

Insights and learnings from the Food Standards Agency (FSA) exploring the use of Blockchains

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Summary

The Food Standards Agency (FSA) is committed to ensuring food is safe and what it says it is. The FSA hypothesized that distributed technologies such as blockchain could be beneficial to the operation and visibility of the food supply chain by moving beyond point to point information sharing to one that provided a greater representation of the distributed nature of the supply chain.

The FSA delivered two blockchain pilots on meat traceability between 2018 and 2019 in collaboration with the food industry, one on Export Health Certification and another on the Collection and Communication of Inspection Results (CCIR). The FSA is currently supporting a third pilot on Australian Wine Imports led by HM Revenue and Customs (HMRC).

The [first two pilots](#) were reviewed by Dr. Garrick Hileman. The review suggested that the use of distributed technologies such as blockchain could offer real potential benefits to enable improvements in safety standards and quality of food. The underlying technology is not a challenge to implement. However, it became clear that many of the layers of policy, trust, legal frameworks, process and data definition and ease of interoperability between all participants in any particular chain are hurdles that need to be decoupled and overcome to ensure that blockchains deliver the promised value to the food supply chain. To unpick the different layers, the FSA considered the principles of Data Trusts, explored by the Office for Artificial Intelligence (OAI) and the Open Data Institute (ODI). The Data Trust work is being delivered in collaboration with Lincoln University.

In parallel, the FSA are using the emerging legal models from the Data Trust work in collaboration with HMRC and Future Border programme to develop a standard set of technical tools to share the minimal amount of data, as products move across the border, by making use of privacy enhancing technologies. The approach is being called the Open Ecosystem Federation (OEF). The output is a technology agnostic toolkit that enables collaboration between people, organisations, and machines in a way that is scalable, repeatable, and extensible, essentially creating standards that

enable multiple ecosystems of Government, industry and other participants to work together.

The work on the Data Trust and OEF has links to strategic work planned by HMRC around a platform approach called the Utility Trade Platform (UTP) under the banner of a supporting framework known as the Centre for Distributed Systems (C4DS). The C4DS would provide a framework for the public sector, private sector and academia to collaborate in the application of distributed systems. Both the UTP and C4DS are in the proposal stage and being developed by HMRC's innovation team.

This paper recommends that FSA continue to provide the impetus for creating innovative solutions to improve traceability and transparency across the food supply chain by working collaboratively with stakeholders across Government and industry.

This paper has been written with support from the digital research and advisory company: [Leading Edge Forum](#).



The FSA and Blockchain

The Food Standards Agency (FSA), have a commitment to make sure food is safe and what it says it is by increasing transparency and processes used in the food supply chain. The 'Food we can trust' strategy first outlined in 2015 has led the agency to explore approaches to increase integrity and veracity to the processes and data used across food supply chains.

The FSA hypothesised that blockchain could be beneficial to the operation of the food supply chain by increasing visibility, transparency where there is clear benefit and improved use of data. The FSA wanted to move beyond the point to point information sharing paradigm to one that provided a greater representation of the distributed nature of the supply chain and one that might be able to see further than, one up, one down.

From an FSA perspective, it was important to demonstrate the opportunities and engage key participants in the food supply chains to explore the practicalities of operationalising a blockchain based solution at scale. It wanted to understand its potential role as the regulator if blockchains were being used in the food sector.

The FSA is also interested in ensuring that any industry wide solution is underpinned by an operating model which enables low barriers to entry, avoids vendor lock in and enables standards led data and information exchange. This is to inform future activity or next evolution of the strategy, which with the exit from the EU, future trade deals and more recent focus on post-COVID supply chains, would increase the emphasis on ensuring transparency and efficiency in food supply chains.

A 'blockchain' is simply a technology that uses a digital ledger that records sequential steps in an immutable manner and controls access to read and write to the ledger via advanced cryptography to ensure only valid actions and participants are allowed. The steps in the sequence are often automated using 'smart contracts' which ensures all expected steps are followed by the right participants before the next step can start.

Here is how Blockchain can create value in the food supply chain:

Blockchain feature

- Increase transparency
 - e.g. to consumers, to the next stage in the supply chain
- Reduce tampering
 - e.g. unpermissioned changes to provenance data
- Increase accessibility
 - e.g. to suppliers and retailers on a blockchain network effect

Effect on the physical world

- Increase Trust
 - e.g. between processors and farmers, consumers and retailers
- Increase consensus
 - e.g. about records between suppliers and vets

Benefit

- Save time
 - e.g. Vet admin, recall
- Reduce costs
 - e.g. Manual Q.A, admin charges
- Increase quality
 - e.g. Meat product, data
- Reduce risks
 - e.g. Settlement, contamination

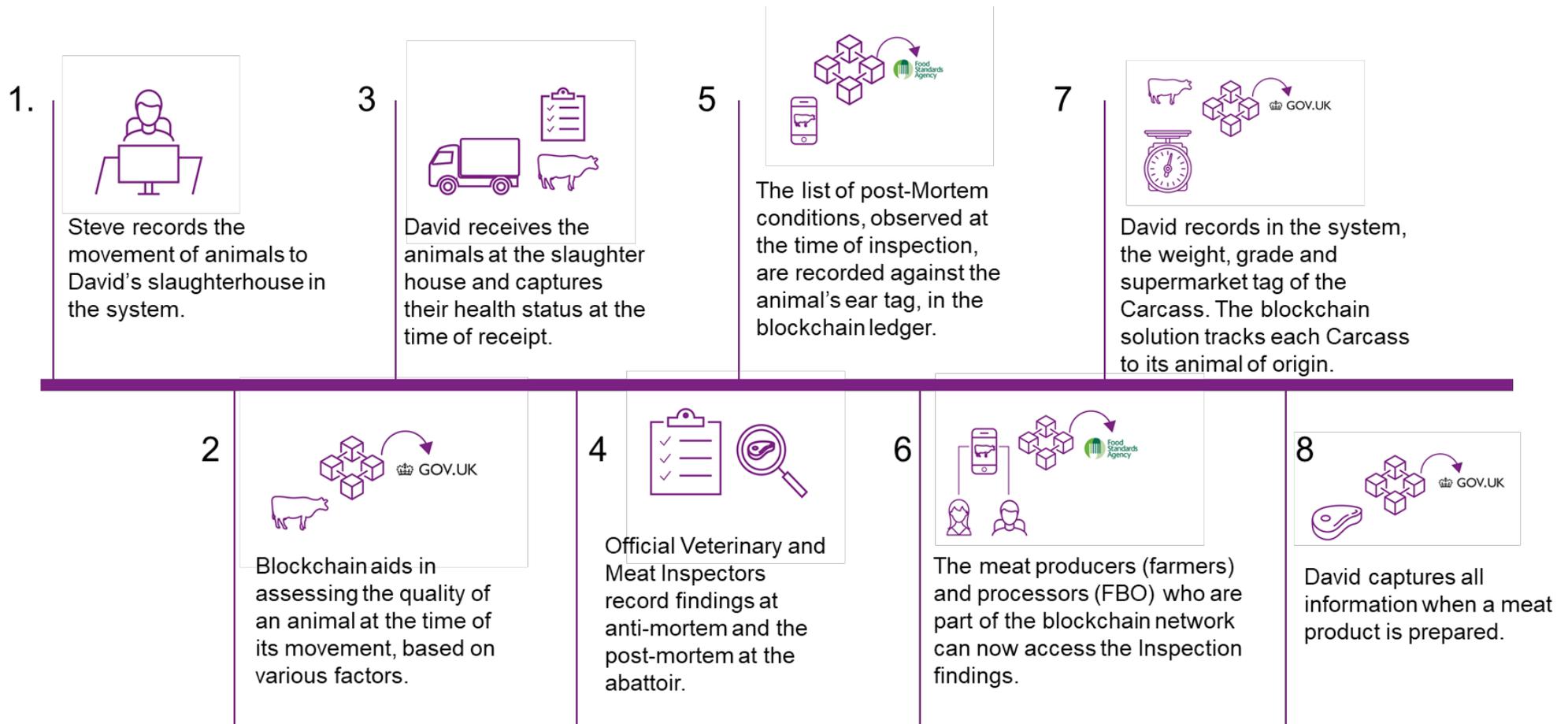
Initial research and projects

During 2018 and early 2019, the FSA actively took part in three trial blockchain projects, directly sponsoring two and continuing to be a key influencer in a third, which is ongoing. The choice of projects maximised exposure to the various aspects of food supply chains with willing industry players who shared an interest in improvements and benefits.

The overall cost of the two FSA led pilots was roughly £300,000 across two financial years which is relatively modest compared to traditional IT projects. Through the shared adoption of standards there is an opportunity to keep costs manageable by enabling blockchain solutions to co-exist and interoperate with other non-blockchain solutions.

The beef supply chain

Figure 1. The beef supply chain – Collection and Communication of Inspection results process (CCIR)



Goals: The CCIR pilot used blockchain to track, report and audit animal conditions. CCIR is a statutory process where information is provided to the producer to start any actions required on farm to improve animal health, welfare and subsequently food safety.

Technology: Hyperledger Fabric.

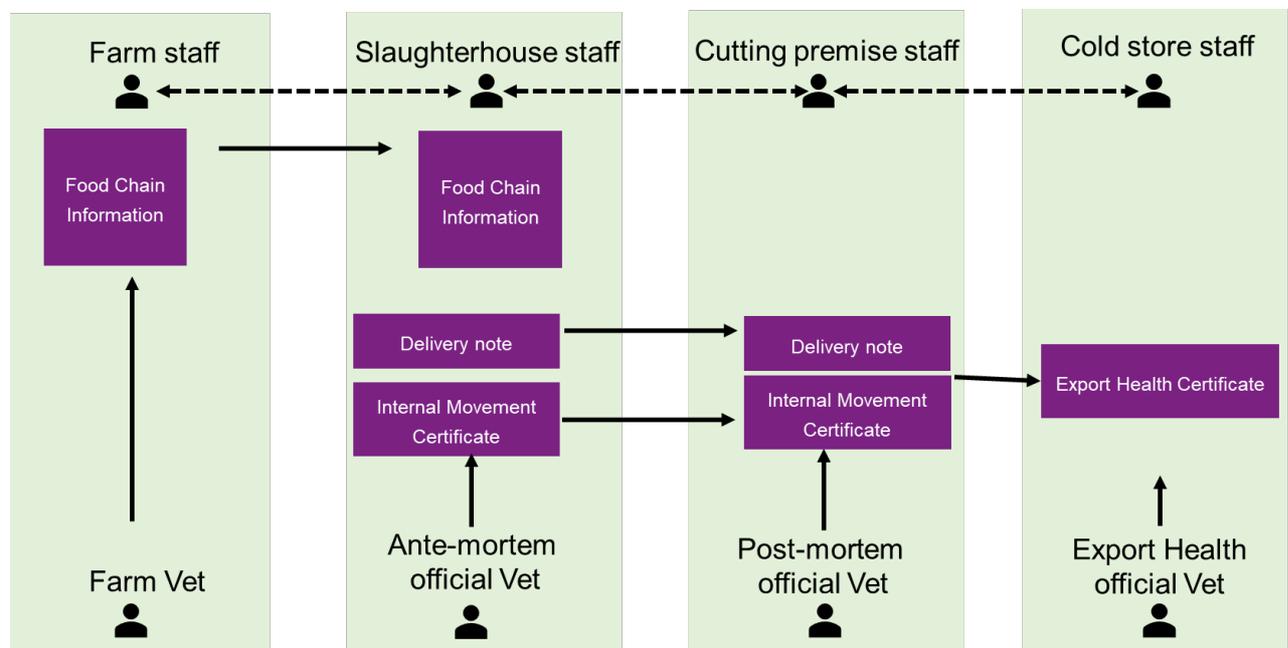
Participants: FSA, Dovecote Park, Dunbia and ABP are three of largest meat processors and suppliers to the UK retail sector. The project also engaged with AHDB and DEFRA.

Process: CCIR recorded information on animal conditions recorded against a unique ear tag number for cattle. No haulier or retail information was captured.

Benefits: Increased use of data standards, ease of finding conditions across various plants. Abattoirs liked the permissioned nature of the blockchain which meant participants could only see data relevant to their supply chain. Additionally, it enabled ease of tracking an animal to the originating farm as the finishing farms were almost never the farm of origin. Barriers around an operating model that created a level playing field for participants, minimal cost overheads and one that did not require significant investment in infrastructure.

Pork exports – Export Health Certification

Figure 2. The data flow to achieve Export Health certification for Pork export to China



Goals: To use blockchain to improve the use of information in the Export Health Certification process.

Technology: R3 Corda

Participants: FSA, Cranswick, Official Vets (OV) and APHA (generates export health certificate).

Process: To ensure all relevant information is collected from the vets and the processor to ensure certification from the Export Health Official vet could be delivered with increased accuracy and speed and issues identified and resolved much earlier in the process.

Benefits: Re-imagined process with blockchain could enable greater re-use of data, greater corroboration. Increased link between OV inspection and supporting evidence e.g. photographs of inspected animals etc.

Reducing Friction in International Trade (RFIT): HMRC led pilot on Wine imports

Goals: Pilot led by HMRC and supported by FSA. To demonstrate a reduction in friction in supply chain of wine imports, determine if cross border compliance can be achieved, use new technologies such as IoT devices, smart labelling to improve traceability and data capture.

Technology: Combination of Ethereum, Sawtooth and Corda

Participants: Portavin, Wine Australia, Wine and Spirit Trade Association (WSTA), HMRC, FSA, Casella Family Brands, Alliance Wines

Process: Work is still in progress, but emerging themes include a view of the necessity of new governance and new operating models that are required to determine how these new technologies should be responsibly constructed to ensure they deliver for the Public Good.

The intention is for this work is to contribute to the establishment of a Utility Trade Platform (UTP) for the UK which will be covered later in this paper.

The 'IDEA farm' – outputs and lessons learned from the research projects

After the conclusion of the two FSA projects, two 'idea farms' were conducted to collect, review and analyse the outputs and learning to inform next steps and future direction. There was also an independent review conducted by Dr. Garrick Hilleman. Whilst there were many individual learnings, these have been categorised into 5 key areas

1. Modernisation of legacy infrastructure afforded by blockchain was seen as a benefit, but businesses expressed concerns about the unknown costs in implementing change
 - In the CCIR project, the large abattoirs were unsure of the level of technical investment and wanted to ensure they could 'plug into' a solution without having to wholesale change their underlying IT infrastructure.
 - These food processors would be happy to take part in any future platform if the technology and associated policy changes would simplify the reporting / engagement requirements e.g. provide data only once and re-use.
2. Concerns over the sharing of data and whether competitors could access their commercially sensitive data requires the consents to be explicit and legal frameworks to be well defined to increase trust and willingness to take part.
3. There is a need for the governance of such distributed systems to be transparent, neutral, and not controlled by a dominant entity
 - It should not be the responsibility of a regulator such as FSA to set up and define and manage such a chain as the scope could increase to beyond regulation.
 - Such a governance set up should be co-funded by participants including government and industry with a clear operating model. A regulator should be part of such governance and agree to any policy and standards

4. Technology standards for blockchain are immature
 - Technology cannot be mandated and for such a chain to be successful and interoperability / translation models needs to be adopted to ensure external systems can interact with the central blockchain with minimal cost of change
 - Adoption of data standards need to be a pre-requisite
 - Data quality could slow down the adoption of new innovative technologies
5. Participation into a chain must be 'low friction' meaning low cost and complexity and encourage innovative participants rather than create barriers of entry for incumbents
 - Participants wanted to understand the operating model for a system operating at scale and what the run costs would be
 - Regulators should focus on encouraging innovative participants as this will drive improvement throughout the chain

The use of blockchains offers real potential benefits to improvements in safety standards and quality of food throughout many value chains. The underlying technology is not a challenge to implement or use and some of the concerns expressed at the time of the pilots have been addressed with continued development of the technology. Furthermore, there is no evidence as to significant cost associated with a blockchain solution (it is not blockchain itself that drives cost, but any technology enabled projects may be costly). However, it became clear that many of the layers of policy, trust, legal frameworks, process and data definition and ease of interoperability between all participants in any particular chain are hurdles that need to be decoupled and overcome to ensure that blockchains deliver the promised value to the Food supply chain.

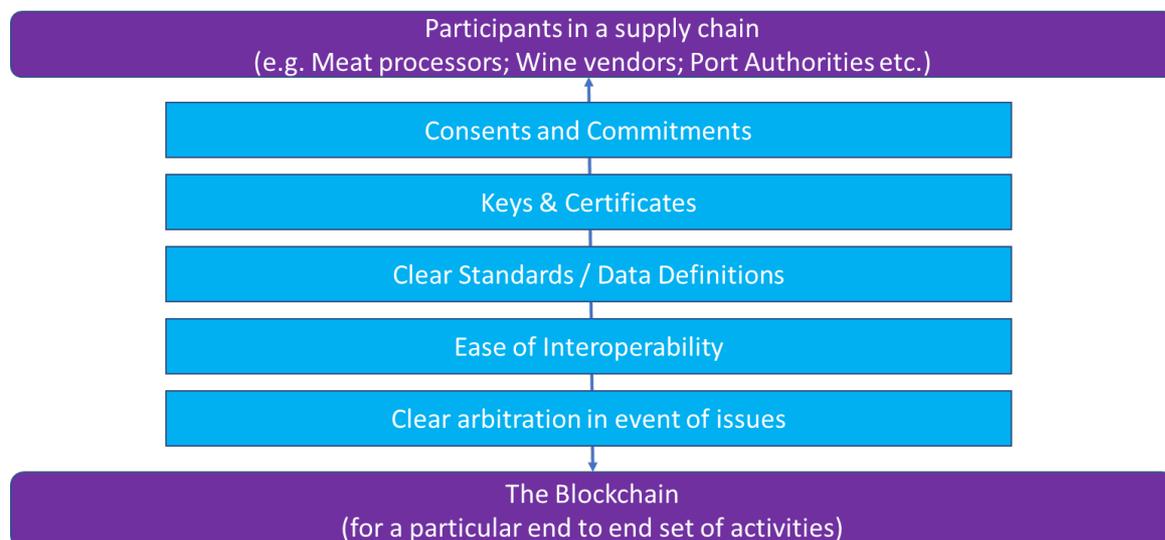
The different layers include:

- Consents and Commitments: Clear a legally robust consent to how data is used, protected and managed that complies to prevailing standards such as GDPR etc.

- Keys and Certificates: The receipt of keys and certificates necessary to participate in the value chain with appropriate encryption of data
- Clear Standards/Data Definitions: A mutually agreed set of definitions for the key data used within the value chain to enable clarity and reduce delays and friction
- Ease of Interoperability: Interoperability model that supports input of data from multiple types of participant systems using API's and other methods
- Clear Arbitration in the event of issues: A quick and accurate 'appeal and arbitration' capability that identifies and resolves issues quickly

The diagram below provides an illustration of the layers above.

Figure 3. A layer diagram outlining the layers that need to be set up to facilitate communication between the stakeholder / participants in a supply chain and the underlying technology.



Follow on from the Projects – Data Trusts and the OEF

Many of these layers will not self-solve, and as a result of these findings, the FSA in collaboration with other Government departments and industry has explored vehicles to increase openness, encourage participation and create the necessary standards.

One of those models, initially explored by the Office for Artificial Intelligence in collaboration with the Open Data Institute, was the concept of a Data Trust, which is covered below.

Data Trusts

The Open Data Institute (ODI) describes a data trust as an entity that...

... provides independent, fiduciary stewardship of **data** with impartiality, prudence, transparency and undivided loyalty.that involves one party authorising another to make decisions about **data** on their behalf, for the benefit of a wider group of stakeholders.

In a food context, this model should apply to the participants in any particular food value chain (e.g. Beef, Pork, Wine from above) consenting to a framework that embodies these principles in order to maximise community value from participation.

The FSA continues to work with the Lincoln Institute for Agri-Food Technology at the University of Lincoln to explore the necessary consent models and legal frameworks that would provide an environment for creating those collaborating ecosystems. The outputs from this work would be a set of models underpinned by ethics and legal principles

In parallel to the data trust work, the FSA is also exploring how to create a model that enables the sharing of minimal footprints of standardised data. This data would ideally take the form of actionable intelligence. The FSA in collaboration with Government and Industry is building a set of technical protocols and building on the work of the Data Trust to create the Open Ecosystem Federation, which is covered below.

The Open Ecosystem Federation (OEF)

The FSA in collaboration with HMRC and Future Borders are developing a set of protocols and technical tools that will enable participants to develop ecosystems to share intelligence and reduce friction within trade value chains.

The output for the work is a technology agnostic toolkit which enables collaboration between people, organisations, and machines in a way that is scalable, repeatable, and extensible. By its very nature it is expected that the adoption of common tools will ensure that participants can share intelligence and participate in an ecosystem using a variety of solutions e.g. blockchain, traditional databases. In other words, the choice of technology by any one organisation will not be a barrier to participation. The OEF is underpinned by a set of governance principles which is being referred to as the 'Rules of Engagement.'

Both the OEF and the Data Trust work will look to address some of the underlying barriers that the blockchain pilots identified, in particular:

- How does an ecosystem of blockchains or indeed other solutions work?
- How do we avoid dominance by large participants in the ecosystem?
- How do we avoid technology lock-in?

The need to reduce friction in international trade is a clear UK government priority and a key outcome from the Lord Holmes report. Additionally, increasing food security and ensuring clear provenance of goods to ensure food safety makes it imperative that the FSA works in close collaboration with other departments such as HMRC.

The lessons learnt and the work with Data Trusts and the OEF has created a view on the components necessary to deliver value from using Blockchains.

Wider Initiatives

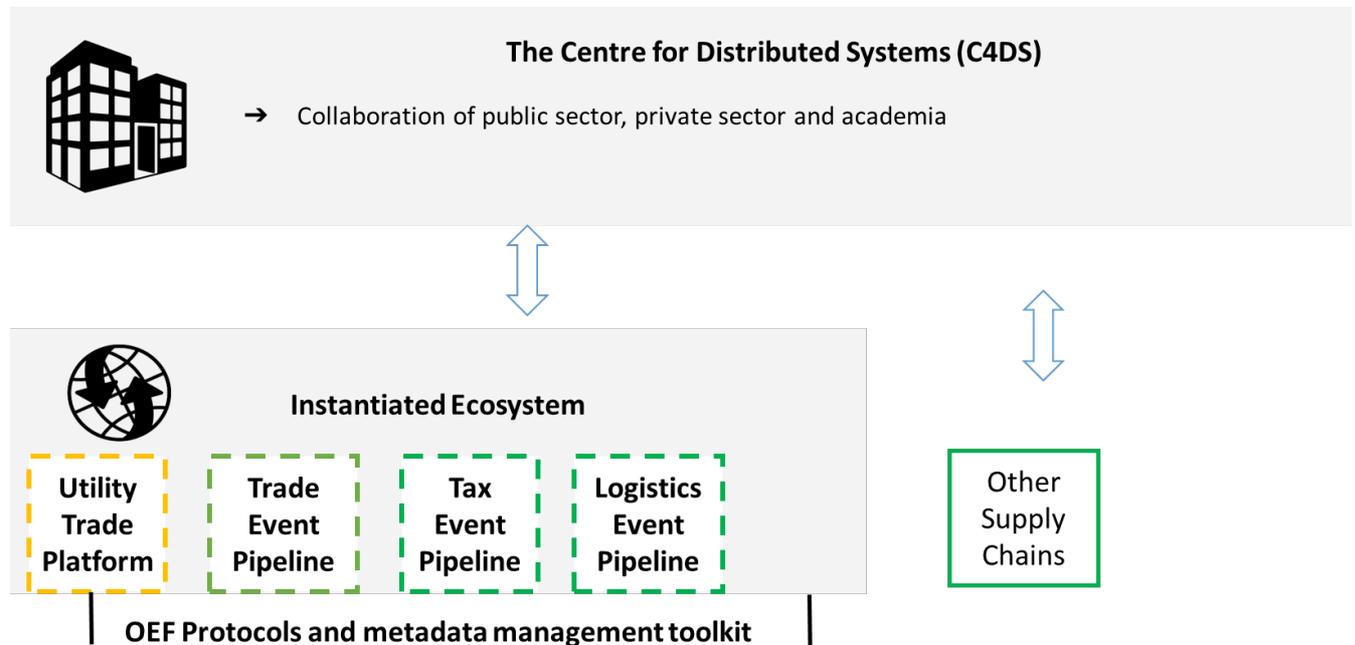
In addition to the initiatives above, HMRC are leading on two wider initiatives below.

Centre for Distributed Systems (C4DS): HMRC are working on a proposal to set up a Centre for Distributed Systems (C4DS) on similar logic to the founding of the Office for AI and the Open Data Institute. The Centre would provide a framework for the public sector, private sector and academia to collaborate in the application of distributed systems to specific use cases, with the learnings properly captured and shared.

Utility Trade Platform (UTP): The UTP is currently in a prototype stage and the expectation is that it would be available to any and all traders into and out of the UK to instigate their commercial transactions through it, in the knowledge that its use would generate all the data required by the economic and regulatory actors in their supply chain.

Both the initiatives above are being led by HMRC's innovation team. It is worth noting that not all supply chains will need or be relevant to the UTP. But the UTP alongside other sources of supply chain information can co-exist to form an ecosystem (where shared data could become a data trust) based on the OEF protocols. In other words, the OEF could provide the translation and interoperability needed. An illustrative view of this is summarised below in the diagram.

Figure 4. An overview of the ecosystems necessary to deliver the benefits of traceability and provenance in the food supply chain. There are many moving parts that need to be orchestrated around a governed and clearly defined value chain. The OEF are shown as playing key roles in enabling this value to be unlocked



All Party Parliamentary Group (APPG) on Blockchain: FSA are actively participating in the APPG forums which includes participants and thought leaders from Government, Industry and Academia. Discussions to date have focused on data privacy in the context of the on chain/off chain approach, governance of distributed systems and the regulators role in supporting innovation. The FSA’s work with the OEF aligns to the thinking in the APPG around the need to decouple applications into different logical layers and to avoid lock in. The FSA should continue to work closely with the APPG and other cross sector initiatives.

International discussions: Given the international nature of all food systems, the FSA has actively participated in discussions with other food regulators on the potential value of blockchain, and the importance of standards to allow interoperability; most notably the US FDA, Canadian Sheep Chain Federation and the Canadian Food Inspection Agency. The conclusions have been similar to the UK’s as articulated here.

Continuing the journey – Next steps and recommendations

The FSA continue to provide the impetus and support these initiatives whilst working with key industry stakeholders to accelerate the delivery of the benefits that are possible. In delivering the work on the OEF and Data Trust, the FSA should share a technical toolkit and the principles for creating and participating in an ecosystem.

The recommendation for key players is as follows:

Food industry companies

Food companies should be exploring and preparing for a role in the type of ecosystems explored. Active participation in establishing impartial industry/value chain governing bodies would enable early influence on how these are established in the best possible manner that guarantees the greatest improvement in safety and quality and reduce friction whilst minimising the costs of engagement.

SMEs and innovative food companies should outline key barriers of entry to some of the key value chains and actively participate in new initiatives.

Technology Vendors

The focus of technology vendors should be on interoperability and reduction of friction in participation with any chain. All participants will require simple and easy 'plug ins' from their existing systems through an interoperability layer as well as easy ways to collect missing data that is deemed necessary to participate in any particular value chain. The vendors can also participate in the ecosystem to trial emerging technologies that enhance traceability e.g. IoT devices.

Government

Government should continue to collaborate with industry to support the adoption of standards and creation of ecosystems with low barriers to entry. Participation in a blockchain ecosystem shouldn't require organisations to undertake large scale changes in infrastructure. Such changes can be managed by architecting a balance between off-chain and on-chain data so that non blockchain infrastructure can communicate with blockchain ecosystems. Government should also build on the

momentum of the National Data Strategy and the Data Standards Authority to enable standards led information sharing to improve public services and drive efficiency.

Taxonomy used in this paper

Ecosystem

A business ecosystem is the network of organisations—including suppliers, distributors, customers, competitors, government agencies, and so on—involved in the delivery of a specific product or service through both competition and cooperation.

Infrastructure

The basic physical and organisational structures and facilities (e.g. IT systems, processes, people) needed for the operation of a blockchain

Platform organisation

The platform organization is a fundamentally different business model. It facilitates value exchanges between two or more interdependent groups, producers and consumers.

Data trust

A data trust provides independent, fiduciary stewardship of data.