-arounds may simply involve closing the seal but not applying it to the doors).

- Bypassing the digital tamper alert would require access to technical solutions that are outside of the scope of the pilot, however, it was confirmed by all the experts consulted, both in trade and government, that organised criminals can find ways to bypass this type of device.

- Devices could be compromised purposefully so that large numbers mis-report status or fail simultaneously in order to disrupt existing control processes or to deflect staff efforts to compliant trade in order to reduce attention on illicit movements.

Keeping goods under supervision

Some consignments of goods are kept under customs controls after the goods leave the port of entry. For example, goods moving under customs transit, to a customs warehouse, or selected to attend an inspection at an inland location.

Technology could help the government reduce the risk of these goods being unloaded or substituted before officials have an opportunity to examine them, by providing information on tampering, unscheduled stops, and diversions to customs authorities. This information could help inform if an intervention is necessary and the nature of an inspection when required. The information gathered could also inform subsequent investigations and profiles of non-compliant trade set out in trade analytics below. The financial benefits that could be made available, in principle, when technology can secure the integrity of a load is further explored in Table 16.

Customs processes can generally be conducted away from the border, but it is sometimes necessary to select movements for compliance activity. A number of factors are involved in deciding when to apply controls, including whether there is correct information about the origin and destination, and the potential for interference with the goods en route.

Smart seals are already used in some industries to ensure the integrity of goods while they are being transported. These devices typically incorporate GPS trackers - allowing the movements and speed of the vehicle carrying the goods to be recorded - and tamper alerting features that can report if the seals have been cut or damaged. Electronic seals, which can cost a few pounds and are less expensive than smart seals which can cost hundreds of pounds, provide a software record of tamper events and a rudimentary form of tracking based on the locations where they are scanned. But there are challenges. As explained above, these devices do not present a serious obstacle to organised criminal groups intent on unloading or substituting goods prior to an inspection.

A European Commission sponsored investigation into the use of smart and electronic seals as part of Common Transit Convention (CTC) is underway. This exercise is considering if this type of technology can augment or replace parts of the current process which relies on vehicles following a pre-agreed route and travelling between customs offices within predicted timescales. Work to-date has focused on a review to ensure there were no legal obstacles to the use of electronic controls, and an audit has been initiated to determine how electronic seals are being used today by participating nations. After the audit is complete, work will move on to assess the implication for other EU technology initiatives like the EU Single Trade Window and a review of what data and device standards would be useful in assuring successful adoption of the technology. HMRC are representing the UK in the working group along with several other nations and have been feeding back the findings from this pilot exercise.

Furthermore, there is also a separate piece of work on going about standardisation of smart and secure seals as part of the World Customs Oragnisation’s SAFE Framework of Standard

(FoS). In the existing review of the SAFE FoS, the UK also proposed some amendments in the interest of supply chain security and the integrated customs control chain, in particular to ensure a fully secure movement from stuffing of the container to release from customs control at destination. The UK proposed that customs should apply a seal integrity programme based on the use of smart security devices or high-security mechanical seals as prescribed in ISO 17712 at the point of stuffing, including procedures for recording the affixing, changing and verification of seal integrity at key points, such as modal change.

Biosecurity

The integrity assurances offered by devices are relevant to aspects of the controls related to the import of germinal products, animal products, and plants and plant products, covered by SPS controls.

Cold chain management

SPS controls specify the allowed temperature range for transporting chilled and frozen goods. Should officials conclude that the correct temperature has not been maintained during transportation, goods may be destroyed or rejected. Maintenance of temperature conditions during a journey is often referred to as *cold chain management*.

Temperature measurement devices are standard on refrigerated units and - when accessible via the reefer control panel - data logs are accessed by some port officials conducting SPS checks at the port as a way to identify possible issues during the journey. This provides additional information to the testing done at the port which can only assess the temperature at the point the inspection is done at the Border Control Posts (BCP).

The devices used in the pilots, however, are internet-enabled and this allows for the possibility for remote monitoring and reporting. We tested a number of these devices and associated monitoring software during the pilot and they were shown to measure temperature conditions within a unit, periodically broadcasting the status to central monitoring software where the data could be viewed in dashboards or via software interfaces and data extracts. Some of the systems were capable of sending automated alerts, for instance when temperature went outside of specified thresholds for a set period of time.

The technology is mature: for instance, smart containers - where cold chain management is built-in or retrofitted to refrigerated containers - have been in use by large carriers to enable remote monitoring of the status of the refrigerated units on vessels and alert crew members about any equipment problems for over a decade.

We heard from a number of industry experts that, while cold chain failures do happen (either because of equipment failures or human error) it is not a regular occurrence. Defra has analysed data made available by some of the ports on the causes of Products of Animal Origin (POAO) consignment rejections and found that between 2% and 10% of the goods rejected are because of cold chain failures. The method of transportation is assumed to have an impact on this rate, with airports reporting higher rates of rejections due to temperature not being maintained. This analysis only considers consignments from countries outside of

the EU and as such there is also potential for more frequent occurrences in goods travelling from the EU which may not be insulated to the same extent as products on longer journeys.

Consideration also needs to be given to the value of the above challenges being resolved. Veterinary advisors working at BCPs explained that cold-chain integrity is only one aspect of the work undertaken by officials when assessing whether goods entering the country comply with SPS controls. Other aspects of these controls are not assured by this type of technology, for instance, checking that packing is intact and the goods match the health certificate.

While cold-chain management devices demonstrated maintenance of cold-chain during transport, they did not demonstrate that the goods were safe from either a food safety or biosecurity hazard standpoint at the point of loading. Therefore, this technology might reduce the frequency of checks for trade adopting them, but on its own it does not eliminate the need for physical checks.

Marketing Standards

In some jurisdictions, electronic labels can be used as an alternative method for supplying information required by marketing standards. For example, pending changes to the labelling requirements for wine produced or sold in the EU after December 2023 will require the inclusion of ingredients and nutritional information on the label. EU legislation allows for this data to be provided via an electronic label (a QR code that takes the user to a website that lists these details, for instance). Legislation in other jurisdictions allows for e-labels to be used to link to safety and usage data about goods like medical devices.

Legislation allowing e-labels for marketing standards often prohibits the use of the linked websites for advertising purposes, and we saw demonstrations of how consortia systems, operating independently of the producers, importers and exporters, can provide ‘clean’ platforms that help traders comply with these requirements. We also saw how related services can be built that allow multiple supply chain participants to view or submit data relevant to the goods, for instance commercial documentation or data related to the current status and location. These services can be permissioned so that users of the systems only see certain data points, and can participate in workflow based on events occurring inside the system. A proof-of-concept implementation run during the pilot showed how a government official might access the system and submit an enquiry to instruct supply chain participants to take action so that the query can be resolved.

Quality Standards

Some of the devices included in the pilot were able to measure environmental conditions beyond the temperature inside a container or trailer, such as measurements of CO_2 and humidity. These sensors are primarily useful for quality purposes and do not form part of the Official Controls related to SPS controls.

Origin & traceability

Electronic labelling

Electronic labels create a link between physical packaging and data related to the sale, routing and provenance of goods being moved. This information is relevant when assessing the impact of biosecurity or health incidents since it can help identify goods subject to a common issue but despatched to multiple locations, and can help authorities trace back to the area where problems originate. Although we saw demonstrations of the technology being used, there is insufficient evidence on the basis of the pilot to confirm its potential value to the government or to understand how this might turn into benefits to trade, as this information is already currently recorded on EHCs.

The provisioning of electronic labels and potential for due diligence capture as they are scanned across the supply chain present interesting possibilities in terms of an understanding of what is moving and its condition at multiple points in a goods movement. One aspect of this is a low cost and low friction way to incrementally accumulate information about goods rapidly via mobile devices.

Origin of goods is important for customs, SPS and biosecurity purposes. Electronic labels could be used to support evidence of where a product was produced. The technology is already used on products such as wine and spirits, to inform consumers about the regions, ingredients, conditions and alcohol content of the wine.

Electronic labels could enable the government to access data and communicate with the supply chain. The smart labels can be scanned by authorities and link with producers' systems to view records such as certificates, invoices and transportation documentation. Each department would be able to view documents and information most relevant to their needs. During the pilots, we were able to scan a code with devices which linked into the consortia system.

An additional functionality of enabling the government to place queries, questions and updates on the traders systems was being developed to open channels of communication between producer and UK government.

Goods movements transiting the UK

Goods moved through the UK but destined for a third country are currently subject to controls at the point of entry and exit. In principle, it might be possible to reduce elements of these controls if technology could be used to provide assurance that goods were not unloaded during the journey through the country. Transit movements were not in scope for the pilot and so this hypothesis was not further tested.

Trade analytics

In theory, government agencies could use telematics from smart devices to build profiles identifying trading patterns of non-compliant trade. This could inform Trusted Trader scheme enrolment decisions or help identify emerging hazards, and provide part of an overall picture

of assurance alongside environmental sensors and smart seals. Government and industry experts agreed that while this was out of scope for the pilots, it was an interesting development, of which, we would need to seek out examples of real-life application to consider whether sufficient benefit could be drawn out to make investing resources worthwhile. There would also need to be further consideration into the handling, storage and access of the data involved.

Testing technology to assure the identity of a load

Seals - whether smart, electronic or mechanical - provide evidence that no persons have had access to goods after loading. On their own, these do not provide a reliable means of assuring the identity of the goods loaded match the accompanying paperwork. Instead, assurance is required to confirm the status and identity of the goods before sealing. This could be from a trusted or accredited person/company who guarantees the goods are what was declared and witnesses the goods being loaded.

Development of technical features can help mitigate the risk that devices might be misused, either because of human error or deliberate attempts to circumvent them. For example, permissioned devices can only be opened/closed by approved staff and allow control over who can apply the devices and provide an audit trail identifying who, when and where the devices are locked or unlocked. Other features deal with cybersecurity threats aimed at internet-enabled devices.

These developments go some way to mitigate the risks associated with incorrect device usage, however it is expected that other assurances will be needed to provide confidence the devices are being used correctly. For example,assurances gained during enrolment into a Trusted Trader scheme where an assessment could be made of the organisation's quality control procedures and approach to staff vetting and training.

For agrifood, third country agreements allow veterinary officials associated with a nominated competent authority to sign-off on export health and phytosanitary certificates to confirm the goods comply with import regulations. This offers assurances that the goods are correct when they are dispatched, but does not guarantee goods will not be altered in transit. The existing health certificate process does not rely on smart technology, although it could be improved by *digital signatures* for instance which allow officials to electronically “sign” a document. Digital signatures are a mature technology and widely adopted, however, they are not permitted in the current Official Controls legislation which still requires wet signatures and stamps to be used. Defra is aiming to adopt digital signatures as part of the Target Operating Model.

Challenges

There are challenges to using devices as part of government control processes:

- Responding to new information related to potential issues flagged by devices may require government staffing at border locations to be increased. Given the limited selection of devices, routes and commodities available during the pilot, it was not

possible to assess the potential cost of standing up a new process to handle device alerts.

- Work is required to assess the process controls that would be needed to ensure high confidence that the devices had been correctly applied - at the right point in the journey - and that they had not been tampered with or damaged during transit. Government would need to have oversight on whether businesses had the correct assurance procedures in place.
- Given that it is unlikely that process controls can entirely eliminate the possibility of false alarms due to malfunction or incorrect usage of devices, efforts would be required to 'calibrate' the reliability of the devices so that the costs of responding to false alarms could be balanced against potential improvements to government interventions on non compliant trade.

Getting real time augmenting technology data into government systems

Telemetry data from augmenting technology could be used to corroborate other information sources and build a clear picture on the status of moving goods.

There was no scope for integrating telematics (the data generated by augmenting technologies like smart seals) with government systems during the pilot, with data instead made available primarily via dashboards and data extracts. The information captured is based on expert opinion from government border agencies as there was no data integration during testing.

In a scaled model, regulatory authorities and other participants would need to access existing and new categories of supply chain information in a number of ways, including via online dashboards alongside APIs (system-to-system technical interfaces), and potentially other operational and historic data transfer methods.

Departmental teams expressed different preferences for how new categories of information could be used in an operational context where volumes can be large. However there was general consensus from UK government experts in risking and compliance that it would be preferable for information to be available via both traditional means (e.g. batch, dashboard and API) and via notifications that specific activities or events have occurred. Some teams would not want to receive new information unless a problem is encountered by one of the consortia systems i.e. by exception.

Departments also have an interest in accessing telematics data generated by augmenting technologies in internal systems. We heard that the data has potential to play a role in a number of government activities, including refining risking and targeting decisions, supporting Trusted Trader arrangements, credibility checkers, and audit and investigation. Further data analysis would be needed to understand and calibrate the data against these use-cases and this would require investment in new government data capabilities and access to the larger data sets that were available in the pilot.

4. The Ecosystem of Trust model

This chapter sets out how the capabilities tested in our pilots can be organised into a new "Ecosystem of Trust" border model, as well as how industry and government would need to collaborate to bring about this model.

This chapter also highlights a particular learning from the pilots which is encouraging: we have found new methods by which it's possible for government to access and use commercial data for compliance purposes without putting burdens on the supply chain, and those new methods can co-exist alongside existing patterns where the government leverages industry data through APIs and third party software.

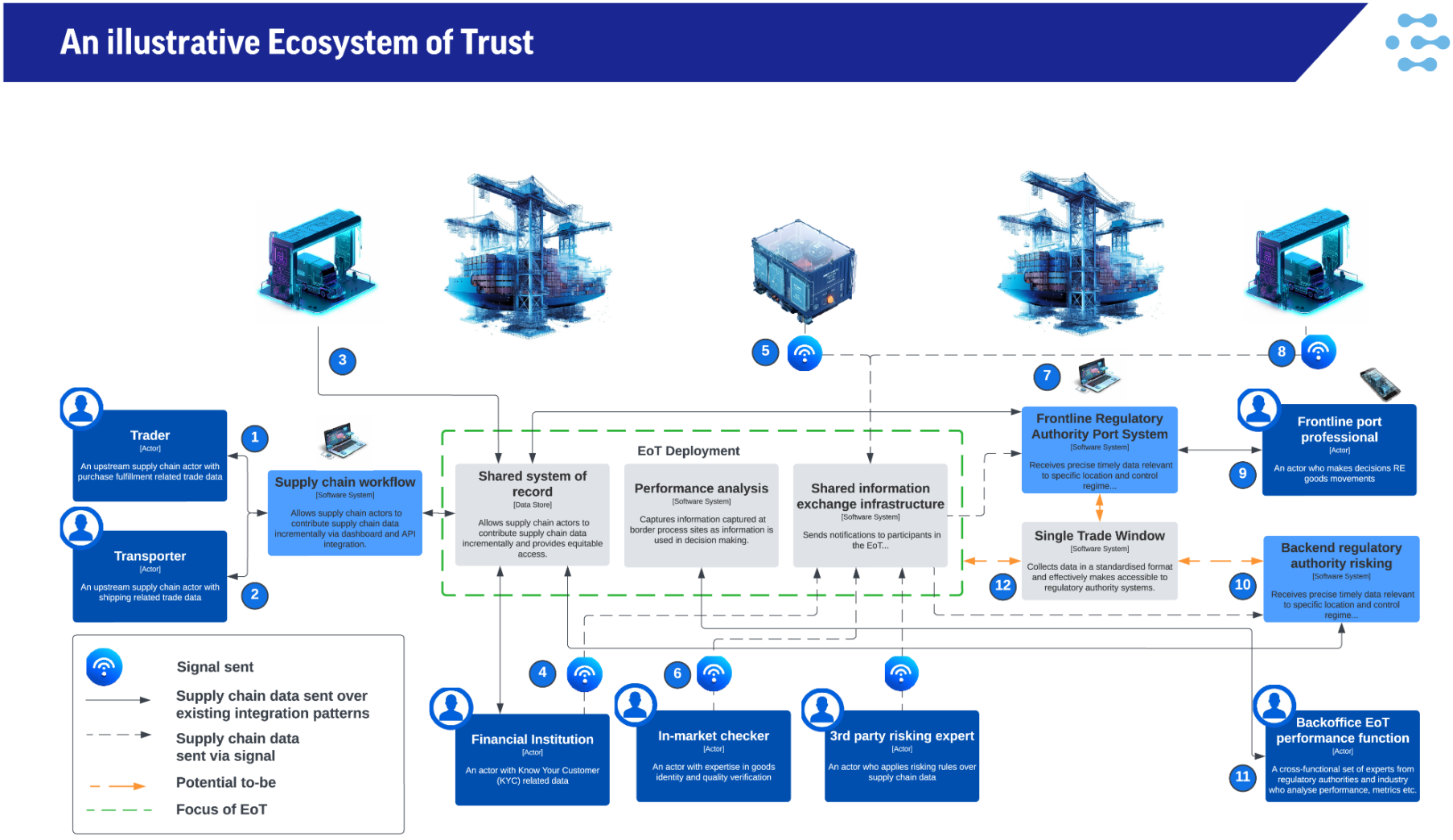
Taking advantage of cutting-edge technologies and real-time data helps the government better assure the movement of goods across the border. Automated assurance and reliability can help to build and ensure trust between actors, creating an "Ecosystem of Trust" (EoT) that could allow processes to be moved away from the physical frontier and alleviate burdens on traders without compromising the UK's security or biosecurity.

The EoT model is an organised collection of capabilities and participants operating at and around the border. Each part of the model aims to remove border frictions while improving biosecurity and security outcomes. While the pilots assessed particular elements in isolation and with limited integration into government systems, they demonstrated the potential in organising capabilities, people and information in a mature, scaled EoT model.

The strategic vision of the EoT is that, by working with industry to harness innovative technology, we can create a frictionless import/export experience for compliant and trusted traders and enable enforcement of controls to be more focused on traders deemed to be of higher risk.

Figure 4 represents an illustrative EoT which involves industry supply chain actors and one or more regulatory authorities.

Figure 4: An illustrative Ecosystem of Trust



1	A trader directly enters initial procurement data related to a goods movement. This is accessible immediately to all in the ecosystem who should need to see or work with it.
2	A transporter or other supply chain actor views the trader supplied information directly and adds unique transport related data to it. A richer incremental picture of the data relating to the goods is progressively made accessible.
3	The moving goods are digitally scanned. The results of the scan are stored for comparison later. No notifications are sent at this point.
4	A financial organisation (e.g. bank or financial technology) analyses the goods movement data. An opinion is formed on whether the actors involved are in order. The opinion is shared as a signal with other ecosystem participants who have subscribed to this kind of notification. The signal is precise, represents the result of the expertise deployed by the financial organisation and includes mapping to permit the receiver to look at the related information in the shared system of record.
5	Augmenting technology (for example a smart seal or environmental sensor) applied to the goods movement transmits a “signal” updating interested parties where integrity, location or environmental conditions are not in order.
7	A front line regulatory authority system receives “signals” in advance of receipt of goods or full completion of supply chain data. This information includes key fields which allow operations to effectively control goods, whilst providing an audit trail in the System of Record if desired.
8	The moving goods are digitally scanned again. Data from the new scan is compared to data from the first. If the system detects a change from a specified level of tolerance it sends a signal to interested parties indicating potential goods tampering.
9	A regulatory authority frontline officer leverages information captured in the port system, makes decisions on goods movement intervening if appropriate and captures the outcome of using the port system information, indicating if the “signals” and supply chain data in the System of Record were accurate or useful
10	Regulatory authority risking systems collect timely, standardised and high quality supply chain data applying relevant risking rules and other selector based targeting criteria. This produces cases for operational staff to assess for potential non-compliance against the specific regime they are responsible for. Timelier data gives border agencies advanced knowledge of potential; additional data that is of higher quality, improves positive targeting outcomes.
11	Regulatory bodies and industry experts can view and analyse data against performance indicators to evaluate performance at the border (for example, an assessment of whether EoT data leading to an intervention was accurate/useful, and whether it led to fewer false positives over time). This could provide insight on the extent to which the EoT improves UK government's ability to deal with fiscal, biosecurity and security risks at the border

6 A trusted third party analyses the physical goods and associated data. An opinion is formed on whether the goods identity and/or quality are in order. The opinion is shared as a signal. Parties receiving the signal may decide to act upon it if it indicates the goods are not in order.	**12** The Single Trade Window collects data in a standardised format and effectively makes it accessible to regulatory authority systems.

Scaling-up the Ecosystem of Trust model

Our findings suggest the most effective way to scale an EoT across industry and government will be to progressively build out the model starting small with supply chain data feeding into a single compliance regime. The impact of the additional data on that compliance regime can then be evaluated which may lead to improvements over time, such as by adjusting what data is provided, and when it's provided, through positive feedback loops. The model could then be scaled further by expanding the use of this data into multiple compliance systems and integrating further sources of assurance.

A more mature EoT model will be able to aggregate and corroborate information or assurance from multiple different parties. Examples of what the model could include are: data from augmenting technology such as sensors and smart seals, results from due diligence checks (like those tested in the pilots e.g. Retail Asset Solutions as part of the Fujitsu & DBM-ATC consortia) or supply chain actor compliance organised by financial institutions (such as Know Your Customer).

While the EoT model is building up, there will need to be a lot of collaboration between government and industry to explore the necessary assurance and interoperability requirements required to deliver benefits to all parties. Mechanisms like the Ecosystem of Trust Interoperability Working Group, which was established during the pilots and brings together government and industry to discuss and "solutionise" these issues, will need to continue.

Further detail of the components of an ambitious model and a visualisation of how the model operates in a collaborative and progressive environment between government and industry is shown in **Annex D**.

"Signals" as a method of supply chain participants exchanging data

During the pilot we started to experiment with new ways of exchanging data between supply chain participants and the government, one of which we called "signals".

Signals are simple messages that can be exchanged between organisations to indicate that an action has been taken or that something has been decided. It is not necessary in every use case to move a large footprint of 'raw' data. In the context of international trade, a vast

number of events are generated and it is not necessary to broadcast every one of these and all associated data. To illustrate:

- Each goods movement generates many events (the seller mails an invoice to a buyer; the carrier issues the shipper with a bill of lading; a health certificate is approved; an import declaration is created and a movement record is started on GVMS and so on).

- Each of these events is the potential basis for a message that could be passed between the systems used by traders and government. The messages could be very simple and might include a description of the type of event, details of when it happened and who was responsible, and a link where other organisations can retrieve additional data.

The signals approach has advantages:

- Signals recipients can pick which signals they are interested in and get tailored data feeds that meet their needs. For instance, an organisation might want to know only when a device has been unlocked rather than processing lots of irrelevant data generated by devices.

- Signals are multi-directional, moving from trade to government, government to trade and from business to business and creating the ability for new info to flow to EoT participants e.g. the government could publish signals that provide early indication that an inspection is required, or that additional paperwork should be supplied before the goods enter the country.

- Signals could flag new data from due diligence activities performed by third parties, such as indicating that an export has permission to leave the country, or a veterinary inspection is complete.

- Signals can create effective feedback loops between relevant parties e.g. between government, border agencies and business. For instance, risking and surveillance outputs could be shared as signals between parties to collaboratively investigate potential emerging risks, such as biosecurity or food and feed safety risks

The pilots' Interoperability Working Group made progress establishing a draft data format for signals and sketching out a simple protocol that sets the ground rules for signal message exchange. If taken to completion this work would explore how government could take advantage of novel supply chain information and insight which is very likely to be useful in addition to more usual forms of information.

Examples of a signals-based approach that could be used by the FSA

EoT development has the potential to improve the UK government's ability to monitor and manage imported food and feed safety risk, with significant benefits if exchange of intelligence and communication could be made more seamless and timely. To deliver this aim, government should progress essential data governance work and co-develop the required shared information exchange infrastructure. There are numerous opportunities

where government departments, PHAs, local authorities, labs and industry could develop and improve how information is exchanged for mutual benefit.

Example operational use cases include:

Feedback loops for food and feed sampling results: If any EoT stakeholder receives unsatisfactory sampling results, they could be shared quickly to all other relevant parties through signals. Those stakeholders could then target their resource to conduct further testing on the products identified in the original signal, sharing their results back to all parties through additional signals. The FSA could then use all the additional data generated to help ascertain whether there is a systemic issue that requires further control, or if initial results found were just an isolated anomaly. This collaborative working would make the best use of resource to protect consumers, maintain confidence in the market and help ensure import controls remain targeted and proportionate.

Lab results: Labs used for port samplings use the Laboratory Information Management System (LIMS), PHA have Port Health Information Management Systems (PHIMS). Currently PHIMS engages with ULIMS through an intermediary system. The feedback loop for the LIMS outputs to other PHAs dealing with similar imports will be valuable particularly around signals for failed samples rather than sharing raw data. There's also opportunity for FSA/UK government systems to retrieve relevant data (e.g. for intelligence gathering). Sharing the raw data would create more complexity in controls and require a larger number of agreements to be in place. The pass/fail results could be shared within an ecosystem to help better targeting of risk, facilitate feedback loops and address issues like port shopping.

PHA interventions on non-compliance: PHAs will undertake a number of checks at the border (e.g. identity and physical checks). The ability to share non-compliance insight rather than raw data with other PHAs, BCP, LAs, FSA, and Defra in a timely manner, particularly for RoRo loads which move quickly will enable faster interventions. The signals outlining the business details and the nature of the non-compliance generated in this process will enable the updating of the risk models and targeted risk interventions. Sharing details of business non-compliance efficiently to all relevant border agencies across the country would help mitigate negative impacts of potential port shopping (traders avoiding targeted controls due to local intelligence not picking up historic non-compliance occuring at other ports) or traders using triangular trade routes to avoid controls (where goods real origin, which dictates whether controls are applicable or not, is obscured). There might be some quicker wins with this use case by linking with existing systems or systems in development.

5. Measuring the value of an EoT model

The pilots established the potential economic 'size of the prize' that could be released from an EoT model, or specific capabilities. The purpose of this analysis is to be used as a benchmark against which to compare costs, in order to inform the scope and scale of a future model.

In summary, there are a wide range of benefits from an integrated data source that is immutable, secure, shared with correct access controls in place and trusted across the supply chain.

There are benefits for industry: reduction in data duplication and the need to manually enter data yields a corresponding reduction in administrative overhead and submission errors, simultaneously improving data visibility, traceability and tracking. There are also benefits from increased facilitation to businesses that demonstrate that they fulfil the UK government's data and assurance requirements.

The EoT could apply to many different types of declarations but we have used customs declarations as an initial test case at this stage. Based on the most recent published estimates, the costs of individual import customs declarations are between £20 and £56 (note these 2018 estimates may not reflect the current costs experienced by traders). Our analyses suggest that the EoT could result in between £15m - £225m of benefits by reducing the costs of customs declarations for traders.

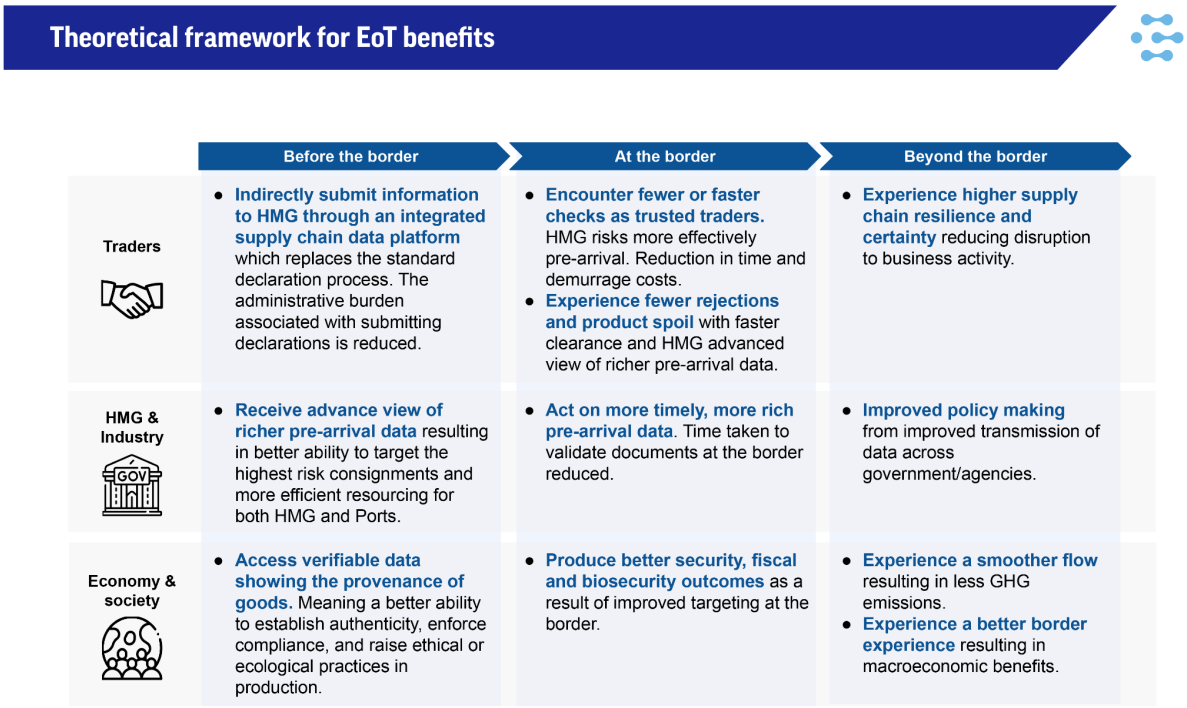
Based upon data from one BCP importing goods from non-EU countries, we have established that up to 13% of rejections could potentially be prevented utilising aspects of the EoT model, with the potential for an additional 49% to be added to this category pending further testing.[4] Given that a quarter of imports of SPS goods currently experience delays at the UK border[5] - with knock-on consequences for product spoil - this benefit is significant.

On a macroeconomic level, the costs to industry of paperwork associated with border crossings could be reduced by 75% from digitising border document processes.

Earlier chapters set out what the benefits to the government might be, as better data improves risking systems and provides opportunities for border efficiencies. For industry, there is a spectrum of benefits, from time and cost savings of data automation, reduced rejections and disruption through to other benefits summarised in the figure below. In order to release these benefits, stringent assurance criteria will need to first be met. These "hypotheses" and their associated value are discussed further in the remainder of this section of the report.

[4] ID and Physical check rates for goods from non-EU countries are expected to change under the TOM, which will impact this analysis.
[5] clearBorder (2023). The State of the Border - Business Experience of the UK Border 2022. Based on a survey of 300 businesses with experience using the border covering the period January to November 2022.

Figure 5: Theoretical framework for EoT benefits

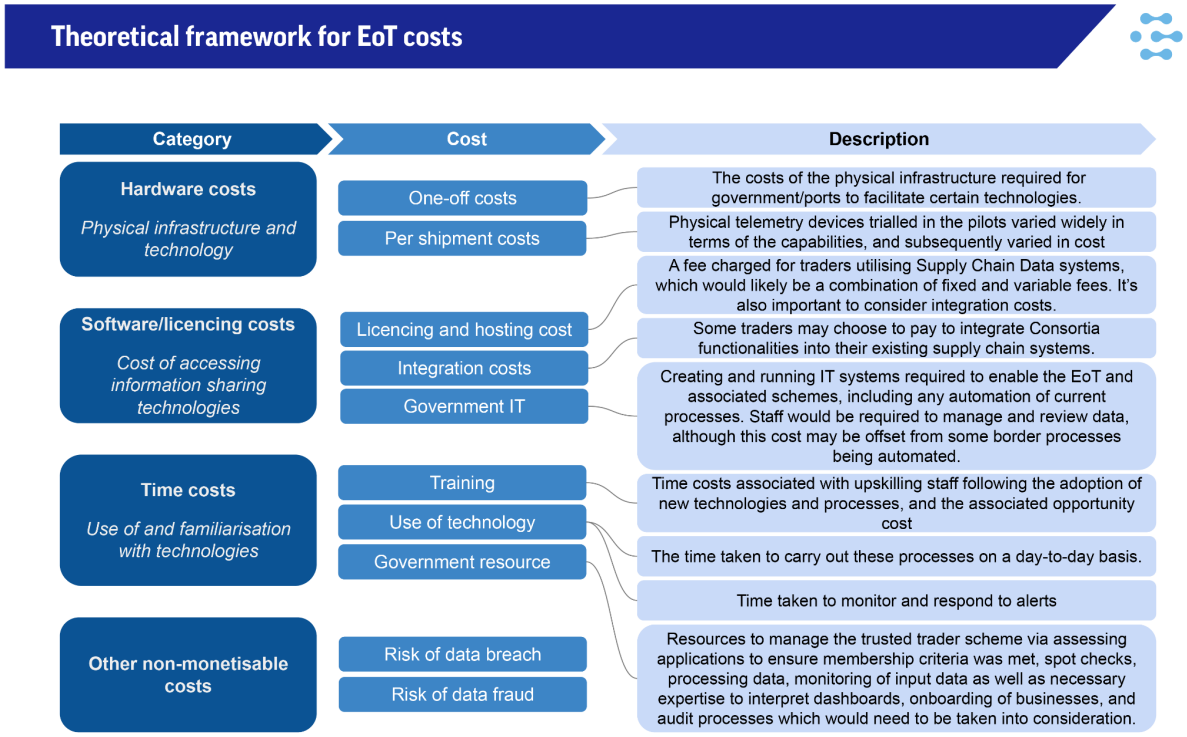


More ambitiously, data and technical capabilities providing new assurance to the government in lower friction ways allows government to reduce the burdensome mechanisms through which risks are controlled. Industry providing more assurance allows government to make changes to provide further facilitation, alleviating trader pain points. This is important as part of making an EoT model attractive to trade. We worked with departments and agencies to define what data they would need to receive before they could release facilitations and set out some examples below to illustrate the sequencing involved in solving tech challenges before we can implement ambitious policy facilitations. These “hypotheses” and their associated value are discussed further in the remainder of this section of the report.

Costs

Our analysis has aimed to establish the potential economic ‘size of the prize’ that could be released from this ecosystem of trust model. The purpose of this analysis is to be used as a benchmark against which to compare costs, in order to inform the scope and scale of a future model. There would be significant costs involved with scaling up and operating an EoT model, as demonstrated in the figure below.

Figure 6: Theoretical framework for EoT costs



We have been provided the following evidence from consortia on the indicative hardware and licensing costs associated with their technologies.

Box 1: Evidence on hardware costs

Indicative evidence from the pilots suggests that telemetry devices (in this example, smart seals) are typically either bought outright and then integrated with consortia platforms for a fee or leased from consortia for a monthly fee. Devices bought outright can **range from £8-£328 in cost**, depending on the configuration required. The cost of other telemetry devices may fall outside the upper end of this range. On top of this, there would be a fee charged to traders for the data from their smart seal to be made available in consortia platforms, which could be **up to £13p/m**. Alternatively, **traders are given the option of paying a fee of £13-£41p/m** to use devices provided by the consortia.

Device lifetime varies with device type and capability, with evidence suggesting this could range from 300 hours up to 3 years. Additional costs for consideration in relation to telemetry devices include the **charging and recovery of the devices**, which would be incurred between uses. At lower price points where the devices are not reusable there is also a need to consider disposal from an environmental standpoint.

Initial, anecdotal stakeholder research suggests that small to medium sized enterprise (SMEs) are currently less likely to use technology such as smart seals and smart containers.

Some consortia who provide dashboard services already said that they do have SMEs in their customer database, but no numbers have been gathered nor is it clear what products these customers import. Although the pilots were aimed at benefiting these SMEs, research and consideration towards these businesses would need to be given to understand if the scheme would be beneficial and viable for these traders if they would need to provide upfront funding for technology required.

Box 2: Evidence on licensing costs

For the use of supply chain data platforms, traders are typically charged a platform fee and an additional fee based on the frequency of their usage of the platform. This usage fee varies greatly depending on the size of the trader, and the scope of the platform under consideration. Some consortia also have variable fees dependent on the type of platform access traders would like.

The value of the EoT to the UK biosecurity and food safety regimes

Overview of the UK biosecurity regimes

The UK's SPS[6] regime process includes pre-notification, documentary checks, and examination - identity, physical checks and sampling.

Pre-notification is required and mandated for live animals, Products of Animal Origin (POAO), High Risk Food products Not of Animal Origin (HRFNAO), and for Plant & Plant Products (P&PP) that are regulated and notifiable**.** Live animals were not under the scope for the pilots, and so are not considered further. In theory (by legal default), P&PP pre-notification must be made at least four working hours before consignment arrival at a UK port for air and RoRo freight and at least 24 hours before consignment arrival at a UK port for all other forms of freight. For animal products, by legal default pre-notification must be made one working day in advance of arrival, or four hours if there are logistical constraints.

The **documentary and identification cross referencing check** is the first key stage in the assessment of compliance with import conditions. Under the Target Operating Model, a risk-based approach will be applied to SPS imports, and controls (including documentary checks, ID and physical examination) will be appropriately weighted against the risks posed by both the commodity and country of origin.

[6] When considering SPS goods, we stress that the EoT should not be restricted to goods that require notification, our economic evaluation should be considered a lower bound. For example: Illegal, unreported and unregulated (IUU) catch certificates are required to confirm that fish have been caught under an approved fishing regime (these can be an additional requirement for SPS consignments); All organic imports are subject to a documentary check; and Plastic Declaration Documents (PDDs) are required on imports of kitchenware from China or Hong Kong, that contain polyamide or melamine, to ensure that the goods have been subjected to appropriate tests. In addition to documentary checks, these consignments may be subject to identity/physical checks and sampling.

All consignments require some form of border process as part of the SPS regime. Examinations have three elements; **documentary checks, identity check** (this can involve a seal check which is mandatory for some Animal By-Products (ABP) and **physical checks** which can include sampling**.**

While the majority of checks are compliant, those which are non-compliant require more time to process and bring to a resolution as there are legal processes to follow.

Data suggests that approximately **12%** of pre-notifications for HRFNAO and POAO goods are made after the consignment arrives at a UK Port, for checks by the Port Health Authority (PHA) or APHA.[7]

Late pre-notification can cause delays at the border - for example, based on anecdotal evidence (applicable to LoLo consignments) from APHA:

- The impact on delays depends on the availability of staff and the time of day that the error is found. If a load with an error comes in at the end of the day the goods will not be checked until the following day. If APHA can contact the importer to correct the error, the delay is usually 12 to 24 hours. If APHA cannot contact the importer, this will be longer.

A significant amount of PHA and APHA effort associated with the **documentary checks** is to bring the consignment into compliance by raising queries, seeking amendments, or additional documents. Suffolk Coastal PHA estimates that **9% and 26%** of all HRFNAO and POAO documentary checks require PHA intervention to bring them into compliance respectively.

For **examinations** (i.e. **identity checks, physical checks, and sampling**) within a deep-sea container port,the logistics associated with the movement of containers is provided by the port operator. The presentation - the time from when a container is requested to when it is moved into the BCP for inspection by the PHA or APHA - can range between **2.4 and 5.2 days**.[8] These times are applicable for LoLo transport, and are likely to differ for RoRo.

Temperature sampling for analysis, laboratory testing, or diagnosis may also be required. Where **samples** are taken, they are submitted to an approved/accredited laboratory for analysis, or - under certain circumstances - can be analysed on site. The time taken for the laboratory report will vary depending on the product and the analysis required. Suffolk Coastal PHA has provided us with figures that suggest sampling time can range between **2 and 15 days**. Analysis of FSA data suggests that on average, around **13%** of HRFNAO consignments are currently selected for laboratory testing. For POAO and P&PP consignments, it is generally assumed that around **10%** of consignments that go through physical testing will be selected for further sampling checks.

After all of these processes, there is a possibility that consignments will be rejected for being non-compliant. This could be for a range of reasons - including microbiological

[7] We note that this and the following data is based on RoW trade with the UK, since we will not have data on EU trade until the TOM is implemented.
[8] Based on anecdotal evidence.We note that during this period the port did experience industrial action, and therefore we consider these estimates as an upper bound.

contamination, composition, or labelling. Analysis suggests that on average across ports, **2%** of POAO goods are rejected, while data provided by the FSA suggests that the average rejection rate across ports for HRFNAO goods is **1.3%**. This equates to over 85,000 import consignments being rejected per year (assuming 1.3% rejection rate also applies to P&PP). In almost all cases, this is due to a consignment failing a physical examination or a laboratory test.

Potential value release

Departments involved have given thought to what assurance points they would need in order to issue any new facilitations to trade, and we have been able to match these against the assurance points which consortia are capable of providing. This gives us a picture of how feasible these assurance requirements are for industry to fulfil, before we try to quantify the sort of benefits this would release.

Table 11: Defra and FSA requirements for assurance, and how the consortia meet them

Country of origin and commodity code, along with other crucial data fields (specific commodities require additional information, such as dairy products and composite goods), if made available early in the movement of goods, would inform better planning and targeting of resources for operational staff working at the point of entry or to help make adjustments that reflect the latest thinking on dynamic risk rules so that the goods are controlled appropriately.
Summary: All consortia are capable of meeting the requirements of this assurance criteria. Some consortia (*Fujitsu, IBM-Maersk, DBM -ATC)* are capable of providing this information in a structured format as well as from source documentation, allowing for improved deployment of dynamic risking rules. All consortia are able to provide this information before goods arrive at UK points of entry. This could permit improved planning and targeting of resources for operational staff.
Departments receive a notification detailing a single assurance opinion (or attestation) which has potentially been corroborated by other departments or supply chain actors.
Summary: Most consortia platforms are capable of making signals available based on a single assurance point, such as a check that is performed during the import process. Two consortia (*Connected Borders, DBM -ATC)* are capable of allowing multiple actors, such as departments and agencies, to corroborate and manage actions related to these signals on their platforms, meeting the assurance criteria in full.
Greater level of food and feed commodity/product information including details such as batch number, brand, ingredients lists (if applicable) which include origin of animals and other ingredients.
Summary: Most of the consortia did *not* provide this additional information through their pilots, with the exception of Chainvine and Azarc who manage and deal with regulation associated with highly specific commodity groups. Several consortia described a risk with asking for this additional information increasing unnecessary administrative burdens on the trader unless a clear agreement is made on its collection and usage with the UK government.
Cold chain monitoring and smart container technology confirms that appropriate temperatures for chilled or frozen goods are maintained at correct levels. Provide signals to PHA/FSA/Defra identifying where cold-chains are broken.
Summary: All consortia are in theory capable of collecting data points generated by smart devices for cold chain monitoring. Chainvine & IBM collected this data during the pilots. All consortia are capable of setting

parameters, or configuring when exceptions should be triggered when an acceptable range has been exceeded. Each consortia can generate this assurance as a signal that is triggered in the event of a deviation and made available to the relevant department or agency.
Electronic seals and smart Container technology can provide assurance that consignments have not been tampered with between leaving establishment of origin and UK arrival. This technology can provide signals to PHA/FSA/Defra where unexpected deviations occur on-route.
Summary: All the consortia are capable of capturing data elements related to tampering generated by smart devices on their platforms and systems. Azarc, DBM -ATC and Fujitsu each deployed smart devices during the EoT pilots that were able to determine if a consignment had been tampered with outside of an authorised event. All the consortia, whether they had smart sensors deployed during the pilots or not, are capable of generating a signal based on this type of event occurring. Some consortia recommend that this type of event be captured by exception to prevent large amounts of costly unimportant data being captured.
Imported food and feed have electronic labels so if an issue is identified within the supply chain (including inland at commercial premises, labs or consumers) traceability data can be obtained and shared straight away, allowing for incident management to be more efficient and effective.
Summary: All consortia are capable of capturing this data, which is generated through existing industry solutions. As part of a workflow, consortia systems can capture which device scanned the code (ensuring only authorised people use the device), as well as who. This can then be linked back immediately to the relative traceability data and shared to government border agencies.

The potential benefits that could be released as a result are:

Fewer or faster checks could be given to those traders if the assurance were deemed by Defra and the FSA to be substantial enough to ensure overall risk mitigation was sufficient.

Traders could experience fewer rejections and product spoil if government had an advanced view of richer pre-arrival data (albeit this would be dependent upon the consignment and the quality of the pre-arrival data and so is currently speculative). Access and fast response to data provided by assurance technologies on the conditions of a consignment - such as temperature, humidity, carbon dioxide and oxygen levels - could result in reduced product spoil. This is applicable not only to foods which have completely spoiled, but where border processes have resulted in delays and therefore a reduction in shelf life. clearBorder (based on a survey of 300 businesses with experience using the border covering the period January to November 2022) found that in 2022, of respondents trading perishable goods, 24% reported delays at the border. 47% of traders who experienced delays linked this to difficulties moving goods across the UK border.[9]

From reviewing rejected consignment data for imported POAO goods from non-EU countries received at one BCP, **initial analysis suggests that up to 13% of issues seen could be potentially prevented, identified or reduced in number utilising aspects of the EoT model[10,11].** For a further 49% of rejection it is unclear, and would require further testing to conclude, whether an EoT could reduce rejections. This assumes that if business documentation can be made available to government, targeting teams can triangulate

[9] clearBorder (2023). The State of the Border - Business Experience of the UK Border 2022
[10] This analysis is based on rejected goods data of imports from countries outside the EU arriving at one BCP between January 2020 - December 2022. This provided a list of 30 different reasons that goods are rejected, with goods sometimes being rejected for multiple reasons.
[11] ID and Physical check rates for goods from RoW countries are expected to change under the TOM, which will impact this analysis.

information between these documents, certification and pre-notification information. This may allow for corrective action before goods depart the Country of Origin, however this would need to be tested to determine whether this is feasible within logistical restraints. Further testing would be required to comprehensively understand whether a proportion of the uncertain rejections could be preventable and what investment and/or resource would be required to realise that figure. More detail can be found in **Annex A.**

Improved biosecurity outcomes. With the additional advance data utilised alongside the risking matrix being developed, **further steps could be taken to identify biosecurity risks** and other reasons for rejection. This could then allow BCPs to apply intelligence-led targeted checks with greater accuracy which could allow for more effective resourcing for both government and ports and could increase the likelihood of biosecurity risks being identified at an earlier stage.

The UK faces significant public health, plant health and animal health risks associated with the importation of goods. An effective import regime is therefore essential to protect domestic food safety and animal and plant health and welfare. It serves to monitor and enforce UK import controls that prevent biosecurity and food safety hazards entering the UK, which can and have had considerable consequences to the UK economy and agricultural sector (see below). With the additional advanced data used alongside the risking matrix being developed, **further steps could be taken to identify biosecurity risks** and other reasons for rejection. This could then allow BCPs to apply intelligence-led targeted checks with greater accuracy which could allow for more effective resourcing for both government and ports and could increase the likelihood of biosecurity risks being identified at an earlier stage.

Table 12: Socioeconomic impacts of biosecurity outbreaks[12]

Contaminated food can have large scale economic implications
- The Foot and Mouth Disease outbreak in 2001 cost the UK an estimated £8 billion and caused widespread damage to the agricultural sector and international trade. - An outbreak of Asian longhorn beetle in Kent in 2012 had an estimated eradication cost of £2 million[13]; - Ash dieback arrived in the UK in 2014, with a predicted cost of £15 billion over the next 100 years[14] - Product recall and withdrawal using the 2013 horsemeat scandal as example, can cost up to £120 million. This is based on FSA analysis of the estimated cost of recall to a business (approximately £8 million) multiplied by the number of recalls associated with the scandal.
Outbreaks reduce confidence in food safety with impacts on business and exports
The agri-food sector contributed £116.2 billion or 6% to UK national gross value added in 2020. In 2021, the UK exported £20 billion of food and drink (6.2% of total good exports).

[12] Figures provided by the FSA.
[13] Eyre and Barbrook (2021). The eradication of Asian longhorned beetle at Paddock Wood, UK
[14] Hill et al (2019). The £15 billion cost of ash dieback in Great Britain

- Our import controls must be seen to be robust by trading partners or they may simply refuse to import our products.

- Our trading partners assess our import regime when auditing the UK for market access; they assess the need for attestations on the basis of the confidence they have in our food safety systems, including the robustness of our imports regime to detect non-compliance and health risks and key export markets such as the EU, the US and China will scrutinise UK borders policy to determine whether existing assurances that underpin our trade are maintained.

Examples of a government need being met through the EoT model

Ongoing EoT work could help ensure STW enables the required data collection, or data access via government and industry systems interoperating, and enables the FSA and PHAs to utilise the data according to their needs. The EoT pilots have demonstrated that industry is willing to provide data and work with UK government on developing mechanisms for data exchange.

Food and feed safety incident management: Timely supply chain data will allow the FSA and PHAs to quickly track imported products that have been identified to cause harm to consumers (illness or potentially death), as well as identify the businesses involved in the supply chain, which would speed up the process of preventing those goods entering the UK market and/or enable timely product recalls.

Imported food and feed surveillance: Detailed supply chain data would also significantly improve the FSA and PHAs ability to target imported food and feed for surveillance purposes. More granular level of supply chain data will enable relevant parties to target specific foods and feed with the aim of gathering evidence to inform continual risk categorisation. The outputs of improved surveillance capabilities will allow SPS import controls to be more targeted and proportionate, providing the required data and evidence to ensure only the riskiest products are subject to additional border requirements/checks.

Reduction in disruption at the border. Disruption at the border may be caused by time taken to prepare paperwork, to receive confirmation of declarations or licence applications, to secure agents and transport or to deal with unprepared customers and suppliers. In 2022, clearBorder(based on a survey of 300 businesses with experience using the border covering the period January to November 2022) found that 58% of respondents experienced delays with imports, with 47% of respondents blaming these delays on difficulty moving goods across the border and over half of them increasing their expected delivery time by up to 3 days.[15] The monetised impact of disruption at the border is discussed further in the remainder of this section.

[15] clearBorder (2023). The State of the Border - Business Experience of the UK Border 2022.

The value of an EoT model to the UK customs and safety security regimes

Customs declarations are required for all goods exported from and imported to the UK. Goverment uses this data to calculate VAT and duties owed on imported goods and to compile trade statistics.

S&S declarations are another example of regulatory documentation, currently collected for all goods exported from the UK, while for imports, they are required for non-EU imports and will be introduced for EU imports by October 2024. They provide data for security risking, to protect our society from harm, by detecting and intercepting illegal and harmful goods from entering our shores.

If industry can provide upstream supply chain visibility in a machine readable way, government could potentially conduct more accurate selection/non-selection of consignments for compliance interventions. Systems such as those trialled in the EoT pilots can also help to reduce the administrative burden associated with providing data to government, as existing trade documents can be made available in a machine-readable way (assuming that government can ingest data in this form), resulting in fewer data fields needing to be manually populated.

The ‘size of the prize’ is significant. The below table highlights the volumes of customs import declarations made in 2021.

Table 13: Import declarations by declarant representation and trade partner, 2022[16]

	Self representation	Direct representation	Indirect representation	Total
UK - EU	4.4 million	10.2 million	11.4 million	26.0 million
UK - RoW	13.3 million	26.2 million	7.1 million	46.7 million
Other	0.2 million	0.5 million	0.1 million	0.9 million
Total	17.9 million	36.9 million	18.7 million	**73.5 million**

Potential monetised value release

The potential benefits that government departments and agencies managing customs and security at the border could offer if rigorous assurance criteria are met by industry are listed in the table below.

Table 14: Examples of potential value release from the EoT - customs and security regime

Example 1: Checks could be reduced, and predictability of passage increased, for participating compliant businesses who can provide supply chain visibility to departments and agencies involved in managing the UK customs and security regimes.

[16] HMRC (2023). Data tables for customs declaration volumes for international trade in goods in 2022

Supply chain visibility achieved through timelier, richer, and more assured data, which is machine readable and interoperates with government systems, could enable more accurate selection / non-selection of consignments for compliance interventions.
In principle this would reduce the number of 'false positives' and therefore the relative number of checks on participating compliant businesses.

Summary: Industry would need to demonstrate the ability to provide additional high quality structured data to improve upstream and downstream supply chain visibility including:

1. Names and other identifying information (e.g. EORI numbers) of supply chain actors and high-level description of processes they take in relation to the goods
2. The licences and authorisations (AEO etc.) each supply chain actors holds.
3. The location of goods at stages along the supply chain and a description of any processes, transformations etc. carried out at each stage. This should be supported by descriptions of changes in physical characteristics e.g. weight, volume, colour etc.
4. The mode of transport used to move goods between each stage of the supply chain and data and time of arrival and departure. Potentially monitored using augmenting technology.
5. Commercial documentation generated along the supply chain including commercial invoices, purchase orders, packing lists, certificate of origin, airway bill/seaway bill, bill of lading, regulatory certification, promissory note, export declaration, health certificate, phytosanitary certificates, shipping instructions, banking records to include records of monies flowing through the company's accounts, contractual info conforming commercial undertakings, relevant test certificate, quality assurance/accreditation certification.

Full supply chain visibility would be the preferable outcome for government but is unlikely to be possible in all cases. However, incremental improvements in supply chain visibility could potentially enable equivalent improvements in the accuracy of selection / non-selection of consignments. This was not conclusively tested during the pilots and requires future collaborative assessments between government and industry.

Example 2: Checks could be reduced, predictability of passage increased, and friction associated with providing commercial documents could be decreased for participating compliant businesses who can provide digital, machine-readable commercial documents to departments and agencies involved in managing the UK customs and security regimes.
Government could, in principle, automate some document checks of digital, machine readable commercial documents which are interoperable with upgraded government systems.

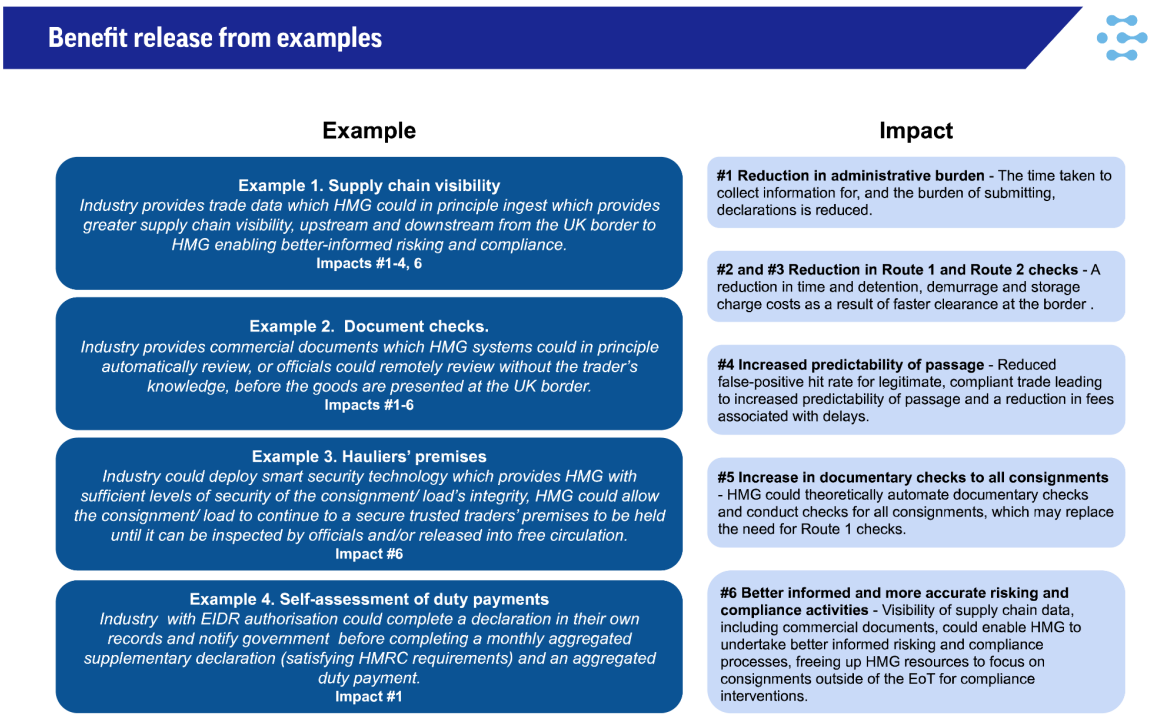
Summary: Industry would need to be able to consistently share relevant digital, machine readable, interoperable commercial documents. This was not a capability demonstrated during the pilots and would require trade digitisation. Government would also need to build capabilities to automate document checks. Dashboards used within the pilots did create the opportunity for virtual manual inspections of commercial documents which could provide some limited benefits to businesses who can provide government access to relevant commercial documents through similar platforms before the goods reach the border.
This potential opportunity would have lower technological barriers but would be a resource intensive process for government and provide less benefits to traders than an automated solution.
Further work is necessary to assess the feasibility, scalability and desirability of both potential approaches.

Example 3: Route 2, physical goods checks, could potentially be moved away from the border and conducted at the haulier or consignee's premises if participating compliant businesses could deploy augmenting technology (e.g. smart seals) which can ensure government of the integrity of the load.
If a load of goods is selected for a physical check, and government is content that the augmenting technology can provide a sufficient level of assurance that the goods will not be replaced or removed, in principle government could allow the load to continue to a secondary location, away from the border, where officials could conduct necessary checks.

This could potentially reduce disruption for hauliers and/or traders.
Summary: UK government needs to be content with the level of security and assurance that the technology provides is sufficient for its needs which would require further testing of devices available on the market and standards used by industry. The information from augmenting technology would need to interoperate with government systems and these systems would have to be capable of communicating effectively with hauliers, consignees and compliance teams.
Example 4: A consortium could self-assess their duty payments. A consortium with Entry in the Declarant's Records (EIDR) authorisation, and providing a supplementary declaration could complete a declaration in their own records and notify relevant departments before completing a monthly aggregated supplementary declaration (satisfying HMRC trade stats requirements) and an aggregated monthly/quarterly duty payment. The consortium would make the declaration in their own records available, via a dashboard-type interface, where HMRC officials could review them without the consortium's knowledge. Supplementary declarations could only be aggregated to the degree that they still allow departments to fulfil their functions e.g. HMRC trade statistics requirements.
Summary: The consortia need to demonstrate the ability to successfully aggregate duty payments and data requirements for consignments. Therefore we need to do: • An assessment of industries ability to make trade data and relevant commercial documents available through a dashboard type interface. • Industry's demonstration of the ability to aggregate duty payments and data requirements for consignments while providing sufficient granular detail to enable departments to fulfil their functions including HMRC obligation to provide trade statistics.

These benefits are discussed in the remainder of this section:

Figure 7: Benefit release from examples



Reduction in administrative burden for traders. The EoT pilots have demonstrated the possibility of making existing trade documents available in a machine readable way. Noting the complexities associated with doing so, if in the future government systems can ingest this data, this could reduce the number of data fields that need to be manually populated as part of the current declarations process, equating to a reduction in the administrative burden to traders.

Example: Monetised benefit for traders

To quantify the scale of opportunity, we have focused on import declarations as a case study. This is one of many applicable use cases - including, for example, S&S declarations and SPS pre-notification - and as such, the benefits should be considered as only a portion of the total potential reduction in administrative burden from the EoT.

Analysis of data provided by two consortia during the pilots indicates that between 38-42% (with a midpoint of 40%) of the data fields required for an import declaration were made available during the pilots.

The cost of an import declaration ranges from **£20-£56,** depending on trader size and method of declaration, although these estimates are from 2018 and therefore may not truly reflect current costs. The total number of import declarations in 2022 was **73.4m**. The administrative burden associated with submitting declarations is split into an internal and external cost, as follows:

- **Internal cost** - The time taken to collect data required for customs declarations and costs incurred in doing so.
- **External cost** - Software costs and fees paid to intermediaries in order to submit customs declarations.

UK government analysis demonstrates that scaling a 40% reduction in the internal cost of submitting customs declarations would result in an annual average cost saving of between £15m - £225m.[17] The impact on an individual business would be dependent on whether an intermediary is used to submit customs declarations, the type of declarations that are typically submitted and the volume of declarations which are submitted. This analysis only applies to import declarations (rather than S&S, or SPS pre-notification, for example) and can therefore be considered an underestimate when considering the benefits of the EoT in aggregate. The assumptions underpinning this analysis are detailed in **Annex A**.

Consortia have indicated that if the right commercial incentives were in place, all government data requirements could be made available through supply chain platforms. Building in 20% contingency but assuming all data requirements are fulfilled, Cabinet Office analysis suggests that an 80% reduction in costs would equate to an associated average annual cost saving for traders over a 10-year period of **£365m**.

Reduction in route 1 and 2 checks for participating compliant businesses. With an EoT model providing sufficient upstream insight, government could carry out more accurate

[17] It is assumed that there is no effect on external costs.

targeting of non-compliant consignments and avoid particular checks (and associated delay/cost for traders). **Legitimate trade would be less likely to be selected for customs clearance Route 1 checks, because equivalent checks could be completed without having to engage with traders, or Route 2 checks, where the government could be made sufficiently confident that they are not necessary.**

Route 1 checks require all documentation to be sent to the National Clearance Hub (NCH) for clearance.

Route 2 checks also require documentation to be sent to the NCH for clearance, but physical examination of the goods by a Customs Officer is also required.

Better fiscal outcomes. The EoT would enable government to better target all forms of fiscal risk arising at the border and its associated processes. The pilots have shown that it is possible for additional data and insight to be made available for the purpose of "risking" border traffic, providing government with a wider range of risking inputs and thus potentially leading to improvements in identification of issues. The EoT could also enable the UK customs regime to focus its resource-intensive interventions on those higher risk traders that would be outside of the scope of EoT, and hence potentially improve fiscal outcomes at the border and from its associated processes.

Better security outcomes. The UK faces a considerable amount of risk at the border, including national security risks. Border security plays an integral role in promoting the prosperity of the UK, preventing cross-border harms whilst underpinning legitimate business. Of the £37bn (FY 2015/16) in socioeconomic cost of serious and organised crime, border smuggling accounted for a significant portion.[18] To secure the border, the government uses targeting to more effectively determine when to conduct physical inspections and effective targeting requires advanced data to make the right decisions. **Higher quality data can result in more effective targeting, reducing delays at the border while simultaneously reducing harm.** Similarly, **additional data can be used to corroborate existing sources or reveal inconsistencies**, making it more difficult for organised crime groups to evade checks.

The value to the macroeconomy and wider society

Increasing the attractiveness of trade with the UK. A reduction in the burden to traders, and the enhanced protection of legitimate trade - through the EoT - are likely to promote the reputation of the UK border, improving its perceived efficiency and resilience among international importers and exporters. The costs of trading can act as a barrier for some firms looking to operate across the UK border.

On average across the Commonwealth, it costs around £378 for a shipment of £18,148 worth of goods (roughly equivalent to a 40-foot container) to cross borders[19].

[18] Home Office (2018). Understanding organised crime April 2015 to March 2016 second edition.
[19] Commonwealth Institute (2021). Quantitative Analysis of the Move to Paperless Trade.

The implementation of smoother border crossings alone would reduce costs to an estimated £72 per £18,148 shipment.[20] This is an estimated average 81% reduction in border costs.

The amount of paperwork associated with trading across borders costs, on average across the Commonwealth, US$79 (£57) per US$25,000 (£18,148) shipment.

These estimates suggest an average cost reduction of 75% from digitising the processes of documentation associated with border crossing and rules of origin.

If these findings were aggregated, they could enable an additional $90bn (£65bn) in trade across the Commonwealth. This effect could be multiplied through the use of Single Trade Windows and Digital Identities, as these would enable excluded groups to access trade more readily.

Improved view of the provenance of goods. Over the past several decades, globalisation has led to unprecedented complexity in global supply chains, which has brought huge benefits, but also aggravated concerns about disruptions, delays, inefficiencies, or fraud and consequently brought challenges for businesses, regulators and consumers. For various industries within the EU, mandatory frameworks have already been adopted requiring businesses to conduct due diligence on the provenance of their supply chains but for the majority a voluntary approach is relied upon, leading to suboptimal outcomes.[21] The introduction of legislation does not necessarily equate to compliance throughout the full supply chain. As a result, there is a clear case for the value of a technology driven solution, such as the EoT, to provide a mechanism for accountability. The EoT could provide essential visibility into the supply chain, and to whether a good is being produced legally and ethically. It could reduce information asymmetry in purchase decisions and encourage the parties involved to make more ethical decisions around supply chains/the goods that they choose to consume. The potential benefits are :

- Trust, transparency and accountability between disparate supply chain entities.
- Process automation through smart contracts.
- Real-time tracking and monitoring of products.
- Immutable audit trails, full transaction history
- Proof of certification, identity, authenticity or compliance.
- Unique, shared source of truth; no data silos but also no central point of failure.
- Ultimately, improved product safety and standards.

Reduced disruption at the border. Disruption can result in significant financial and reputational damage to businesses, and particularly so those which have extensive supply chains. Disruption at the border can happen for a number of reasons, some of which being outside of the government's control - including bad weather, industrial action, or failure of transport mode, for example. clearBorder (based on a survey of 300 businesses with

[20] Costs are estimated from the Ease of Doing Business survey.
[21] European Parliamentary Research Service (2020). Towards a mandatory EU system of due diligence for supply chains

experience using the border covering the period January to November 2022) find, however, that of the 58% of traders who experienced delays at the border in 2022, 60% cited the time taken for checks on goods,55% problems with paperwork from suppliers outside of the UK, 27% problems with paperwork from their own firm, and 48% a lack of border capacity.[22]

On average, disruption causes financial costs of between 6%-8% of annual revenue as a result of increases in the cost of operations, delayed cash flows, loss of productivity, and loss of sales and market share. Businesses are as likely to report damage to brand reputation as a consequence of supply-chain disruption as it increases costs of operations: disruption increases the number of customer complaints received, as well as loss of regular customers.[23]

Whilst a unit of freight is awaiting a check to be completed, it may incur costs. **For accompanied freight,** the majority of these costs will be generated by the waiting time of the haulier due to a direct impact on the driver's time.This waiting time will add to the driver's hours and impact the availability of both the driver and the HGV / trailer assets. Hauliers have now become aware of this situation and are starting to add a 'waiting time' rate to their contracts. We estimate that for each hour an accompanied consignment is delayed the incurred costs would be between £35 - £50 per hour.

For **unaccompanied freight**, the additional duration the consignment stays at the port may result in the following charges:

- Demurrage charges, which apply for the usage of container equipment inside the port terminal. For the import phase, demurrage starts when the ship arrives at the port or after the container has been discharged, and ends when the container is picked up from the terminal. Demurrage charges are typically only applied if the consignment exceeds the initial dwell rate period in the commercial agreement.

- Detention charges, which arise outside the port terminal. For the import phase, detention charges start when the full container is picked up from the terminal, continue during its delivery to the consignee, and end upon return of the empty container to the container yard. Detention charges can apply if a shipping container isn't returned empty to the agreed location within an agreed time period.

- Storage charges, which cover the use of storage space occupied by the container on terminal grounds, inside a warehouse or at the container yard. For both import and export phases, the storage period starts when the container enters the storage facility and ends when it is taken out from the premises.

Table 15: Combined demurrage and detention tariff at all UK ports, terminals and depots[24]

Days	Cost range for non-refrigerated	Cost for refrigerated
1 to 7	Free	Free

[22] clearBorder (2023). The State of the Border - Business Experience of the UK Border 2022.Based on a survey of 300 businesses with experience using the border covering the period January to November 2022.
[23] Economist Intelligence Unit (2021). The business Costs of Supply Chain Disruption
[24] Source: Maersk. Charges are applicable per container, per day. Non-refrigerated range applies for 20' Dry, 40' Dry & 40'HC & 45' Dry, 20' Flat & Open top, 40' Flat & Open top. We note that both detention and storage charges can vary by port, region, and shipping line.

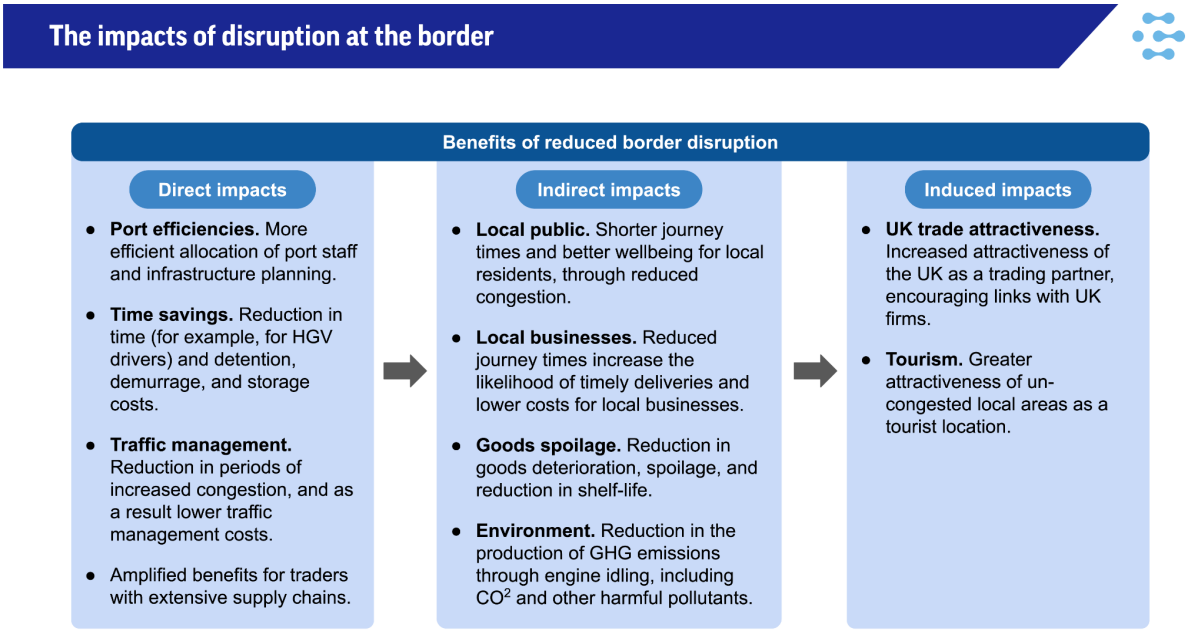
8 to 14	£35-95	£95
15+	£55-125	£125

Table 16: Storage tariff for UK ports, terminals and depots, excl. Liverpool, Teesport & Belfast[25]

Days	Cost range for non-refrigerated	Cost for refrigerated
1 to 5	Free	Free
6 to 10	£24-36	£95
11 to 14	£48-72	£110
15+	£60-90	£125

During the pilots, one consortium stated that official checks cause 13% of all consignments to take more than an hour to be cleared to leave the ports in question[26] and that physical border checks increased UK port and broker fees by up to 234%.[27]

Figure 8: The impacts of disruption at the border



The EoT could improve current processes and reduce the impact of disruption when it occurs**.** The benefits of an integrated data source that is immutable, secure, shared and trusted across the supply chain include: reduction in data duplication and the need to manually enter data yields, a corresponding reduction in administrative overhead and submission errors, and improved data visibility, traceability and tracking. The opportunity to perform processes away from the border minimises delays at the border. The EoT could therefore improve current processes, therefore acting as a buffer during periods of disruption. These impacts would be 'multiplied' for those traders most integrated in global supply chains.

[25] Source: Maersk. Charges are applicable per container, per day. Non-refrigerated range applies for 20' Dry, 40' Dry & 40'HC & 45' Dry, 20' Flat & Open top, 40' Flat & Open top.
[26] Data covers all 106 UK maritime ports and frontier locations services serviced by Destin8 for Jan, Feb and Mar 2022. This includes both temporary storage and pre-lodgement models.
[27] Evidence from the pilots provided by IBM and Maersk. This analysis considers the costs incurred per consignment rather than per container.

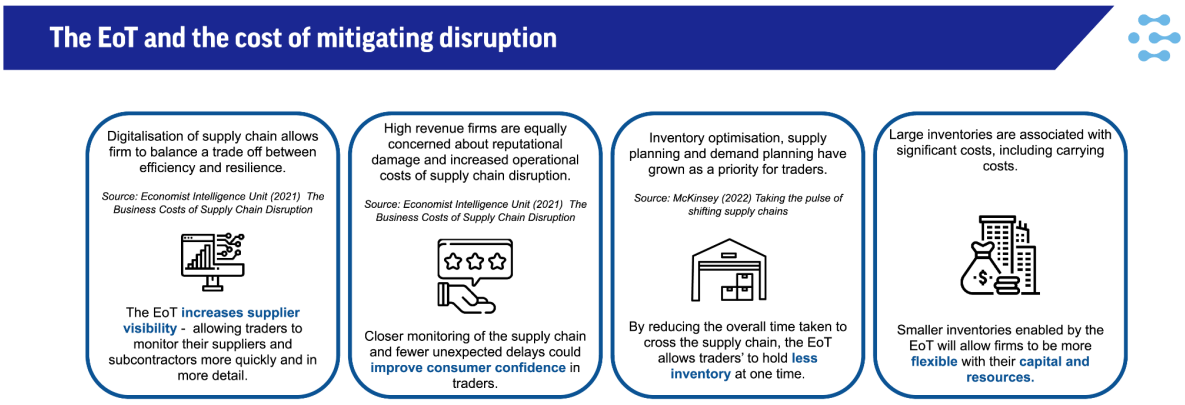
Businesses and customers have taken a number of actions to mitigate disruption like inventory management and employment strategies, diverse and long-term partnerships with producers, and deeper investment in digital tools. As demonstrated in **Figure 9**, the EoT could be a valuable addition to this list. Consortia evidence suggests that reduced order to delivery lead-time variability enables companies to reduce the cost of carrying additional inventory. Median inventory carrying costs are found to be approximately 10% of inventory value[28], presenting a significant saving for traders if inventory levels can be reduced through border predictability.

Example of a trader burden being ameliorated through the EoT model

Trader insight: *"We are responsible for helping one of our customers import large amounts of containerised freight into the UK on a daily basis. To ensure that the goods can be unloaded, a physical Bill of Lading is required upon arrival. Frequently these physical documents do not arrive on time and the goods are subsequently held at the port, incurring costly demurrage charges and preventing goods flow. Working with the UK government to improve the use of legally recognised digital Bills of Lading would help to alleviate these issues"*

The collation of commercial documents related to import/exports is a challenge for industry because documents are owned by different supply chain organisations working in an international environment that creates timezone, language, technology and related communication issues. The EoT model provides a mechanism for these organisations to collaborate on the provision of data in a way that breaks down some of these barriers and makes possible new incentives to improve data collection and sharing. For instance, documents can be uploaded once by the originating party and at the point they are first created, and then shared onwards with many parties, reducing communication costs for the parties involved.

Figure 9: The EoT and the cost of mitigating disruption



[28] Inventory carrying costs include cost of capital, storage space costs, insurance, handling/administration of inventory, shrinkage, and obsolescence

6. Recommendations for how we address the challenges to EoT adoption

We have established that there are data and technology capabilities with the potential to meet government's assurance needs and provide value to all border users, and that they ought to be integrated into an EoT model. But getting to a point where these capabilities are deployable at scale is the challenge.

This chapter deals with the blockers to tech and data capabilities' deployment at scale - technical, interoperability and governance challenges - and what we think government and industry ought to do next to tackle them.

Industry is already using third party software to more efficiently manage their supply chains and provide data needed for current border requirements, including discrete declarations, to government departments. The challenge is to build these data exchange models into a more ambitious and transformative model where we use a variety of methods to get data to departments and where other categories of data (like assurance data from devices) can be added and made visible to the government without undue burdens on industry. We'll need to address interoperability challenges - like governance - which are currently preventing the model from being scalable, adaptable and flexible enough to suit different user groups. Given the pace of technological change and the stand-up of the STW, it is important that EoT model design is open from the outset.

Addressing the blockers to EoT model deployment

A: Enable data interoperability between government and industry systems

Accessibility of data proved a challenge in the pilots. Supply chain participants predominantly made unstructured data accessible, like PDF formatted digital files, sometimes accompanied by physical copies. While convenient for trade, unstructured data:

- Is difficult to turn into useful formats more suitable to the needs of ecosystem participants.
- Cannot be shared precisely or selected in flexible ways, so information sharing network participants suffer from information overload.
- Cannot be made machine readable without time consuming and expensive further processing applied which carries significant risk of introducing errors in the transformed data.

Government systems require structured, machine readable data - organised into separate data elements so that each item can be retrieved and processed separately by software - to

enable automation of the processing of official border requirements. Industry and government have a mutual interest in this automation as it allows data to be quickly organised and assessed, and this in turn reduces costs and allows rapid decisions to be made about the status of goods crossing the border.

A number of standards bodies including UN/CEFACT, WCO, ICO and W3C have developed standards which support data interoperability for trade processes. These for example support the exchange of structured digital data in relation to the purchase, financing, shipping, payment and trade compliance regarding the international movement of goods, and digital identity and credentials. Collectively these can provide the basis for fully digitised trade. However, the practical challenges to the standardisation of business data are far from trivial. The majority of the business documents presented in the pilots did not conform to international interoperable data standards and we understand why: ultimately the unstructured (PDF/paper based) approach to exchanging data prevalent in the supply chain today, while inefficient, is tried-and-tested and works regardless of the location, technical maturity and legislative constraints on the organisations involved.

The outcome of limited progress towards cross-border paperless trade means governments continue collecting data for border controls using procedure-specific declaration data formats that businesses must comply with in order to move goods across the border. These requirements often duplicate data contained in standard business documents. The lack of progress towards the use of structured, standardised, fully digital processes for cross-border trade leaves businesses a choice between low-technology solutions (paying someone to key in the data) or integration (arranging systems and processes within an individual business) to capture the necessary data in government-specified structured formats before submitting it to government systems. Both carry a cost to business.

Despite the existence of data standards, legal frameworks and promises of improved business operations, private sector businesses often perceive standardisation as having limited value because:

- New systems have to be built and internal processes established to make the technical data exchange processes work.
- Exchanging structured data, rather than documents, can create dependencies between organisations that can be hard to manage and costly to maintain.
- The cost of failure in processes relying on technical integration between organisations - which tend to impact multiple transactions and require interventions by technical teams - are generally larger than failures with manual processes where issues can typically be worked around with phone calls, emails etc and tend to impact only individual transactions.
- There are also some legislative obstacles: countries are removing them - with the UK being an early mover - but a wider critical mass of countries will need to follow, as the problem is, by definition, international.
- Encouraging progress has been made in containerised goods where there are well established standards for exchange of Bills of Lading (eBLs). However, we heard that

although it was normal for carriers to exchange data in this format, the number of individual traders sharing eBLs as data, rather than documents, was very low.

- In some cases, government mandates have been successful, for example eInvoices are widely adopted in Latin America where mandates are common.

Although there are challenges getting international trade to move more quickly on the adoption of data standards, the opportunities are significant. Government has taken action and is on course to shortly enact the Electronic Trade Documents Bill. A collaborative effort between standards bodies, government and industry to promote and incentivise adoption is now warranted. Experts in the field project that increasing volumes of commercial supply chain documents will be exchanged digitally. The Impact Assessment for the Electronic Trade Documents Bill projects that 45% of UK exporting firms will adopt trade processes which use digital trade documents within 10 years and many international commercial trade bodies have committed to ambitious targets for digitalisation:

- The Digital Container Shipping Association has committed to 100% digital eBLs by 2030.
- BIMCO, one of the largest of the international shipping associations representing shipowners, has committed to to 25% of eBLs by 2025, and the;
- International Chamber of Commerce (ICC) has committed to 60% of eBLs by 2027.

The UK government can help drive digitisation and standardisation of commercial trade data, across both the negotiable trade documents covered by the Electronic Trade Documents Bill, and other key commercial documentation. Government will work through the National Trade Facilitation Committee, to promote trade digitisation, including working with industry to ensure the new opportunities for digitisation, and resulting efficiencies afforded by the Electronic Trade Documents Bill are exploited fully and flexibly, in ways which support goals for wider trade document digitisation.

A further step is welcoming the **World Trade Organisation/International Chambers of Commerce's Standards Toolkit.** It is an industry-led and international effort to equip every supply chain participant, both public and private, with the most notable and widely used standards and interoperability frameworks to digitise cross-border trade. The toolkit provides an overview of over 100 available standards, frameworks and initiatives which allows new adopters to identify and invest in the most appropriate standards for their organisation.

The design of data standards reflects the needs of the organisations that use them and - because these needs evolve over time and vary between industries and the local legislative they operate under - we expect new standards to continue to emerge and that others will be deprecated or require ongoing updates to reflect these developing needs. **No single universal standard for borders data has emerged that covers all these needs** and it is not clear that such a model would be possible given the diverse range of business requirements that must be catered for. We heard from experts in international standards bodies that requiring all international trade and government agencies to update their technology to handle new standards was not a realistic goal given the likely high costs involved. **A more feasible approach is to accept that some level of translation between**

standards is inevitable and to focus efforts on minimising the costs and disruption when it is necessary.

By providing users with a core set of standards, and frameworks for aligning these standards, the toolkit has the potential to enable the parties in global supply chains to make informed choices on standards when purchasing or creating border software, encouraging business to converge on a recommended set of common standards whenever possible. The toolkit aims to promote the use of common semantic data standards that reduce the cost of translating between the data standards where converging on specific standards is impractical. Several UK government departments have already aligned to the toolkit, and a critical mass of more departments aligning to it, would instil confidence in industry and ultimately lead to trade data being more interoperable and usable by the wider economy, which is a key goal of the National Data Strategy. The UK government will also support international organisations in promoting the adoption of these standards and provide guidance and technical information on their implementation to companies wishing to adopt them.

In promoting the toolkit as a useful resource for standard adoption we recognise that some countries have already adopted other standards frameworks (and there are many existing standards, catalogued at **Annex C**); development of the EoT model needs to take account of this reality. But given the merits of greater global harmonisation of data standards, we believe standards should be internationally aligned wherever possible (e.g. where domestic standards haven't been adopted and hard coded into legacy systems, or where new categories of information appear that require the development of new standards).

In operating the EoT model, the UK government and trade will need to be able to interoperate with other countries' data and systems. Therefore, the government will work with other countries to promote and share evidence on the benefits of trade digitisation, and is already in regular contact with jurisdictions with a mutual interest in testing interoperability, discussing future projects with Thailand, Kenya and others.

Some of the consortium members used or were experimenting with machine learning techniques to extract machine readable data from unstructured business documents. A number of techniques are potentially relevant, including automatic document classification, statistical machine translation and the automated identification of named individuals, organisations, places and other entities referenced in unstructured text. Some of these techniques are already used in government risking systems, however this is a technical area that is improving rapidly and needs to be continually monitored. For instance the recent developments in the Large Language Models popularised by services like ChatGPT create interesting potential for summarising and identifying themes in large sets of documents, and for interrogating individual documents to isolate particular data elements of interest. The potential for these technologies, both as an input to human decision making or as the basis for automated decisions, creates ethical and safety considerations and should conform to relevant legislation and government guidelines.

Recommendations for addressing this challenge

Through the pilots, we learnt what data is contained in commercial systems but the next step is to test whether government systems can use the data that has been extracted from industry documents.

- **Government should integrate industry data into government systems without the artificial "dashboard" element used in pilots.** The development of a sandbox/ technical demonstrator would represent one high value step towards this, allowing the government to assess the scope for structured upstream trade data to meet official border requirements, and border compliance process use cases, and how to scale and automate transfers of data from industry into government.
- **Government ought to undertake a programme of work, collaborating with industry and internationally, to fully understand and identify how to address the barriers preventing mass adoption of digital, machine readable, interoperable commercial documents**. Government should:
    - Lay out an EoT interoperability roadmap for how government can best support industry to solve these problems, looking at how structured data and new methodologies for making it accessible will increase the suitability of information for machine/automated processing and integration into government systems.
    - As part of this, the EOT Interoperability Working Group - an existing industry-government working group set up to support the pilots - should continue to work on upstream data analysis collaboratively with standards experts and industry digital experts. A focus will be placed on upstream structured data and whether new standards are required to capture it and make it useful at scale.
    - The National Trade Facilitation Committee will provide a key UK forum for steering this overall program of collaborative work between industry and government.
- **Government ought to continue developing the variety of ways by which data can be exchanged between supply chain participants and government agencies at the border.** One of which is a signals-based approach (see Section 4) where development of government-hosted signals infrastructure needs to be considered in the light of priorities for the UK Single Trade Window programme, but in the meantime the obvious next steps are to:
    - Design the protocols to govern the exchange of signals with industry. The focus would be on establishing an approach that creates minimal barriers for traders or government agencies that want to try out the approach and we believe It should be possible to design a protocol that allows new signal publishers to start up, or for new types of signal to be created.

- Enable opportunities for government departments to share insights and decisions with one another where this is not possible today without running expensive data integration projects.

B: Need for better legal and governance arrangements between parties

Before commencing the pilots, data sharing agreements were concluded between industry and each government department and agency so that industry data could be sent to departments via operational data transfers or accessed on dashboards. This proved challenging and resource intensive for both government and industry. There are a series of legal and governance issues to unpick but overall, in order to effectively operate a scaled model of multilateral commercial data sharing which underpins the EoT model, we need to make the legal/governance issues clear and easy to navigate.

Firstly, the government should explore what powers it needs to collect and use new supply chain data to best suit its border processes. Government may need new powers to collect, use and share (within government) supply chain data as it sets up the STW, and as part of this, develops capabilities for the enhanced data provision from the supply chain. For example, some central government border departments may require new powers to collect additional data from the supply chain and transmit of information from and to supply chain actors (for instance to collect new types of data in an automated way from new sources of information, and providing additional, more granular feedback to supply chain actors). In determining whether legislative changes are required, departments will carefully consider the future data collection activity they will need to operate the EoT model.

Given the number of actors across industry and government who need to access the data it is critical that access control, liability, ownership and other key concerns are addressed sufficiently well by business, contractual and governance arrangements.

The ability to accurately link the digital footprint with the physical movement and ownership of goods is critical to the rapid identification of the source of a problem in a supply chain. As these goods move between multiple parties (exporter, shipper, haulier, importer etc.), building a golden thread of traceability information that can be easily exchanged is a challenging process. Individually negotiating legal documentation underpinning point to point data transfers at each stage of the supply chain is a lengthy and resource intensive process.

Most EoT consortia provide their data through a shared system of record. This captures authoritative information incrementally as supply chain actors contribute the data they are responsible for, and provides second hand access (mostly) to ecosystem participants who need to see it. For example, the FSA might want to onward share insights it gathers from supply chain data with PHAs and Local Authorities. Individual point to point data sharing agreements with hundreds of local authorities can make that process of sharing very challenging. Most point-to-point agreements will only allow for information to be onward shared on a case-by-case basis. This approach is neither scalable nor feasible with an ecosystemic approach to information sharing.

The next stage of EoT needs to focus on alternative data governance mechanisms, and governance that is co-designed and co-evolved cooperatively by regulatory authorities, industry and trade associations and other external experts so it meets the needs of modern data sharing.

Recommendation to address this challenge

- **Industry and government will need to work together to find solutions to the legal issues around new capabilities,** including: data access and acquisition, data ownership and liabilities, privacy and permissions, anonymisation, data interpretation and how far data can move in a supply chain. Government will work with the International Chambers of Commerce who have created a core set of techno-legal resources to understand whether these can be endorsed by industry and government. For example, multilateral share agreements (i.e. collaboration agreements) may solve some of these problems for business-to-business and business-to-government transactions, and can be deployed repeatedly in a number of ecosystems. A prototype exists which can be tested with departments and consortia. In the longer term there is industry desire to transition to more digital forms of information governance, with multilateral share agreements potentially governing individual digital transactions in a more adjustable way.

C: Make rapid progress on operationalising and scaling the EoT model

Multiple systems for businesses to share assured supply chain data to support trade processes were demonstrated through the pilots, and some are already making supply chain data accessible to the government. The task now is to open this opportunity to all and to set the conditions for further supply chain data sharing networks, or EoT hub systems. to be created and scaled. Therefore, we have to prioritise producing clarity around what an EoT is and set formal requirements.

To do this we need ongoing industry and government collaboration to ensure the EoT model meets requirements for both. During the pilots we established an EoT Interoperability Working Group to tackle the technological issues arising in setting up and running the live supply chain data sharing networks between commercial participants and government. We want to continue this, broadening it out to include participants and issues from other sectors - like trade finance - who want to be part of trade ecosystems and who face similar issues.

While we know we need to extend participation as we establish a pathway for the EoT model to operate at scale, we want the six EoT pilot consortia to remain core contributors to this work. The pilot consortia have been indispensable for the last year - giving us their energy, expertise and time - and many of the consortia remain intact and will continue delivering data to the government even as the pilots end. We want all consortia to stay in our working group.

Government must work with other countries to encourage them to collaborate with industry and government in developing the emerging EoT approach with a special focus on working with other countries when trade digitalisation and interoperability issues arise. The pilots included international partners but working with more countries will allow us to increase trader confidence that trade corridors support their digitalisation efforts on both sides. Trade needs to know that regulatory authorities are in this for the long game. A concerted effort

with regulatory authorities, trade associations and standards bodies advising and enabling trade via the EoT approach will be far more likely to meaningfully increase adoption.

Recommendations to address this challenge

We want to encourage trade digitisation and the proliferation and deepening of EoT hub systems. Government can support both by taking practical steps, for example providing a framework of what is required in order to be part of the model to make it easier for industry and for international partners to understand how to interoperate with government. The UK has an opportunity to be influential (and to encourage particular models and standards, and digitisation) if it acts quickly. In order to create the correct environment for digitisation and more supply chain data sharing networks, we recommend that:

- **Strong coordination across government is needed going forward, with a core team coordinating the development of EoT hub systems across the multiple government departments and agencies who will use supply chain data to enhance risking operations and reduce the burdens to trade, and the STW.** It's important to do the work on a cross-government basis because, as demonstrated in this evaluation, the benefits of the EoT model and better data are multiplied when more departments are involved and able to explore and adopt new capabilities.
- **Government prioritises maintaining the momentum around strong collaboration and co-design of the EoT model with industry and other experts.** We have the existing EoT Interoperability Working Group which will continue and be broadened to other relevant sectors. This group will dock into wider governance concerning border transformation including the STW Trusted Trader and TOM implementation.
- **Government should continue to undertake practical activities at pace to develop the EoT model. This should include developing an EoT Maturity Assessment** as a way of testing the viability of potential EoT hub systems in terms of meeting the requirements of government and other key participants in the EoT model. Industry needs a clear checklist for what good looks like including government requirements and other standards. The assessment is likely to be tiered, so the most basic supply chain data sharing networks can see how they need to develop. Example criteria include:
    - The requirement to provision a subset of fields relating to 'pre-notification' for multiple control regimes.
    - Ensuring sufficient data portability is in place through export functions.
    - Evidence that security and cybersecurity are designed into the EoT product sufficiently.

    - Availability of an operational file export capability which provisions for several established data formats compatible with regulatory authority needs.
    - Availability of structured machine readable data in addition to the more traditional digital documents.

- **Government wants the EoT pilot consortia to remain core to its next stage of work, while broadening industry engagement out to more companies and other sectors with similar issues.**
- **Government should agree an EoT transition plan** for the next year so existing consortia, and new industry partners, know they are operating and information sharing sustainably, with government endorsement and help.

D: Clarify how the EoT model can progressively release value to government and trade

We must clarify the value proposition that developing and participating in the EoT model will provide to government and to trade.

The pilots have shown the EoT carries material benefits for government and trade, but there are significant uncertainties on their exact magnitude. There are up-front costs to the system and process changes which will be required in implementing the EoT model and government and particularly industry will need a compelling business case.

For government, industry can provide most of the data fields wanted and at the right time, so there are opportunities to have an enhanced set of information available. To use the S&S regime as an example, during the pilot a number of the consortia established prototype solutions to demonstrate how data derived from commercial documents could be used to provide the minimum data set proposed for S&S entry summary declarations (ENS). Deriving this data from business documentation, when contrasted with the existing process used to submit ENS data, suggests possibilities for improvements to the current pre-arrival data collection process:

- There are opportunities for the EoT model to deliver an early provisional view on goods movements in advance of current S&S deadlines.
- Opportunities to improve the capture of the ‘original consignor/final buyer’ - this data is generally required in the business documents used to organise trade but is often omitted from ENS entries today.

For industry, we have laid out how the model could create material savings, for example reducing the ongoing costs to industry of providing data to government to meet official border requirements. However, there remain gaps in our overall understanding, including the level of compliance improvements that the EoT model could enable. Furthermore, for many parts of industry, much of the value is likely to come when government crafts new Trusted Trader schemes around tech and data capabilities and new assurance flows, and when

government has the confidence to offer trusted traders new facilitations. The TOM notes government's long-term aspiration for a single cross-government Trusted Trader scheme but in the short term departments like Defra are designing their own specific schemes.

Another way to provide value back to trade is to apply new capabilities to areas we know are a "trader pain point" or where there are stoppages to goods flow. That will take ongoing government-industry collaboration so that we can collectively work out where it is best applied to border processes. So far we have worked with a core of Defra, FSA, Home Office, Border Force, HMRC but we know there are other use cases for better data (within the Office of Product Safety and Standards or the Forestry Commission for example).

The economic analysis developed as part of the evaluation of the EoT pilots provides a good starting point for robust, consistently specified quantitative assessment of value of the EoT model both at an individual department or businesses level, and system-wide level. Government will build on this as we develop our assessment of the value released and upfront costs of the EoT model, providing business and government with the basis for better informed, more certain decisions on whether and when they should invest in the range of capabilities which underpin the EoT model.

Recommendations to address this challenge

Government needs to identify precisely what data and assurances it needs in order to operate high quality border processes, so that industry can attempt to provide them. Equally, reducing trade frictions is a priority and government will continue to work with industry to identify ways to incentivise trade so that new information flows between industry and government can be established and adopted.

- **Government should continue identifying ways to incentivise trade so that new information flows between industry and government can be established.**
    - Border departments and agencies should ensure that the necessary resources are available to coordinate activity developing the EoT model; including determining where border processes would be improved by the availability of supply chain data, or other types of assurance described in this report.
    - Departments and agencies should continue performance and economic analysis of the EoT model in order to evidence the benefits being offered so the government and industry can make decisions around future investment decisions.
- **Government departments need to understand how best to exploit new data flows that the EoT model provides, including the enhanced data provision from supply chains that will be supported by the STW.**
    - All departments have varying requirements for supply chain data so they will have different programmes of work around how they incentivise its capture, and use it once it is received. All departments should nominate

representatives to the EoT Interoperability Working Group and contribute to the interoperability solutions being devised.

- Other activities that departments will need to consider in order to take advantage of new data made available by the EoT model include determining how new data allows them to fulfil their objectives in new ways, for example, allowing them to omit particular requirements for paperwork, amend particular data field requirements in declarations, amend risking rules, amend targeting strategies, or have different physical check rates where data provides adequate assurance.
- Industry has proven that it can provide the most desirable data fields when it knows what government wants to receive. Departments will want to assess and articulate what high-value data it currently lacks, or has insufficient assurance of and identify the priority areas for further development work with industry.
- The EoT Interoperability Working Group will work with departments and industry to understand the business processes it is necessary to orchestrate within the EoT model. This will help ensure that the representations being presented for trade data are compatible with the needs of actors consuming trade data. In addition the picture on information traceability and provenance will be improved.

- **Industry and government ought to further explore use cases for augmenting technologies and test practical deployment of devices at greater scale,** taking into account issues around the critical mass required before they could be used in any controls. In particular there is Home Office appetite to understand augmenting technologies better including the value of multiple assurance sources corroborating compliance results, how they could make risking processes work better and ultimately allow the redesign of border processes. For example, during the pilots, aggregate assurance was provided through the structured data presenting journey details on top of both journey tracking data collected by smart seals and invoices presenting more accurately the country of origin. Given that presence of smart seals gives targeters greater confidence and may be a key data field to use when aggregating assurance, sufficient field testing should be conducted to test their benefits (including whether the devices are fool-proof as this would improve targeting confidence).
- Some recommendations are specific to departments:
  - **For HMRC specifically,** we recommend
    - assessing how augmented technology and the EoT could support customs with processes to supervise goods entry into GB for inland inspections for pre-clearance checks.
  - **Defra's announcement that it will develop a new Trusted Trader** scheme is a positive development that ought to utilise aspects of the EoT

pilot learnings and apply them to the SPS compliance regime. Defra will define their scheme's requirements but given what we have learned through our piloting work on technology and data, we recommend that Defra incorporate the use of supply chain data and telematics to test real facilitations in the pilots, and consider potential wider benefits, particularly around health certification, in the longer term. we have elicited new use cases for tech and data capabilities that can balance biosecurity with alleviating trader burdens - like the ability to obtain industry imported food and feed testing or sampling data - which would improve Defra/FSA's understanding of food and feed safety compliance levels and potential emerging risks.

- **For the FSA specifically,** we recommend that:
  - The FSA should consider assessing an automated feed of structured data, along with PHAs and LAs, to assist SPS import operations at the border. Specifically, we recommend that FSA focus their assessment on documents they have identified as being potentially valuable like CHED-P, CHED-D, Export Health Certificates and Certificates of Analysis.
  - The FSA should assess whether industry systems can fulfil the remaining risking data fields that were missing during the pilots and understand how to improve consistency of data collected through supply chain documentation.
- **For Home Office and Border Force,** where there is potential in accessing supply chain data for improving their risking methodologies so long as accessibility issues can be resolved, we recommend that:
  - **Industry needs to know where particular documents and data are required in order to improve targeting outcomes for compliant traders and to make those available to UK government.** Some data fields and documents provided very high levels of confidence to Border Force but were provided inconsistently. We recommend that Border Force and Cabinet Office perform a joint discovery exercise with industry to determine why this inconsistency occurs.
  - **We recommend that Border Force, HMRC and Cabinet Office organise a set of focused co-working sessions with Industry to determine the value and effective use of specific documents - eg Road Consignment Note, Packing List.** There were a number of issues and inconsistencies preventing these documents from giving targeters high confidence so departments might assess how to use them more effectively.

- **The Home Office, as part of its work on Border Transformation, ought to further explore augmenting technologies. Particular focus should be given to whether and how they could enable new border processes, including potential checks away from the border.** Due to the short pilot period, the availability of some of the technologies and limited budget the Home Office was unable to conduct as rigorous testing as they would have liked.
- **We recommend that Home Office and HMRC** assess an automated feed of pre-arrival structured supply chain currently unavailable to government (based initially from specific key supply chain documentation found to have been useful during confidence scoring exercises) with other participating departments to assess operationally whether they can be used for risking and compliance purposes. For example:
    - Test whether the supply chain data can fulfil core S&S requirements at scale in Government risking systems.
    - Where supply chain data was able to fulfil these requirements, make comparisons of data timeliness, accuracy & reliability with that of current S&S data.
    - Test at greater scale, in a real-time operational environment, the value of data fields, not currently provided through border control regimes, in improving the outputs of risking systems.

E: Single Trade Window as the key enabler of the integration of supply chain data into the UK border model

The STW will become the single digital gateway at the UK border for traders to complete their import, export and transit obligations. It is a fundamental enabler for a range of ambitious government border transformations including supply chain data integration into the UK border model. STW aims to be fully operational by 2027, and to support data provisions from commercial supply chain systems by 2025. Supply chain data provided to the STW will be accessed and used by government departments and agencies. Diagrams at **Annex B** illustrate how the EoT interacts with the global trading landscape and the STW respectively.

There is a synergistic relationship between the program to design and deliver the STW, and the development and implementation of the EoT model. The findings of the EoT pilots help inform the design of the STW functionality, supporting more automated provision of high quality supply chain data directly from businesses' systems, which when implemented will be a key enabler of the EoT model.

The STW user research and co-design that will be undertaken to further develop the design of this planned functionality will help inform the design and refine our understanding of the

benefits of the EoT. For example it will assess how the integration of supply chain data integration into the UK border model could best support the reduction in administrative burden from providing formal declarations and support more accurate and timely data for performing government risking operations. The EoT pilots have shown us that border agencies want to receive data in various ways, supporting different operational use cases. Government built, owned and operated APIs should be the key mechanism for providing supply chain data to the STW, enabling accessibility to all without conferring competitive advantage on particular companies.

Some border departments and agencies want to receive data in other ways, through the receipt of "signals" (see Chapter 4 for description) or through amalgamating newly available, raw supply chain data into central risking systems where it can be processed with other data to inform decisions. In these cases, the delivery of different supply chain data integration patterns will be addressed by the STW programme in planning the scope of future Strategic Releases. That means working between industry and departments, with support from the STW programme, to design the protocols and infrastructure that departments will require in order to receive data they need.

Recommendations to address this challenge

- **The STW will undertake user research and co-design to inform the design of functionality, planned for first release in 2025, enabling enhanced data provision from supply chains to the STW.** This will examine how the integration of supply chain data into the UK border model could best support the reduction in administrative burden from providing formal declarations and support more accurate and timely data for performing government risking operations.
- **In developing the capabilities supporting supply chain data exchange with commercial systems, the STW programme should:**
    - **Minimise costs to the taxpayer by enabling and encouraging third party vendor systems**, including EoT hub systems. This will increase sophistication and innovation present in solutions presented to traders and other supply chain actors. It will also minimise dependency on government products and support.
    - **Only build government software where there is a clear need**. Where software (eg websites, mobile apps etc) is created, it ought to be designed to adhere to government APIs standards. Over time, harmonisation of data standards can also simplify these transactions.
- **The STW's supply chain data exchange capability has strong potential to be an innovative feature** given the industry appetite and proven benefits of delivering supply chain data to government. The EoT is progressively deployable, so it is possible to initially leverage just a subset of capabilities e.g. automated customs declarations compatible with HMRC's systems (with virtually no cost in terms of time or resource to UK government) and build from there.

- **The STW should consider piloting integration with commercial supply chain systems, such as those tested as part of the EoT pilots, to inform the design of planned Strategic Releases.** This would build on the industry appetite and proven benefits of delivering supply chain data to government demonstrated by the EoT pilots. There are a range of design benefits to the STW, including the potential for the data transformation work required to make supply chain data compatible with UK government systems to be simplified as a result of innovation being undertaken by Commercial System Providers.
- Any **legislative powers sought,** in order to enable the STW core functions, should enable government to exploit commercial data when the technology allows.

7. Annexes

Annex A: Rejections Analysis

Each reason for rejection was allocated either:

- ***Resolvable in principle*** - Although it has not been comprehensively tested whether it is possible, it is assumed that this could be achieved as part of a future EoT model. As noted above, this assumption is on the basis that by providing documentation in advance issues whereby the documents are inconsistent, within either the document itself or with other documentation made available, or incorrectly completed, the opportunity could be given to resolve problems in advance and thus prevent delays or rejection. However, this assumption has not been tested via EoT pilots, and there would need to be exploration as to the feasibility, considering the time frames involved, and a cost-benefit analysis, to look at the cost of advance resource and replacement of documentation especially where it requires certification by an accredited professional.

- ***Uncertain*** - It is assumed that the EoT could - for example - signal to government and/or traders that something is not in order earlier in the process, but is unlikely to prevent a given issue from occurring. However over time, the EoT could lead to an improvement by flagging persistent issues.

- ***No impact*** - The reason for rejection does not align with any EoT model capabilities and the EoT is therefore assumed to have no impact.

By using these allocations, we were able to calculate the proportion of preventable rejection under the EoT. For goods with multiple reasons for rejection, it is assumed that:

- A rejection is ***'Resolvable in principle'*** overall if all reasons for rejection are classed as ***'Resolvable in principle'***.

- A rejection is ***'Uncertain'*** if a combination of ***'Resolvable in principle'*** and ***'Uncertain'***.

- There would be ***'No impact'*** if any of the reasons are ***'No impact'***.

It should be noted that the data analysed covers only the rejections of POAO consignments from one BCP and those of consignments received from countries outside of the EU. Other BCPs which received fewer containers and higher numbers of imports via air or road transport are likely to differ in terms of the rates seen for each type of rejection; specifically initial data indicates that whilst cold-chain interruptions make up 2% of rejections at this BCP, this number rises to 9% at one airport BCP. There has been no testing of the sensors that monitor temperature and environmental conditions on airfreight through the EoT pilots to determine whether they would work for imports received via this method. Further, it is reasonable to consider that goods received from the EU may differ in terms of rejection issues to those received from other countries, for reasons which include, but are not limited to, companies being less familiar with processes and different challenges due to the nature

of the product such as “just in time” consignments. As such these figures in terms of the number of rejections which could potentially be reduced by the EoT model, are not necessarily scalable to the whole import market as well as being untested.

These conclusions implicitly assume that the cause for rejection is not malicious intent, which may not necessarily be the case in reality. Furthermore, changes to government IT systems, processes and legislation may be required in order for these results to be accurate, rather than the EoT model being developed in isolation. Business documentation is also assumed to be available, timely and accurate and accessible to government early enough to allow for corrective action.

These conclusions should be treated as hypothesised outcomes rather than an analysis based on known capabilities and outcomes.

The table below summarises the impact that the EoT is expected to have on the various reasons for rejection. This is based on analysis of 746 rejected POAO consignments from non-EU countries at one BCP, observed from January 2020 to December 2022.

Table 17: Potential impact of the EoT model on rejections of SPS imports

Reason for rejection	EoT impact
> Certificate inaccuracies > Duplicated certificates	***Resolvable in principle.*** In principle, signals could be used to provide alerts that machine readable data is missing or incorrect, prompting trader action, although some may require physical intervention to validate. The EoT could also provide recommendations to fill out certain fields. While these signals would not themselves solve inaccuracies, they could serve to inform traders who could intercept and correct these before the consignments reached the border or where the issue cannot be resolved (such as the consignment having departed already) allow for earlier notification of rejection.
> Wrong certificate > No hygiene attestation > No third country handling attestation	***Resolvable in principle.*** In principle, signals could be utilised to provide assurance that a consignment is accompanied by the correct documentation, and alert to missing documentation that would be expected. While these signals would not themselves solve inaccuracies, they could serve to inform traders who could intercept and correct these before the consignments reached the border or where the issue cannot be resolved (such as the consignment having departed already) allow for earlier notification of rejection.
> Certificate postdates consignment departure	***Resolvable in principle.*** In principle, signals could be utilised to provide alerts that SPS goods should not depart without a valid EHC, prompting trader action.
> Certificate and product batch numbers differ > Production dates post certification	***Uncertain.*** In principle, signals could be used to provide alerts that prompt trader action, but it is not yet clear whether this specific capability would be in scope of the EoT.
> Cold chain interrupted	***Uncertain.*** Smart container technology could be used to confirm that appropriate temperatures for chilled or frozen goods are maintained at the correct levels. The EoT could provide signals to traders and the UK government identifying where cold-chains are broken. For traders, this could mean

	identifying persistent malfunctions in the cold-chain, in doing so preventing rejections over time.
> No health certificate	***Uncertain.*** The impact of the EoT on missing health certificates is likely to depend on the underlying cause. It should be possible for an EHC to be constructed by the EoT, but it wouldn't be possible for the system to arrange someone to inspect the goods and sign it off. An underlying operational issue and traders being unaware of their requirements could therefore not be fixed, as these reasons for rejection are not about the data.
> Uncertified ingredients	***Uncertain.*** This issue is rarely the only cited cause of rejection. It is uncertain whether the EoT could have an impact, however if information could be provided to traders that changes their understanding and could facilitate better decision making, then there could be a positive impact in aggregate over time.
> Not appropriately labelled/identified on packaging > Consignment not declared size > Undeclared ingredients, product not as described > Mismatch identification numbers > Incorrect/missing seal number	***No impact.*** The EoT is assumed to have no impact on these reasons for rejection. This is due to the requirement for a physical inspection/examination in order for a good to be rejected for one of these reasons. In the case of a mismatch of identification numbers, it may be possible that with the right technology (e.g. some trialled within the pilots) there could be ways of reducing the opportunities for physical and digital information to be different.
> Packaging damage > Live insects > Lice infestation > Unsatisfactory based on laboratory results > Expired product.	***No impact.*** These are influenced by external factors and would therefore not themselves be impacted by the EoT. However, supply chain data could be useful for supporting tracking and traceability. For example, an event could be traced to be one item in a batch of multiple, it may be possible to avoid repeating UK government actions. Incident investigations might take advantage of batch identifiers to locate other problematic batches and take preventative action.
> Unapproved country > Unapproved establishment	***No impact.*** Signals could identify that a consignment is not compliant with controls at an earlier opportunity, informing better planning and targeting of resources for operational staff working at the point of entry.
> Missing commercial documentation	***No impact.*** This is assumed to not be preventable by the EoT as this would require the checking of business rules. However, the EoT may be able to alert traders that this documentation is missing
> Returned to UK - no evidence of product unaltered > UK RETURN	***No impact.*** These relate to export consignments that have been rejected and as such returned to the UK.
> Personal import allowance exceeded	***No impact.*** This is assumed to be a mistake on the side of the trader that the EoT cannot resolve.

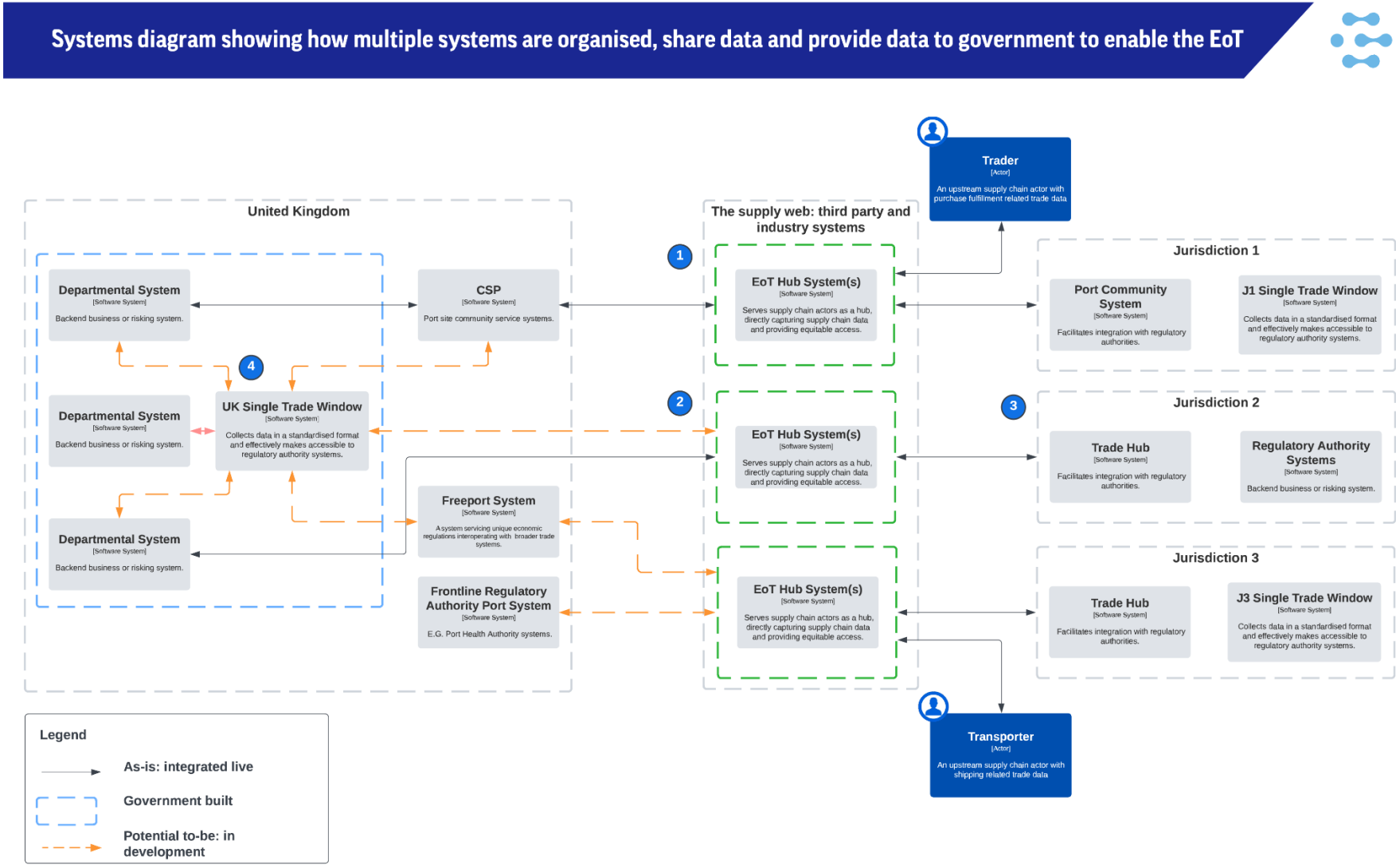
Customs declarations administrative burden analysis

Table 18: Caveats and assumptions to consider alongside this analysis.

Caveat/assumption	Impact on analysis
The analysis assumes that the TOM and STW have been implemented, meaning: • **TOM.** Controls are assumed to apply to EU imports; and • **STW.** Duplication of fields required in customs declarations and already provided in prior declarant submissions has been removed.	N/A - We believe these changes more accurately reflect the future trader experience at the border, and bring the analysis in line with that produced for the TOM and STW workstreams.
This analysis assumes that the EoT would only impact the internal cost associated with submitting customs declarations, which includes the time taken to collect and input the data required for declarations.	If a reduction in manually populated data fields led to a fall in the external costs associated with customs declarations (e.g. agent and software fees), then the benefits presented above would be an underestimate.
The administrative burden of customs declarations ranges from £20-£56, depending on the method and volume of declaration that the trader submits. These estimates were published in 2018, so may not reflect the current costs experienced by traders. Furthermore, these estimates assume that customs declarations from RoW have the same cost as those from the EU.	If the true costs experienced by traders have increased since this analysis was published then the benefits estimated will be an underestimation.
This analysis does not consider declarations associated with fast parcel operators, which typically have a lower administrative burden associated with declarations. This is due to a lack of information about volume and administrative burden for these operators	This has the effect of underestimating the potential benefits compared to if fast parcel operators were in scope.
This analysis assumes uptake in line with the upper and lower bounds of uptake in the Electronic Trade Documents Bill Impact Assessment.	This is the primary reason for the large range of benefits, as the 10-year adoption rate ranges from 10% to 80%.

Annex B: Systems diagram

Figure 10: Systems diagram showing how multiple systems are organised, share data and provide data to government to enable the Ecosystem of Trust.



This systems landscape diagram captures at the highest level all of the systems that are part of a number of trade corridors, demonstrating how they interrelate and what their responsibilities are.

1	EoT hub systems are scaled to operate in the middle of trade corridors supporting interoperability between a range of commercial and institutional actors according to the business, operational and policy intent set out in underpinning agreements.	**3**	EoT hub system already provision for a wide spectrum of different trade systems operating in other jurisdictions including; trade hubs, Port Community Systems and Single Trade Windows.
2	EoT hub systems are typically cooperatively operated within a governance framework designed and implemented to provide more highly assured and standardised data and documents to all supply chain actors within the network who need them.	**4**	The Single Trade Window captures the data made accessible by EoT hub systems and benefits from the form that data is received in - it may be re-routed to where it needs to be in government systems without transformation (e.g. converting to new standards or cleaning) and with critical aspects of governance provisioned for (e.g. ownership, liability).

Annex C: Standards of note

This is a non exhaustive set of standards, using the Digital Standards Initiative as its principal source. Additional sources consulted include:

- W3C Verifiable Credentials Data Model
- Verifiable Credentials for Cross Border Trade

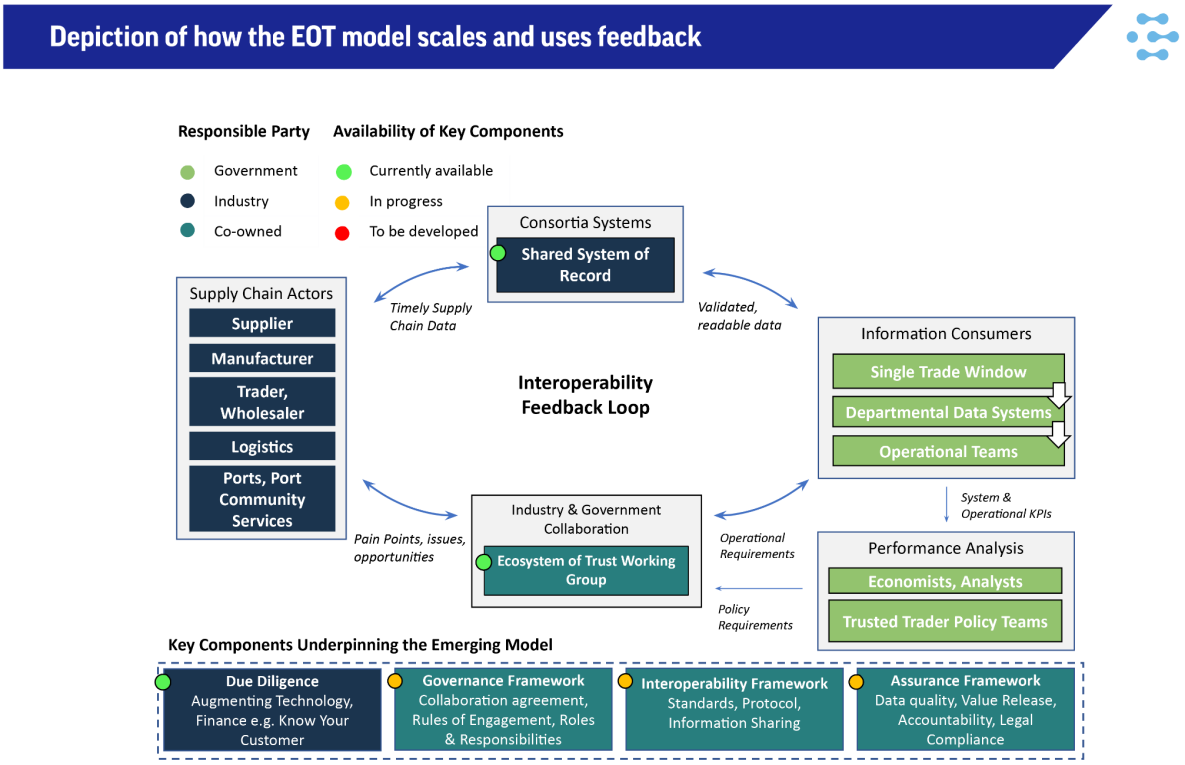
Standard Codes and Identifier Schemes	Examples
Foundational: It is useful to start with foundational standards as they are well known across both government and industry and thus part of an established best practice. ISO standards especially are atomic and composable and often underpin higher level standards.	ISO 3166-1 (Country code) ISO 6346 (Freight containers) ISO 8601 (Date and time) UOM (UN Unit of Measure) MLETR (UNICTRL Model Law on Electronic Transferable Records)
Identity standards permit a universal view to be formed over a set of information elements. This permits mapping to be undertaken to understand whether organisations are deploying their expertise over the same information.	Product Code (HS Code – Harmonised Commodity Description and Coding System) LEI ISO 17442 (Legal Entity Identifier) and GLIEF FIDO (multi-factor auth, passwordless sign-ins, biometrics) DID (W3C Decentralised Identifier) ISO 14533 series (Electronic Signatures) EORI (Economic Operators Registration and Identification number) ISO/IEC 15459 (Unique Identification System - GS1, FIATA, UPU) IMO (Ship Identification Number System) Global Product Classification (GPC - GS1)

Clearance and Tracking	IMO Compendium DCSA Interface Standard for Track and Trace ISO 24533:2012 Intelligent transport systems
Attribute/Attestation and Information Sharing	ISO/TC 307 Blockchain and distributed ledger technologies Verifiable Credentials (Open cryptographically secure, privacy respecting and machine verifiable information sharing) Open Attestation (Document Endorsement and Verification Framework)
Semantic Reference Data Models	UN/CEFACT Global Supply Chain RDM (BSP RDM) WCO Data Model
Trade Artefact	Commercial Invoice (CII - UN/CEFACT Cross Industry Invoice subset of UN/CEFACT BSP RDM) Certificate of Origin (ICO COO) and Pref COO (subset of UN/CEFACT BSP RDM Bill of Lading all aligned subsets of UN/CEFACT BSP RDM (BoL – DCSA eBLs, BIMCO eBLs, FIATA eFBL) Air Waybill (IATA e-AWB) based on IATA Cargo XML aligned to UN/CEFACT BSP RDM eCMR - Road Consignment Note (subset of UN/CEFACT BSP RDM CIM - Rail Consignment Note (subset of UN/CEFACT BSP RDM) Packing List (UN/CEFACT Cross Industry Export Packing List - subset of UN/CEFACT BSP RDM)
Assurance/Quality. The EoT looks specifically at supply chain visibility issues related to securing critical supply. Several consortia move shipments of food for example.	ISO 9001 (Quality Management) SO 22000 (Food Safety) HACCP (Hazard Analysis and Critical Control Point) CoA (Certificate of Analysis)
Regulatory	Import Declarations (e.g. H1) IPPC SPS (which aligns to UN/CEFACT eCert - subset of UN/CEFACT BSP RDM) S&S (which aligns to SAFE – WCO SAFE FoS Framework of Standards to Secure and Facilitate Global Trade) Codex Alimentarius (CAC FAO, Defra, FSA - aligns to UN/CEFACT BSP RDM) Electronic Trade Documents Bill Uniform Rules for Digital Trade Transactions (URDTT), URC 522 and other
Hardware standards (Container Security Devices CSDs, Digital scanners, Smart Labels etc)	ISO 10374:1991 (RFID automatic identification) ISO 10891:2009 (RFID - supersedes 10374?) Other ISO RFID standards ISO 17712:2013 (Freight containers – Mechanical seals) ISO 18185 (Freight containers - Electronic seals) DBM Phase III TM Catalyst – Secure Supply Chain Intel Secure Device Onboarding (SDO)
Operating standards	WCO SAFE Framework UN/CEFACT Business Requirements Specification for the global supply chain procedures (BSP BRS) Collaboration Agreements (Multilateral Share Agreements)

	Trust Frameworks Usability (including searchability, facilitation for export and copying information) Accessibility Data portability Sustainability

Annex D: Creating an emerging EoT model

Figure 11: Depiction of how the EOT model scales and uses feedback



The diagram above shows how government and industry might begin building and scaling an EoT. The interoperability feedback loop is first driven by small amounts of timely, validated supply chain data feeding into a single compliance regime (initially) which can then be evaluated by government and subsequently with industry in collaborative forums such as the Ecosystem of Trust Interoperability Working Group. Any learnings and requirements that are found from this evaluation are fed back into the feedback loop to help drive further positive impacts - continuing the cycle. This emerging model should also help develop a further set of critical capabilities underpinning the model, which have been identified as being necessary for a mature EoT, which are described below.

Capabilities

Shared system of record - All the solutions have a mechanism for recording information about the business processes related to the buying, selling and transportation of goods

internationally. The technical architecture of these solutions varies and these details are not particularly important for understanding the model. The key properties of the solutions are:

- Provision of **authoritative** data: information is contributed by the person or organisation where it originated, rather than passed on second-hand.
- **Incremental** collection of information: Data is contributed at the point it is created and added to as new information is made available.
- Provision of **transparent** data: data is available to all supply chain organisations (including regulatory authorities on both sides of a trade corridor) at the same time.
- **Immediate** access to information: participants in an ecosystem or information sharing network must have the **option** to access information directly from the system of record, data platforms and other sources of transformation must not be the **only** means by which information can be accessed.

These features help avoid some of the issues we see in the current declaration processes where data is typically subject to complex collection and processing activities - which can result in the degradation of parts of the data, which commonly occurs in good descriptions and buyer and seller details - prior to arranging it for it to be delivered according to government deadlines that are not always synchronised with business processes trade are involved in. Specifically we know through prior projects and consultation with industry that the information regulatory authorities can omit important details, such as true buyer and seller details (agent to agent details are provided instead), that are available earlier in the supply chain through upstream systems.

Some aspects of the EoT Systems of Record vary between deployments. This is important to understand when instances of the model are assessed to understand maturity and fit.

- Some features only make sense for particular industries or modes of transport and therefore vary depending on the markets and trade corridors the EoTs operate in. For instance, GPS tracking devices are more applicable to RoRo trade than for trade being moved by containers.
- The number of supply chain organisations participating in the solution can vary according to the benefits each organisation derives from the solution (the most complete picture will be established where the entire supply chain actively participates in the solution)

Augmenting technology - Many of the EoT deployments use internet-enabled devices (also known as *Internet of Things* or “IoT” devices) to help secure and track the movement of goods. However there are many limitations to these devices that are detailed in chapter 3. These IoT devices can be broadly classified into two categories:

- **Smart seals:** have features that allow the location of goods and integrity of the load to be tracked. They can typically record opening or tamper events and detect when equipment enters specific locations (“geofencing”). Smart seals are usually attached to the doors of the transportation unit.

- **Smart sensors:** are generally GPS enabled, permitting the same type of location features as smart seals, and are also equipped with environmental sensors (light levels, humidity, temperature etc). The devices are generally inserted with the load and are used commercially to track the integrity of the goods. Correlation of sensor data (for instance a spike in light & CO2 corresponding with a signal that the vehicle is stationary) may indicate the unit has been tampered with.

This type of technology can also be permanently built into transportation equipment, and are called “smart containers” or “smart trailers”.

Two types of “passive” devices (i.e. devices that do not requiring a power source) are used:

- **Electronic labels:** These generally contain a QR code, URL or radio frequency devices that, when scanned, will redirect the user to a website. The website might provide information about the goods or provide services that allow approved users to submit or review other data related to the item, for instance data about the production, distribution, status and location of the goods.

- **Electronic seals:** contain a radio frequency device that transmits information when scanned by a portable reader device. The devices can only be read when closed and undamaged - once opened they will no longer transmit identification information, thus alerting the scanner that the seal was broken. Although these devices are not GPS enabled a rudimentary routing picture can be obtained from scan events which are tied to the location where the scan occurred.

The telemetry data generated by augmenting technology is available inside the EoT solutions and allows data about the physical status of the goods to be combined with data and business documents associated with the commercial transaction which helps provide a more complete picture of the import or export event.

Utilising existing due diligence processes - Many industries have well established controls that increase transparency for supply chain participants and provide assurances that goods are delivered as per the original invoice. Although these processes are generally designed to protect the commercial interests of the organisations involved, this information might also be utilised to inform government decisions about the application of border controls.

EoT systems provide a mechanism for the events associated with this type of due diligence - for instance the result of in market checks, commercial due-diligence, supplier life-cycle management etc - to be shared with other parties operating within the ecosystem. There would need to be exploration of how consumers would receive and access this information as well as in-depth investigation into the requirements of the schemes and whether they aligned with participant needs, to determine if there is any benefit to be unlocked through utilising such data.

There is a risk that attempting to utilise the processes in place for commercial and quality purposes for SPS and public health purposes creates additional work, due to the need to continually audit external parties, ensure outside controls do not deviate from government

legislation, and ascertain which processes would need to be performed by government as they are not relevant to other procedures.

Through the incremental collection of more highly assured and transparent supply chain data EoTs can synthesise new information from the data they accumulate, for instance by making connections between events or parties involved that were not obvious in the original transactions or by overlaying analytics to help corroborate information or to identify patterns or anomalies.

This move to leveraging the results of the deployment of expertise over data at remote sites will benefit all parties participating within EoTs, reducing the volume of data that regulatory authorities and industry must make sense of. The potential for a smaller “data footprint” has the potential to reduce the associated data security risks, and the financial and environmental cost of collecting and storing data.

Frameworks

Three frameworks support the development of EoT solutions:

Interoperability framework - This framework ensures interoperability between the systems of all participants operating in information sharing networks, permits a broad range of technologies and information sources to be used in the EoT environment and guarantees that regulatory authorities and industry may communicate across many trade corridors in a world where technology is rapidly evolving. This framework covers:

Standards

- Working to increase awareness of the ICC, UN/CEFACT and WCO Digital Standards Initiative (DSI) which outlines tried-and-tested data standards from organisations such as ISO, GS1, UN/CEFACT and WCO in addition to commonly used hardware, quality and regulatory standards.
- Ensuring interoperability progress is made through the adoption of a model, standards, scheme, technology and vendor agnostic approach, permitting EoTs to be used as part of solving the broadest possible range of business, customer and policy needs.
- Improving access to good documentation to reduce the complexity of integrating with the EoT environments.
- Promoting efforts to fill gaps in the standards for emerging technologies like IoT.
- Co-creating and co-evolving new standards within the context of the DSI where necessary for example where new categories of information are being made available.

Information sharing

- Data access patterns: explaining the supported patterns for data exchange, from the traditional model submitting declarations and licence applications through to new

patterns such as Signals that enable the multi-directional exchange of information about events occurring in the supply chain and recommending the circumstances each model is suited to.

- Technical integration patterns: providing guidance, test facilities, documentation and support to help participants to integrate with an EoT service
- Event Based Supply Chain Data (EBSCD): describing the set of supply chain events that all categories of EoT participant are interested in some subset of. The EoT approach to onboarding supply chain documents, availability of structured data and minimum supported data sets all contribute to this event set, improving it over time ensuring it can answer to a broader set of business, policy and trader needs.
- Workflows: overview of the mechanisms that will allow new business processes to be established based on data made available via EoTs

We have begun to tackle aspects of the Interoperability Framework through the pilot, but one of our core recommendations is to prioritise and complete this work by joining up cross-government in the Borders digital space.

Governance framework - This framework will attempt to move beyond MoU-based data sharing solutions - which tend to be bespoke, inextensible and point-to-point solutions that are hard to repeat or scale - towards a Collaboration Agreement (multilateral information sharing agreement). Government solicitors are currently considering the proposed Governance Framework.

The Governance Framework looks to augment the legal and technology-legal public contractual work being undertaken by the ICC an example of which is the Electronic Trade Documents Bill.

Assurance Framework - A good assurance framework will incentivise the onboarding of users to an EoT model through guarantees of a level playing field, information accuracy, an understanding on how liability works and the ability to resolve issues. The framework will cover:

- Data accuracy
- Data provenance and traceability
- Corroboration via attestations
- Data portability
- Release of value to customers
- Usability (including searchability, and convenience data extraction mechanisms)
- Accessibility
- Observability and measurability

- Accountability
- Legally compliant

It is the Assurance Framework that will bridge from deployments of the EoT model to the relevant requirements in government Trusted Trader schemes and potentially to the business, operational, policy and scheme needs of regulatory authorities across multiple jurisdictions.

Further work is needed to establish the Assurance Framework (departmental engagement will be crucial since this framework will outline any easements or facilitations offered to EoT participants and will permit participants in EoTs to form their position in terms of confidence in the information being made accessible by them and therefore inform on how supply chain data may be used in risking).

Annex E: Consortia members and expert advisers

Consortia Members	DBM-ATC	Chainvine	Connected Borders	IBM	Azarc	Fujitsu
Consortia Leads	• The Institute of Export & International Trade • TradeMark East Africa	• Chainvine • Contained Technologies UK Ltd	• Palantir • clearBorder	• IBM UK Ltd • Maersk Logistics & Services	• Azarc	• Fujitsu (technology integrator)
Technology Partners	• IOTA Foundation • KATLAS Technology Ltd • SCT Technology Ltd • MCP Port Community • Secure Trak – BT Group • AWS • Beyond now	• Contained.io (Bluering SC and data mgt platform + intruder detection tech) • Chainvine (supply chain data platform) • Infoculture • K&L Gates (smart contracts)	• Capita • Fera Science Ltd • P2D • Connected Places Catapult	• TradeLens • Maritime Cargo Processing plc • Quantexa	• Azarc Rune SC and data mgt platform • Mastercard • Tech Mahindra • BT CCS-UK User Group Ltd • Psyfr	• B4b group (IoT connectivity) • Entrust (digital ID) • Competere (legal advice) • Entopy (supply chain visibility platform) • Fortinus Global (border consultants) • Gatekeeper Security (vehicle and driver scanning) • KGH (customs advisory) • RAS (in-market audit) • Ubloquity (blockchain platform)

						• Vodafone (tech comms specialism)
Academic	• University of Surrey	• Lincoln University (framework) • The Institute of Import and International Trade	• University of Kent		• Coventry University	• University of Reading (automated solutions for the border research) • University of Kent
Traders and Logistics Service Providers	• AB Agri/Premier Nutrition • Olam Specialty Coffee Europe • Vollers UK Limited • The British Coffee Association • DP World – London Gateway and Southampton • Geodis FF UK Limited • Retail Asset Solutions Limited (RAS) • DFDS • Nomad Foods • ECS • Taylors • Dutch Flowers Group	• Wine & Spirit Trade Association • Fetzer Wines • UPS • FreshLinc • CMA • Felix Solis • DHL/Hillebrand • Wine Institute USA • Melon & Co • Agricola Famosa • Greensea Shipping • Concha Y Toro • K&N	• Freight Link • Port of Tyne • Irish Ferries • PwC • DFDS Ferries • Ligentia • Forth Ports • Port of Dover • Eurotunnel (GetLink) • Stena Line	• Wm Morrison Supermarkets • Pure Electric • Westbridge Foods • Hutchison Ports: Felixstowe • Freeport East • Maritime Transport Ltd • Maersk Line, CMA CGM, Hapag Lloyd, MSC, ONE	• Cue the BBQ	• Fujitsu (as an importer) • Jaguar Land Rover • Kuehne + Nagel • McLaren Automotive • NTG Ebrex • Palm Paper • Pearson Education • TAS Valley Mushrooms • Thetford ltd • Unipart Logistics
Technical Support	• Forum for the Future					
Expert advisers	Sue Probert (UN/CEFACT), Oswald Kuyler (International Chamber of Commerce), Mike Brookbanks (University of Surrey)					

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