Open Call NGI Atlantic

Food Data Marketplace

Deliverable 3: Experiment Results and Final Report

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Deliverable 3: Part I

Analysis, results, and wider impact

The information contained in sections 1-11 will be used in part to update the NGI Atlantic's public deliverables (including the Experiment Catalogue on the website).

1 Abstract

Food Data Marketplace (FDM) is an inclusive marketplace fostering new economic models for sustainable food supply chains by allowing farmers and food companies to keep control of their data and offer it for purchase. The best control and data sovereignty is achieved with **data privacy** (unified approach using private storage and public networks), **data integrity** (immutable cryptographic fingerprints published on a public blockchain), **data interoperability** (multiple open data standards) and **data interconnectivity** (a single knowledge graph automatically connecting relevant data). FDM achieves these key characteristics by utilising **OriginTrail Decentralised Network, Network Operating System** and **data marketplace smart contracts**. FDM is designed to support integration with existing systems, like IoT devices produced by Kakaxi, a San Francisco based company. Kakaxi devices have multiple sensors (temperature, humidity, luminosity, rainfall) and include a camera. By integrating the two solutions, we enabled a decentralised data marketplace for all Kakaxi devices globally, providing another revenue stream potential for farmers with devices on their farms.

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2 Project Vision

Food Data Market (FDM) is an inclusive marketplace fostering new economic models for sustainable food supply chains based on data. It leverages key benefits of distributed ledger technologies **(trust, neutrality, inclusiveness**) while keeping the key advantages of participants intact by employing **privacy-by-design approach** thus enabling farmers and cooperatives to regain control of their data, give it a price tag, and sell it to interested partners in the supply chain. By integrating with Kakaxi, FDM receives immediate access to relevant data captured across the globe that has a potential to be valued and monetised. The joint approach delivers a global data marketplace of IoT data from a wide variety of farms.

This contributes to **greater visibility and trust in food supply chains**, more **equitable sharing of gains** from data exchanges (value moving upstream supply chains - farmers) and to more **sustainable environmental practices** by making trusted information about food production available to consumers.

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3 Details on participants (both EU and US)

EU partner - Trace Labs (Prospeh d.o.o.)

Founded in 2013, Trace Labs has built award-winning enterprise solutions for supply chains, including those for traceability and verifiable claims. In 2017, Trace Labs received an award from Walmart Food Safety Collaboration Center for a supply chain solution. Trace Labs believes sustainable supply chains are only possible when all organizations, big or small, benefit from decentralised data governance.

Table: Team focused on the success of Food Data Marketplace in Trace Labs was:

Name of the person	Role in the project and short CV	LinkedIn
Jurij Škornik	Project manager - Before joining Trace Labs, Jurij had spent 5 years solving supply chain management challenges for one of the world's largest logistics providers, Deutsche Post DHL. As General Manager, he has been leading Trace Labs' most important projects in collaboration with international partners such as BSI. Jurij led the project management as well as engagement efforts with key stakeholders deploying the project and made sure that the pace of NGI Atlantic was aligned with the timeline and all the communications between partners were running smoothly. Additionally, Jurij focused on outlining the user stories, key for designing a seamless stakeholder user experience.	Link[1]
Tomaž Levak	Partnership facilitation - Tomaž is a founder of Trace Labs and has focused on challenges related to enhancing visibility in supply chains for the last decade. Within NGI Atlantic, he assisted in facilitating the partnerships that put FDM and Kakaxi technologies to test.	Link[2]
Žiga Drev	Partnership facilitation - Žiga is a founder of Trace Labs and has focused on challenges related to enhancing visibility in supply chains for the last decade. Within NGI Atlantic, he assisted in facilitating the partnerships, as well as designing the marketplace scenarios for potential future stakeholder involvement within existing partners' use cases.	Link[3]
Branimir Rakić	System architect - Branimir led successful implementations of OriginTrail technology with various systems, integrated advanced features (identity, consensus check, zero-knowledge proofs) to the protocol, and designed solutions with Ethereum and Hyperledger Fabric blockchains. He is participating in open source communities (W3C, Fiware, NGI), and is an expert on identity standards (GS1, W3C). He is the core architect of the FDM solution. Branimir focused on translating the business requirements into technical requirements and identified all missing technical components required to ensure smooth functioning of the FDM.	Link[4]

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[4] https://www.linkedin.com/in/branimirrakic/

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Djordje Kovačević	Engineering lead - Djordje is an experienced software developer with several years of experience in developing identity-based solutions (eID). He has ample experience developing user-centric applications, from web applications to mobile solutions. Djordje is a certified scrum master and is leading the tech team and solution deployment. His tasks were ensuring engineering work was precisely planned and carried out within the required timeline. He worked with Branimir on perfecting the requirements as well.	Link[5]
Stevan Nešović	Applications developer - Stevan is the lead application developer in Prospeh, focusing his efforts on the development of applications, particularly the API infrastructure to support integration features with external systems. Stevan has been leading the development team of the BSI verifiable certificates application, built Prospeh solutions, and has extensive experience in working with OriginTrail Decentralized Network and Ethereum. In the FDM project, Stevan was putting his past experience to work on nOS components. In the project activities, Stevan was executing all the required customisations to the FDM and nOS that were needed to enable support for the user stories.	Link[6]
Nikita Abrashkin	Full stack developer - Nikita brings multiple years of experience working on major Trace Labs projects. On FDM he was working together with Stevan, developing all the required customisations to the FDM.	Link[7]
Ana Djoković	Quality assurance engineer - Ana was testing the FDM's code with automated and manual tests to ensure its quality and high performance.	Link[8]
Miloš Kotlar	Protocols developer - Miloš is a PhD candidate at the University of Belgrade focusing on cryptography and data structures. Miloš is predominantly developing privacy solutions within the Prospeh team. He is particularly involved in the development of OriginTrail infrastructure, focusing on the p2p network implementation and communication protocols and linked data. Miloš has considerable experience with the Ethereum VM smart contracts and associated libraries. Due to his wide knowledge, Miloš contributed to the FDM by adapting the smart contracts components, as well as open data standards. This ensured the integrity of the marketplace and high interoperability of the exchanged data.	Link[9]
Uroš Kukić	Uroš is a Computer Science graduate with a great interest in developing distributed systems. He was an important part of all major releases of the OriginTrail Decentralised Network in the last few years. Within the NGI Atlantic project, Uroš focused on smart contract development - optimising and adapting smart contract components of FDM, ensuring better scalability and resilience of the code.	Link[10]
Žarko Stamenić	As the Head of design, Žarko provides important guidance to the design team to ensure all the project's requirements are well understood and the design team's work is running smoothly. He has been crafting OriginTrail visuals since 2015. After multiple awards and	Link[11]

[5] https://www.linkedin.com/in/djordjekovacevic/
[6] https://www.linkedin.com/in/stevan-nesovic-078180187/
[7] https://www.linkedin.com/in/nikita-abrashkin/
[8] https://www.linkedin.com/in/ana-%C4%91okovi%C4%87/
[9] https://www.linkedin.com/in/kotlarmilos/
[10] https://www.linkedin.com/in/kukic-uros/
[11] https://www.linkedin.com/in/zarko-stamenic/

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	recognitions as MSc. of Architecture, he leverages his knowledge of people's behavior in physical space and translates it to digital experiences.	
Irena Čuturić	UX & UI designer - Irena has been designing user experiences in the field of blockchain-based applications since 2016 and has experience with user-centric tools, agile product development, graphic design and fashion design. Irena was focusing on seamless UX of the FDM and state of the art user interface.	Link[12]
Aleksandra Jelenić	UX & UI designer - Aleksandra worked with Žarko and Irena to make sure FDM's user experience was smooth and interfaces were easy to use. A lot of her project involvement was focused in the first few months, having to translate business requirements (user stories) and technical requirements into a unified user experience. She is experienced in agile product development, photography, videography and 3D animation.	Link[13]
Ana Bevc	Community manager - Ana is experienced with managing relationships with different communities both European and global. She is an active participant in NGI workshops for human-centric design. For FDM, Ana facilitated communications within the teams as well as led the dissemination activities in the last phase of the project. Ana was making sure that the updates from the FDM were timely communicated to the relevant communities resulting in blogs, social media posts and similar. She was also facilitating communications within the team, supporting Jurij in project management activities, helping to keep all the activities on track, as well as contributing to the development of user stories and defining business requirements.	Link[14]
Gregor Karlovšek	VP of finance and operations - Gregor is an industry expert and has been engaged in managing the financial position of company/projects where he also overlooks the EU Open Call reportings from the compliance perspective. He contributed to this project in the preparation of the financial report.	Link[15]
Martina Poberaj	Communication associate - Martina was responsible for coordination with internal stakeholders and managing the communication side of the project, which included data gathering and presentations, speakers alignments and organizing webinars. She also contributed to the final report.	Link[16]

US partner - Kakaxi Inc., US, California

Kakaxi strives to connect and visualize the world around us and increase the value of production by enabling full transparency. The company had collaborated with Trace Labs in their effort to deploy the FDM platform in the EU within the scope of the NGI Ledger program. Their hardware and software has been adapted to fit the privacy and trust

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standards of the NGI initiative, and they have implemented Trace Labs technologies based on a decentralized data governance model.

Table: Kakaxi team involved

Name of the person	Role in the project and short CV	LinkedIn
Adam Smith	Project manager - Experienced technology entrepreneur and product marketer focused on developing ways technology can improve agriculture around the world. Led product development from conceptualization to prototype & mass production. During the project, Adam led the engagement efforts with one of the use-case partners in South America and was making sure that the compatibility between business requirements of the two systems working together were clearly understood.	Link[17]
Taizo Otsuka	System architect - Taizo founded 14 businesses from a biotech company to a professional basketball team. Taizo ensured alignment of unified offering of FDM and Kakaxi devices and relayed critical information to the Kakaxi development team. Taizo ensured that business requirements were translated into technical requirements and that the needed customisations were always deployed in time.	Link[18]

[17] https://www.linkedin.com/in/aysmith/
[18] https://www.linkedin.com/in/taizoo/

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4 Results

FDM acts as an inclusive marketplace fostering new economic models for sustainable food supply chains. It targets the challenge of decentralised data governance by allowing farmers and food companies to keep control of their data, valorize it and offer it for purchase. FDM seeks to address this challenge following some of the key Next Generation Internet guidelines and ensuring:

- **Data privacy** - unified approach using private storage with user-controlled permissioned access control and public networks (depending on the requirements of the data).
- **Data integrity** - datasets kept privately or on a public network, all have verifiable integrity using immutable cryptographic fingerprints published on a public blockchain.
- **Data interoperability** - supporting multiple open data standards to ensure interoperability with existing IT systems.
- **Data interconnectivity** - a single knowledge graph automatically connecting relevant data stored on public networks and/or privately. Linked data approach makes data discovery much easier by authorised participants.

These key characteristics were achieved by leveraging previous work done within the NGI LEDGER programme when certain infrastructural components achieved TRL7:

- **Network Operating System (nOS)** - a web-based platform that helps farmers and food companies seamlessly take part in the data economy by enabling streamlined system integration with existing IT systems, data structuring and data publishing to FDM open-source infrastructure.
- **OriginTrail Decentralised Network (ODN)** - as a data exchange layer, the open-source ODN is used to exchange, discover, validate and interconnect relevant datasets utilising a knowledge graph. ODN as a public network is, together with blockchain, used as a data integrity layer.
- **Data marketplace smart contracts** - truly trustless management of relationship between marketplace participants with smart contracts deployed on Ethereum mainnet.

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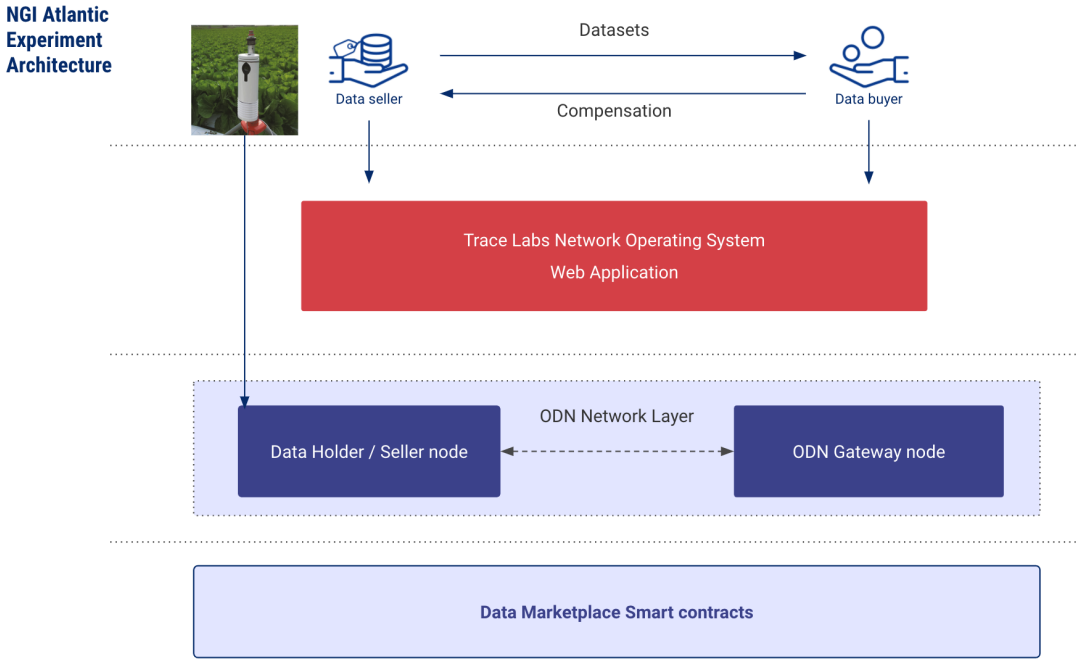
Picture: Kakaxi introduction into the ODN Network



The FDM NGI Atlantic experiment utilised the **FDM infrastructure together with a complementary solution provided by US partner Kakaxi** - an independent, plug-and-play solar-powered IoT device that was equipped with multiple sensors (temperature, humidity, insolation, rain gauge) and camera for capturing images. Kakaxi acted therefore as an **"FDM enabled" device, ensuring undisputed data ownership by farmers by forming direct data connection with farmer's private storage on their OriginTrail node.**

During the experiments, we were validating if farmers and/or cooperatives would be able to create an additional revenue stream by monetising data captured by the Kakaxi devices. As farmers kept devices in the fields, data constantly flowed towards the FDM. **Following the appropriate data standards** (W3C WoT, GS1 EPCIS, W3C Verifiable credentials), data was kept in the private part of the OriginTrail knowledge graph with corresponding fingerprints stored on the blockchain.

Farmers could then utilise FDM to put their datasets on the marketplace and set up relevant discovery settings. According to the settings, appropriate publishing of metadata (identifiers like GS1 GTIN, SGTIN, GLN) was executed and farmers **set a price they expected to achieve**.

On the other side, **interested downstream partners and other stakeholders could discover the datasets** and obtain them via FDM for the price provided by the farmers. Their motivation for purchase stemmed from multiple drivers - product genuinity, safety, quality that was important to them for objectives like retailer/certification compliance, quality assurance, achieving sustainability goals. Certain public agencies were interested in obtaining data for statistical analysis and validating/improving their policies.

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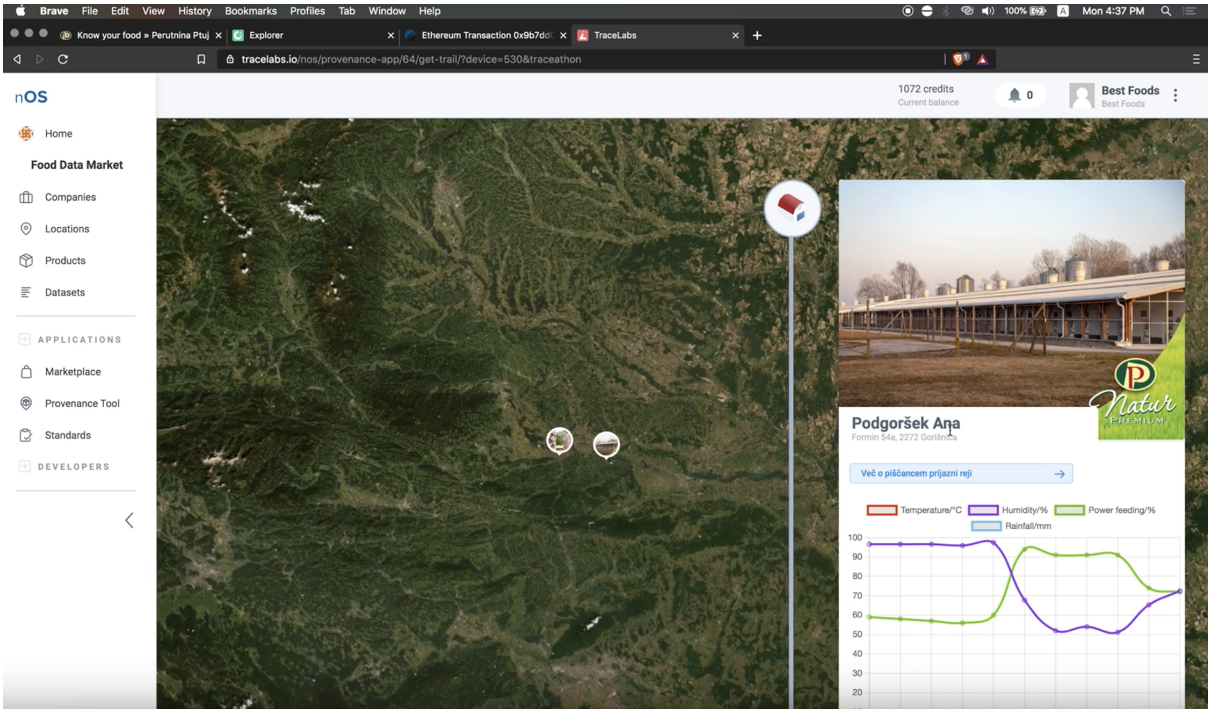
Stakeholders were able to purchase the data using the FDM and verify all steps of the data transaction on the open-source infrastructure (e.g. dataset integrity, issuer identity, purchase receipt). As the dataset was structured in an interoperable format, buyers could also have created automated imports into their IT systems where data could be re-used for their internal purposes or for communication towards other stakeholders/third parties (e.g. certification bodies, end-consumers).

Picture: Schematic preview of additional data available on the site of a traceability application



The experiment was executed over three phases:
Phase 1: Use case definition,
Phase 2: Experiment deployment
Phase 3: Dissemination.

In the use case definition phase, three selected supply chain experiments were executed in short workshop-like exercises determining their background, opportunity and solution. Below is a short summary of each experiment.

#1
Supply chain: Monasterevin Distillery, Ireland
Experiment description: Quality, sustainability, and transparency have been the key values of Monasterevin Distillery. Those attitudes have helped to form the cornerstone of their whiskey brand positioning and customer promise. Since today's consumers have become increasingly cautious and skeptical about the sourcing of products and their underlying ingredients, Monasterevin approached to support their claims with trust and integrity through certification, science and technology.

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For that purpose, the distillery wanted to capture as much relevant data about their supply chain as possible and Kakaxi devices were a great fit to collect key data and imagery that served to substantiate claims on Irish grain provenance and product authenticity. Devices were installed with selected farmers that had been Monasterevin's partners and the distillery was able to purchase the needed data from farmers as required. That way, farmers remained the owners of their data and were also able to re-use them in other ways (e.g., for production optimization and re-selling to other potential partners).

#2

Supply chain: Aroco, Colombia

Experiment description: Aroco is a company committed to the development of regenerative agriculture projects in Colombia focused on cultivating cacao crops and building farmer communities. They are committed to offering their clients cacao products of the highest quality while maintaining a respectful relationship with the environment and society.

The cacao company was interested in building relationships among producers, industry experts, and clients who had shared their philosophy in order to guarantee high-quality and fairly-priced product offerings at each stage of the supply chain. To support their efforts in achieving this, they wished to capture as much relevant data as possible with the help of Kakaxi IoT devices. They had intended to substantiate their claims about sustainable cocoa production and offered data for sale through the FDM to brands purchasing cocoa from them. The FDM would enable the farmers to collect the data which would remain their property and would also be able to re-use them in other ways (e.g., for production optimization and re-selling to other potential partners).

#3

Supply chain: Sunbridge Solar, Nepal

Experiment description: Sunbridge Solar is an organization active in the sustainable energy sector, helping energy-poor communities in Nepal develop sustainable livelihoods through the provision of renewable energy systems and access to technology.

As part of their efforts together with BSI, they were exploring the potential of IoT data for precision agriculture, where they wanted to use Kakaxi devices to measure farming microclimate conditions such as temperature, humidity, radiation, and rainfall. Their goal was to determine the utility and value of these datasets in precision agriculture analysis (e.g. analysis on how microclimate conditions impact yield) by selling them to various Nepalese government agencies on FDM. Another aspect they wanted to test was whether food producers purchasing produce from the farmers - rice, corn, cabbage, pumpkin, cauliflower, and mustard - would be willing to purchase Kakaxi data from the farmers through FDM in order to provide their end-consumers with higher levels of transparency about the food they are purchasing and consuming.

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During Phase 1 of use case definitions, we focused on discussions with the selected testbed partners to produce a well-defined use case for each of them covering three main topics - background, opportunity, and solution. During Phase 1 a further project alignment with our US partner Kakaxi was sought for the solutions that were intended to be used - the Kakaxi IoT device and FDM. The focus was on making Kakaxi devices “FDM-enabled”, ensuring they could push data securely to the OriginTrail node. We also customized the FDM user interfaces to simplify the user experience to the extent possible.
Furthermore, we identified the data relevant for sharing in each of the use cases as well as identified one or more of potential buyers of this data.

During the first three months of the project Phase 1, the use case definition phase, was finalised and Phase 2, the experiment deployment phase, commenced.

In the following Phases 2 and 3, we were seeking to show what impact could be created in these experiments and how it could be expanded to food supply chains globally, ultimately making our food supply chains become more trustworthy, transparent and our food products safer.

In Phase 2 (deployment phase), we commenced the deployment of the experiment. This consisted of two parts - work done on the FDM software solution (IT development) and deployment of Kakaxi devices on locations (pilot use-case implementation). Significant effort was put towards optimising the user experience of the FDM for Kakaxi data, to ensure that all stakeholders (including farmers) could benefit from a seamless interaction with the solution. For that purpose, we re-designed the interface to involve a minimum number of required steps to upload, valorise, publish, and monetise datasets for data sellers and to find, inspect, purchase, and obtain datasets for data buyers, ultimately streamlining the user experience.

We had expected to deploy the Kakaxi devices in all three of the testbeds. In two of the locations, Ireland and Nepal, we successfully deployed the Kakaxi devices, implemented data access controls, and connected the devices with the Network Operating System (nOS) to push data to the FDM. In the third location, Columbia, the discontinuation of US Kakaxi operations, along with unforeseen complexities with customs clearance, prevented us from deploying the Kaklaxi devices as initially intended.

The updated user journey put in operation in Phase 2 can be seen below.

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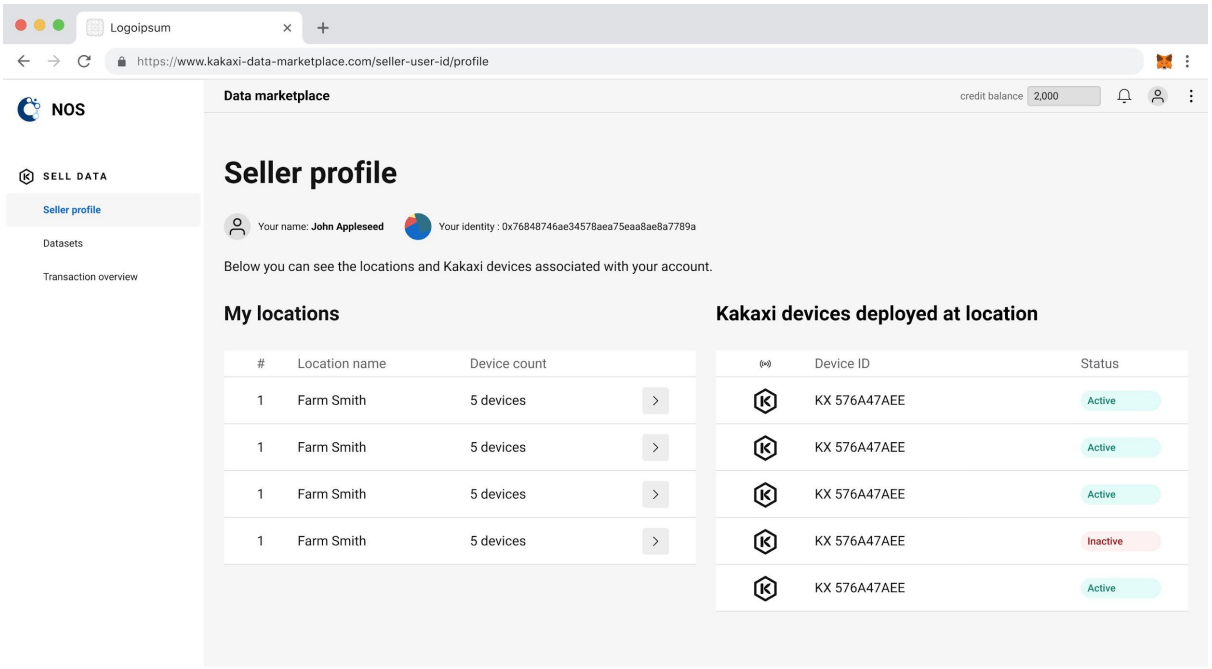
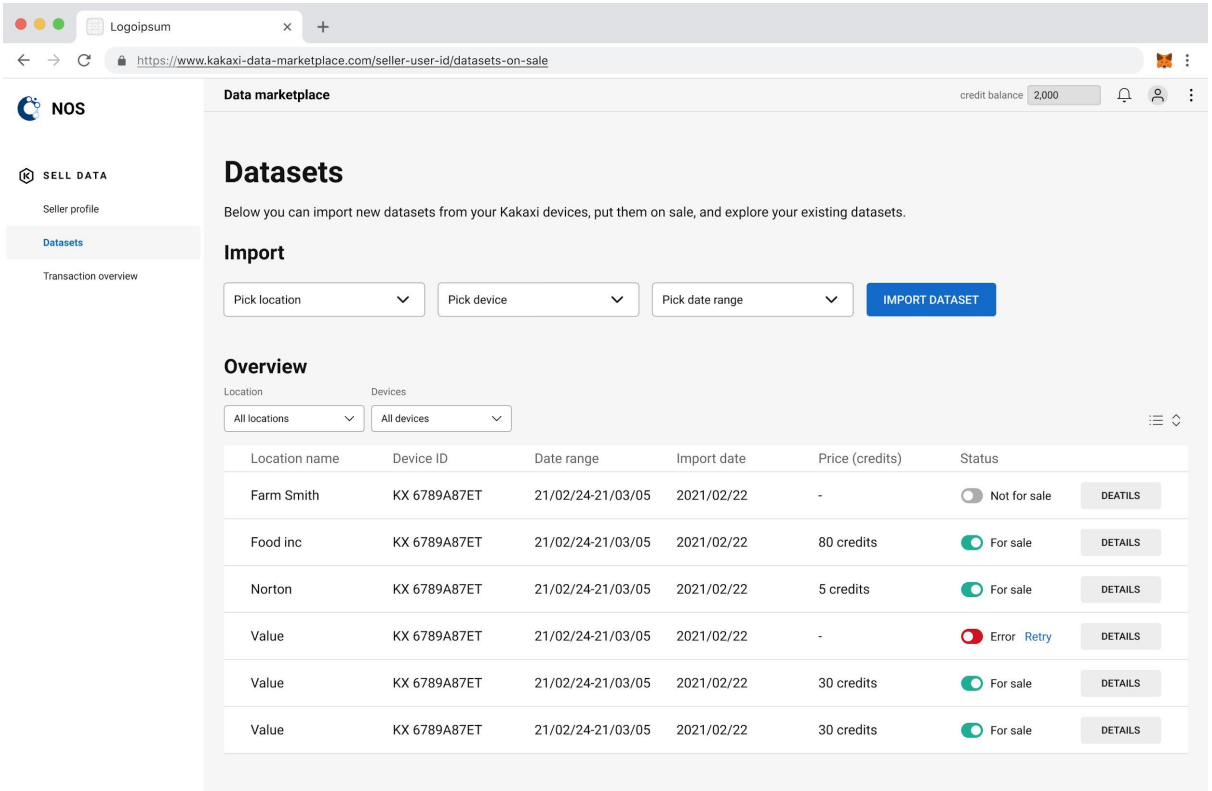
Picture: Seller profile in the project application (screenshot)



Picture: Seller dataset management in the project application (screenshot)



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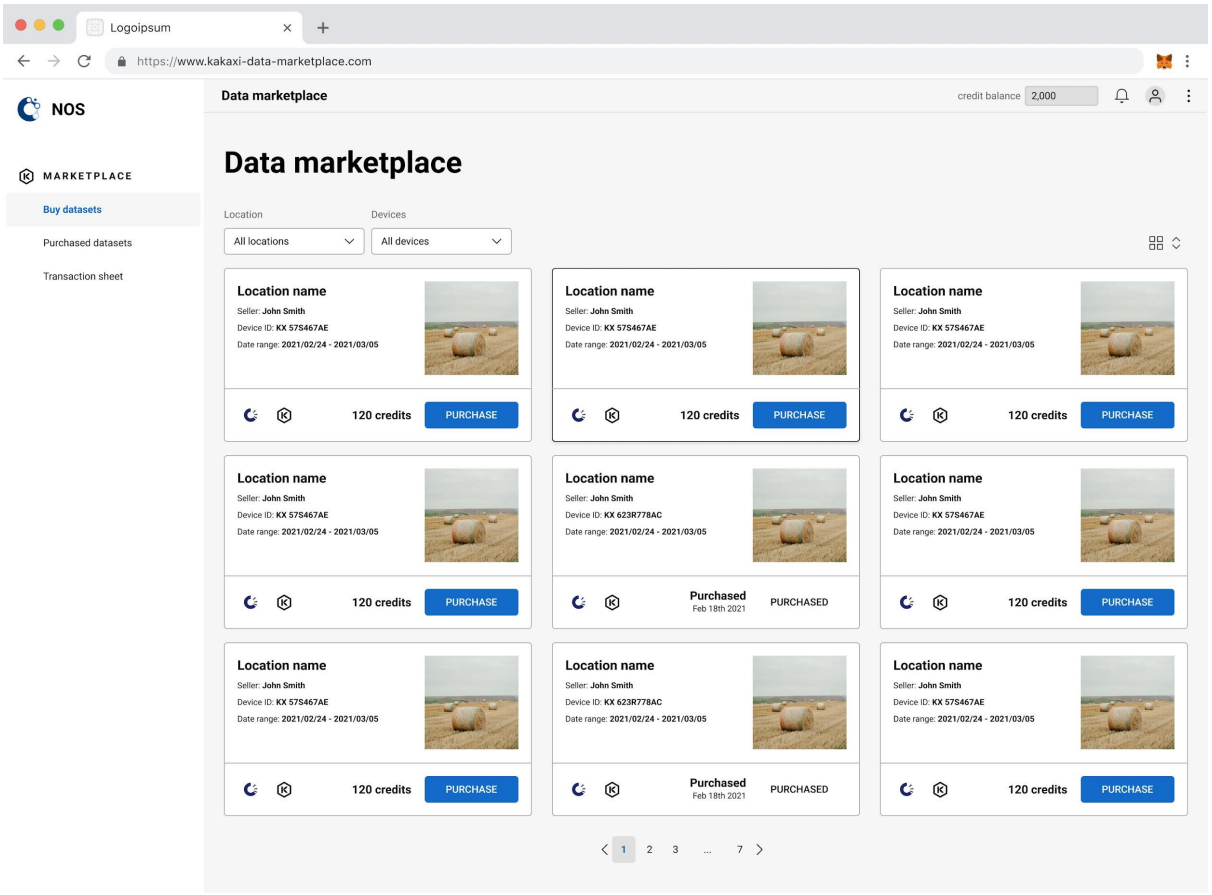
Picture: Buy side data marketplace in the project application (screenshot)



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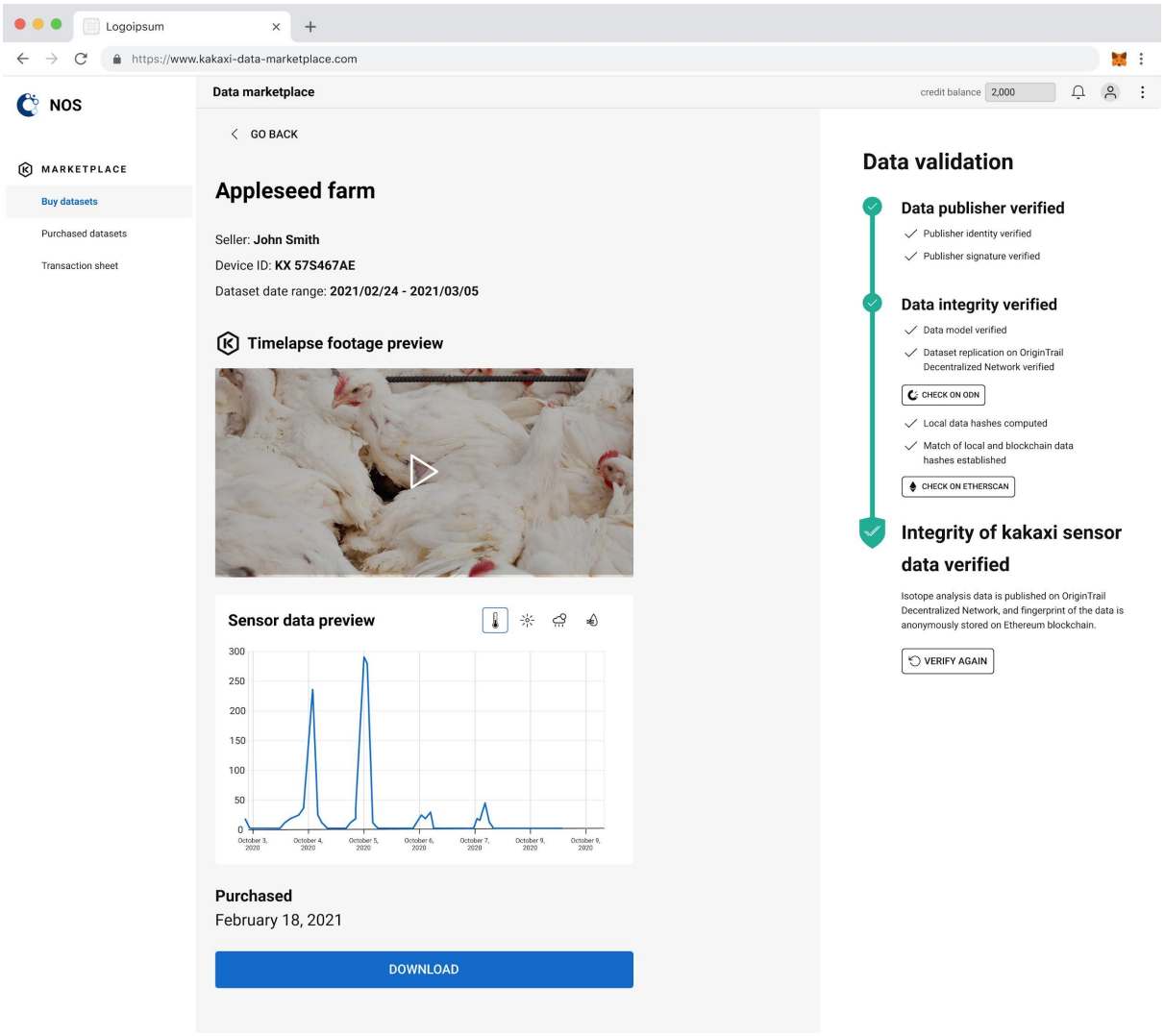
Picture: Buy side dataset details and validation in the project application (screenshot)



As described above, the second part of Phase 2 consisted of the work done on the ground - getting Kakaxi devices in the hands of users and putting them in the ground for relevant measurements. This task was successfully carried out in Nepal and Ireland, but unfortunately unsuccessful in Columbia due to various reasons, provided in the summary table in section 4.1. The photo below shows the deployment in Nepal.

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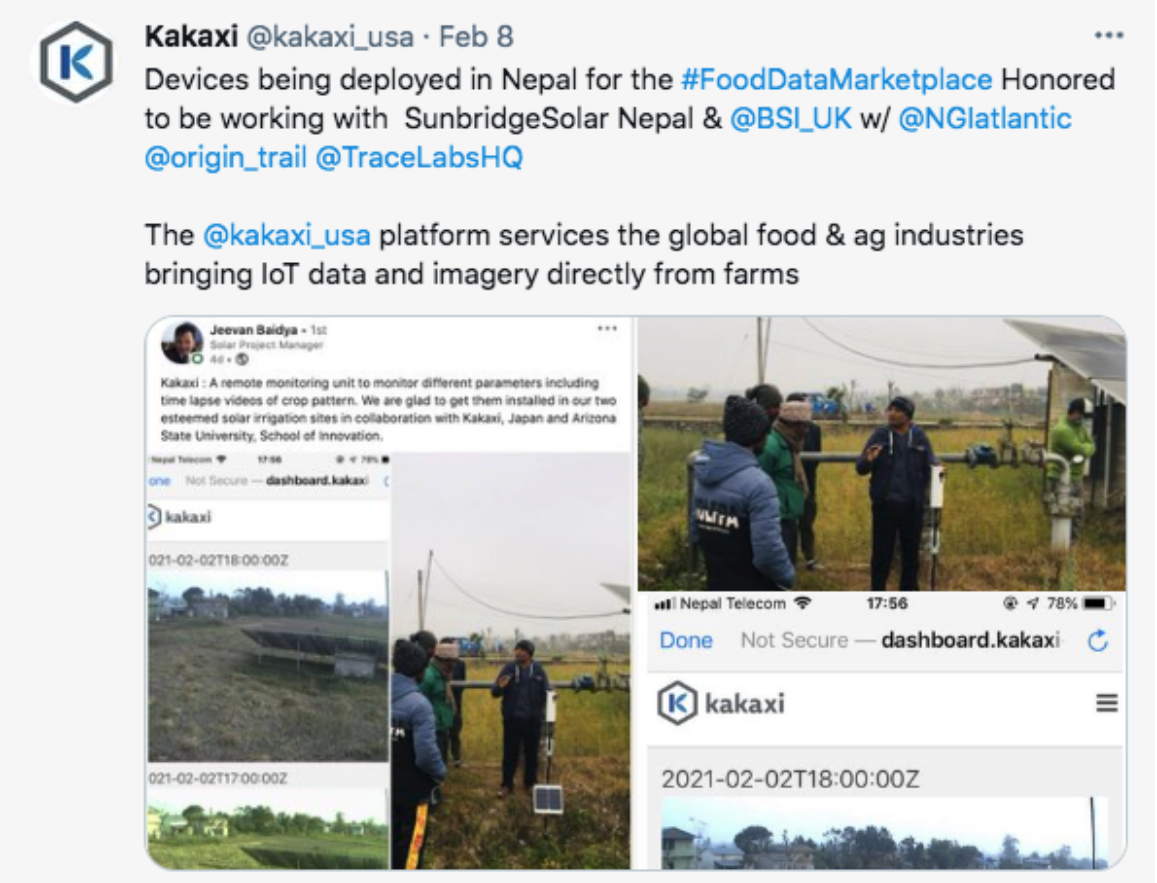
Picture: Deployment of Kakaxi devices in Nepal



In Phase 3 of the project our focus was dissemination activities, where our main objective was to showcase the data marketplace technology developed on the OriginTrail Decentralized Knowledge Graph (DKG) through the project. The DKG organizes humanity's most important assets by making them valuable, verifiable and discoverable. It connects the physical world (art, healthcare, fashion, education, supply chains, ...) and the digital world (blockchain, smart contracts, Metaverse & NFTs, and DeFi, …) in a single connected reality. For this purpose, we organized four webinars for relevant audiences. Our main audience at webinars were the Trace Alliance associated members, because of their existing interest in deploying OriginTrail in supply chain case studies.

4.1 Discussion and Analysis on Results

Throughout the project our analysis showed positive signs in the project's development. Almost all supply chain stakeholders positively perceived the value in the captured data and identified one or more potential buyers of such data. What was even more exciting was that each use case identified different stakeholder groups that were interested in the datasets, e.g.:

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- Irish distillery - farm data were valuable for both, distillery and the large malting companies to substantiate their differentiation on the market,
- Nepal farmers - farm data were valuable to public agencies in Nepal,
- Cocoa producers - aggregate farm data were valuable to brands purchasing from local producers.

Table: Key use case descriptions, objectives during the project, lessons learned and results:

Country	**Company / Use case**	**Challenges**	**Lessons Learned**	**Result**
Ireland	Monasterevin Distillery / whiskey production	COVID-19 slow-down	Monasterevin perceived that the use of OriginTrail-based FDM led to business improvements and decided to continue their exploration. Together, we will explore how to utilize FDM data within the wider scope of our collaboration, such as including it in the consumer application that allows consumers to see and verify the origin of their whiskey.	Equipment successfully deployed and value of produced data confirmed. Monasterevin and Trace Labs are continuing to explore the use of FDM beyond the NGI Atlantic project.
Colombia	Aroco / cacao crops cultivation	COVID-19 slow-down, inability to import Kakaxi devices (customs clearance issues), Kakaxi US operations shutting down, impacting the collaboration with the Colombian partner	Time to materialize the objective is crucial in projects like NGI Atlantic where stakeholders must intensively collaborate. This use case showed how unforeseen challenges such as complex customs clearance processes and partner challenges can impact the successful execution of a project.	Equipment never reached the intended destination, therefore the use case could not be validated as intended.
Nepal	Sunbridge Solar / NGO supporting communities	COVID-19 slow-down	After the implementation, Sunbridge Solar did not decide to continue using FDM and Kakaxi devices. Those technologies were not financially viable for continuation (the costs-value ratio was not favorable), therefore the usage of devices stopped after the project ended.	The value of FDM data did not justify the costs in this use case, so operations will not continue beyond the NGI Atlantic project.

With the FDM experiment, we finished use cases definition in all three chosen food supply chains. However, the experiment deployment was unfortunately only partially successful, in two out of three. In one project we encountered issues already prior to actual field deployment (Colombia), whereas in two others we were successful in field deployment. One

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project did not continue after the project ended due to unfavorable price-value ratio and the other one project has entered into a post-project extension.

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5 Project TRL Results

We advocate the FDM model in the NGI Atlantic has reached TRL 8, system completed and qualified.

By entering this project, we leveraged previous results from the NGI LEDGER programme, where certain infrastructural components had already achieved TRL7, with the new ground of proof of concept - a solution of making Kakaxi devices “FDM enabled” and enabling them to push data securely to the OriginTrail Decentralized Network.

The project with trusted data-exchange technology that has been developed for the FDM, and which enabled the development of additional (new data marketplace) applications, provided system completion and qualification by an innovation within the data and knowledge economy that was enabled by the OriginTrail protocol.

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6 Exploitation, Dissemination and Communication Status

Our dissemination activities were heavily focused in the final phase of the project.

Already during the project, the deliverable and phase results of the NGI Atlantic project were communicated by both project partners, Trace Labs and Kakaxi Inc., over their social media channels (links are available in the footer):

- Blog post announcing the project[19];
- NGI Workshop[20];
- Devices in Nepal getting deployed[21].

High level of involvement from the stakeholders' side was crucial toward the end of the project where disseminating their stories was at the core of the communication content.

Table: Key KPI results are provided in the following table

#	Description	Result
1	Number of different food supply chains in experiments	3
2	Percentage of successful implementations	66.6%
3	Percentage of post-project continuations - out of total number of use cases - out of successful implementations	 33.3% 50.0%
4	Deployed Kakaxi devices - number of planned in the project plan - actual number deployed in experiments (successful implementations) - percentage of completion	 12 7 58.3%
5	Supply chain experiments reaching financial sustainability - number - out of successful implementations	 1 50.0%
6	Registered new business requests (Hubspot entries) - total number received - Food Traceability use case - Industrial Data Marketplaces use case - Get in touch with Trace Labs - planned number of requests - percentage of success	 180 68 35 77 100 180.0%
7	Showcase webinar participants - expected number - actual number - percentage of success(1)	 200 14 7.0%

Comment: (1) We couldn't do the joint webinar with Kakaxi for their operational reasons, which requested pivotal rework of the webinar concept and consequently also impacted overall promotional activities.

19 https://medium.com/origintrail/food-data-market-goes-global-with-eu-commissions-ngi-atlantic-b0004b4761b4

20 https://www.youtube.com/watch?v=qISQaecD9EI&t=1856s

21 https://twitter.com/kakaxi_usa/status/1358840960550076420

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Four webinars[22] were organized towards the end of the project to showcase the technology working in the real world and to access different relevant audiences. On the webinars we introduced the OriginTrail Decentralized Knowledge Graph, we explained the deployment of the Kakaxi devices for the three use cases (Monasterevin Distillery in Ireland, Aroco cocoa fields in Colombia and Sunbridge Solar agricultural production in Nepal), objectives and pitfalls and discussed how successful each of those cases was. Furthermore, the dissemination of the results was made within the OriginTrail ecosystem (Twitter 19.4k+, Facebook 11.4k+, Reddit 9.2k+).

[22] https://www.youtube.com/watch?v=xuRUVXUNd-Y

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7 Impacts

Impact 1: Enhanced EU – US cooperation in Next Generation Internet, including policy cooperation.

The impacts the project brought on EU-US collaboration were to be created in the following domains:

- Proliferation of privacy and trust enhancing technologies
- Dissemination of experiment results globally to assert EU-US leadership and expand the use of privacy and trust enhancing technologies
- Knowledge-transfer related to data marketplaces and farm IoT devices
- Mapping existing data standards to enable seamless cross-continent data exchanges.

This EU-US partnership resulted in the development of new ways of incentivising data capture using a decentralised data marketplace and a business model to ensure sustainability of the cross-Atlantic collaboration. We aimed to bring beyond-state-of-the-art privacy enabling technologies and contribute to the development of a more fair and inclusive data economy to EU and US agrifood supply chains.

Impact 2: Reinforced collaboration and increased synergies between the Next Generation Internet and the Tomorrow's Internet programmes.

The FDM project involved partners that were bridging two Innovative environments, San Francisco-based Kakaxi and EU-based Trace Labs. What has already been observed with closer collaboration between the partners is that much more awareness can be built by exchanging know-how of different opportunities in respective continents, allowing even greater convergence of activities between different programmes and achieving higher impacts because of it.

Impact 3: Developed interoperable solutions and joint demonstrators, contributions to standards.

The FDM project has put great importance on interoperability, especially with the utilisation of OriginTrail Decentralised Network that supports all major supply chain and DID data standards, including GS1 EPCIS (and the upcoming EPCIS 2.0), GS1 CBV, W3C VC, W3C PROV and W3C WoT. Such an approach has decreased the vendor lock-in potential and provided greater portability of data for all stakeholders.

The impact has been addressed by aligning both solutions as well as adopting the aforementioned open data standards as the basis for exchanging data.

Impact 4: An EU - US ecosystem of top researchers, hi-tech start-ups / SMEs and Internet-related communities collaborated on the evolution of the Internet

This EU-US partnership started already during the NGI LEDGER program. The track record of taking part in an NGI initiative already brought a significant level of convergence between both partners and significantly progressed during the NGI Atlantic programme, especially in topics of privacy and trust enhancing technology development and decentralised data exchange.

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8 Conclusion and Future Work

FDM is an inclusive marketplace bringing up new economic models for sustainable food supply chains. It allows farmers and food companies to keep control of their data and offer it for purchase.

The Monasterevin Distillery in Ireland, Aroco in Colombia and Sunbridge Solar in Nepal were the three testbeds within the NGI Atlantic experiment where Kakaxi IoT devices were deployed and tested to aggregate farm data and offer it for sale through the FDM.

The goal of this experiment was to develop the integration enabling trusted data exchange between Kakaxi IoT devices and the FDM, seeking to show how impact created in these testbeds can be expanded to food supply chains globally, ultimately making our food supply chains become more trustworthy, transparent, and our food products safer.

We were validating that farmers would be able to create an additional revenue stream by monetising data captured by the Kakaxi devices. As farmers kept devices in the fields, data constantly flowed towards the FDM. Following the appropriate data standards (W3C WoT, GS1 EPCIS, W3C Verifiable credentials), data was kept in the private part of the OriginTrail knowledge graph with corresponding fingerprints stored on the blockchain.

The project was successfully implemented in Ireland and Nepal, but unfortunately not in Colombia, as Kakaxi US operations were shut down during the project which impacted the collaboration with the Colombian partner (Aroco). Out of two successful implementations, the project in Nepal discontinued with the project-end due to an unfavorable costs-value ratio. The table below summarizes the implementation of the three used cases.

Table: Project use cases and final results in the project implementation

Use case	Final status	Continuation	
Monasterevin Distillery in Ireland	Kakaxi devices successfully deployed and connected with FDM infrastructure	Yes	They estimated that the continuation of the project would successfully affect their business.
Aroco in Colombia	Kakaxi devices not deployed due to unforeseen complexities with customs clearance and discontinuation of Kakaxi US operations	No	The project was not implemented, so there is no possibility for continuation.
Sunbridge Solar in Nepal	Kakaxi devices successfully deployed and connected with FDM infrastructure	No	They estimated that the continuation of the project would not successfully affect their financial operations.

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We have achieved that farmers were able utilize FDM and put their datasets on the marketplace and set up relevant discovery settings. According to the settings, appropriate publishing of metadata (identifiers like GS1 GTIN, SGTIN, GLN) were executed and farmers were able to achieve the prices they had expected to achieve.

On the other side, interested downstream partners and other stakeholders were able to discover the datasets and obtain them via FDM at the price provided by the farmers. Their motivation to purchase stemmed from multiple drivers - product genuinity, safety, quality that were important to them for objectives like retailer/certification compliance, quality assurance and achieving sustainability goals. Certain public agencies were interested in obtaining data for statistical analysis and validating/improving their policies.

In addition to the initial project objectives, the underlying trusted data-exchange technology developed for the FDM also enabled additional new data marketplace applications on top of it, which exceeded project goals.

With this experiment we were researching and innovating in the domain of data and knowledge economy, focusing on trusted data exchange enabled by distributed ledger technologies (DLTs), primarily the OriginTrail protocol. Our work and experience from this experiment will be the basis for future research and innovation within this domain, focusing further on data privacy, data integrity, data interoperability, and data interconnectivity. We will continue to develop the open-source OriginTrail protocol for trusted data exchange as well as research new business applications for the technology developed.

The project was granted an extension on 24 September 2021 for one (1) month from its original deadline 30 September 2021 due to COVID-19 lockdown and Kakaxi import/export limitations and was therefore completed on 31 October 2021.

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9 References

Trace Labs and British Standards Institution (BSI) launching Instruments of Trust Whitepaper [23].

Trace Labs (OriginTrail core developer) a member of the GS1 EPCIS 2.0 Working Group[24].

GS1 Yellow Paper[25] on Bridging Blockchains mention of OriginTrail.

[23] https://www.linkedin.com/posts/bsi_blockchain-white-paper-activity-6673942555635277824-aZ6n/

[24] https://medium.com/origintrail/origintrail-joins-the-gs1-global-epcis-cbv-2-0-a032b98d9437

[25] https://www.gs1.org/sites/default/files/bridging_blockchains_-_interoperability_is_essential_to_the_future_of_da.pdf

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10 Glossary

Table: Glossary in the document

5G	Fifth Generation (mobile/cellular networks)
NGI	Next Generation Internet
R&D	Research and Development
SDN	Software Defined Networks
TRUST-IT	TRUST-IT (Project Partner)
VNF	Virtual Network Function
WIT	Waterford Institute of Technology (Coordinating Partner)
BSI	British Standards Institution
FDM	Food Data Marketplace
NGI	Next Generation Internet
ODN	OriginTrail Decentralised Network

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Deliverable 3: Part II

Financial and cost information

This part is to be treated as a consortium confidential deliverable, and access is restricted to consortium partners and EU commission operatives.

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On behalf of <Organisation Name>, I, <Name of the PI> confirm that this funds utilisation report is in accordance with the contract already in place between <Organisation Name> and Waterford Institute of Technology under financial support to third parties from Article 15 of Grant Agreement number 871582 — NGIatlantic.eu. I confirm that this report also includes all the expenditures (limited to PM and travel) incurred by all EU partners in this project and adhere to all instructions contained in H2020 Annotated Model Grant Agreement[26]. These are referenced in section 3 and 5 of the contract. I also confirm that any applicable VAT or tax payments on the amount due to the Grant Recipient shall be fully borne by the Grant Recipient.

Signed for and on behalf of

Organisation Name

……

Full Name

Title

Complete Address

26

http://ec.europa.eu/research/participants/data/ref/h2020/grants_manual/amga/h2020-amga_en.pdf

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