Sellafield DLT Field Lab

Harnessing the power of distributed ledger technology: how Digital Catapult's Field Lab methodology can transform your business

July 2022

In collaboration with

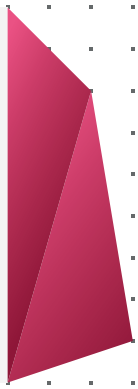
Sellafield Ltd

CATAPULT Digital

Contents

Executive summary

Sellafield worked in collaboration with Digital Catapult to run a DLT Field Lab to explore how distributed systems and distributed ledger technology could be used to solve current and future nuclear industry challenges.



As the UK authority on advanced digital technology, Digital Catapult's remit is to enhance the UK's economy through the appropriate uptake of advanced digital technologies, including distributed systems. Our Field Labs are a proven method for growing the understanding, readiness and uptake of technological transformation within an existing business or ecosystem.

We brought together stakeholders from Sellafield, the UK's Nuclear Decommissioning Authority, and across the wider nuclear industry, as well as technology innovators, startups and scaleups. Discussions around the multiple technical and operational issues that Sellafield faces led to the identification of two pressing challenges to address: **tracking nuclear waste** and **managing worker credentials.**

Both involved the need to coordinate multiple independent stakeholders to enable trusted data exchange and verification, making them suitable candidates for the application of distributed systems and distributed ledger technology. Following a rigorous selection process, two UK tech start-ups, RKVST and Condatis, were then selected to partner with Sellafield to develop solutions to these challenges.

The structured DLT Field Lab approach benefits both corporate sponsors and participating startups and scaleups.

Despite numerous pressures from the COVID-19 pandemic, a nine-month period of close collaboration and commitment from all consortium partners saw the successful deployment of working prototype solutions to each of these challenges at a reasonable cost.

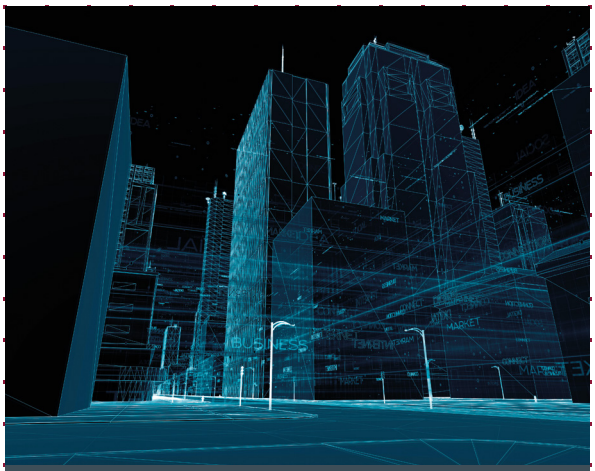
RKVST and Condatis delivered several highly innovative elements. Subsequent review and/or trial of their prototype solutions at TRL6+[15] demonstrated positive business cases, with potentially significant cost and time savings arising from:

- Improved data transparency and multi-party coordination
- Improved item-level traceability
- Intrinsic digital auditability
- Automated compliance with regulations
- Enhanced digital security

A number of future directions became apparent during development, including:

- Enhancing item-level traceability with direct machine-to-machine internet of things communications linked to a ledger
- Enhancing the security, auditability, and control of the nuclear waste tracking solution by consuming credentials from the nuclear passport solution

RKVST and Condatis are now exploring a potential collaboration to combine the power of both of their solutions to link worker credentialing to waste management data access in the highly regulated nuclear environment.



Digital Catapult Field Labs grow the understanding, readiness and uptake of technological transformation within an existing business or ecosystem.

The nuclear sector presents an exciting opportunity to implement advanced digital technologies for driving operational improvements and cultural transformation.

Our DLT Field Labs showed how some of the challenges that seemed perplexing at the start of our journey have been deciphered through innovation and collaboration.

As we embark on our mission to aid the post pandemic sector recovery by implementing new and advanced digital solutions, such highly regulated sectors will pave the way in generating the essential learning outcomes that can be exploited on a cross-sector basis throughout the UK economy.

Pierre Baisle – Head of Innovation Practice, Digital Catapult

Introduction

The UK's nuclear sector is facing multiple challenges.

The Nuclear Decommissioning Authority (NDA) is the UK's primary authority for delivering safe, sustainable, and publicly acceptable solutions for nuclear waste management. The work of the NDA and its subsidiaries is highly complex, and is likely to cost the UK taxpayer over £120 billion over the next century, at current prices.

The NDA operates 17 of the UK's 43 nuclear sites, the largest of which is Sellafield, in Cumbria. Sellafield Limited is the world's largest nuclear decommissioning organisation, with an annual budget of over £2.1 billion – a figure that has risen by an average 1.2% per annum over the past five years[1]. As Sellafield ramps up to deliver its enterprise strategy roadmap[2], the volume of nuclear waste it needs to process is expected to increase from 202,000 cubic metres in 2019 to 4.3 million cubic metres by 2135[3].

SEEKING A LONG-TERM SOLUTION

In line with the Nuclear Sector Deal[4] with the UK government, by 2030 the NDA aims to lower the cost of new projects by 30%, and reduce the cost of decommissioning by 20%.

To be able to deliver these objectives, Sellafield is embracing innovation and actively seeking best practice solutions for exploiting data for better decision making, and championing digital transformation to increase productivity.

We met with Sellafield's CTO and team in September 2019. Following this meeting, Sellafield Limited engaged Digital Catapult to run a DLT Field Lab to address critical challenges to productivity and data-sharing across the nuclear estate, through the application of distributed ledger technologies.

Developing prototypes that could demonstrate the value of this cutting-edge technology to the nuclear industry would pave the way for a cultural shift towards digitalisation, while supporting the delivery of the mission-critical targets for both Sellafield and the NDA.

DLT FIELD LAB: AN EFFECTIVE DEMAND-SIDE ACCELERATOR

The Digital Catapult DLT Field Lab was created to meet an industry need, enabling organisations at different stages of the technology maturity journey to quickly understand new digital technologies and test new ideas with practical examples in live (or near-live) environments.

Unlike traditional supply-side accelerators that focus on the early stage growth of innovative businesses, the DLT Field Lab is a demand-side accelerator for growing the understanding, readiness and uptake of technological transformation within an existing business or ecosystem, which is where the barriers to overcoming tragedies of the commons can appear most insurmountable. The DLT Field Lab follows a methodology that addresses these issues in a practical, low-risk, high-reward manner.

Tragedies of the commons in the digital world are primarily challenges of data sovereignty and data sharing. Owning and sharing data across organisational boundaries can be challenging.

The structured DLT Field Lab approach benefits both corporate sponsors and participating startups and scaleups.

The corporate sponsor – in this case, Sellafield – gains access to the best advanced technology providers (which they may not have found organically). Startups and scaleups benefit from the opportunity to trial and mature their value propositions using real world use-cases, and so grow their businesses.

The DLT Field Lab complements ongoing digital transformation programmes within an organisation or ecosystem – it runs in parallel with them to provide the greatest chance of early success. It also enables participating industry sponsors to understand the value of developing technical solutions using agile project management principles (see Appendix 2).

DLT FIELD LAB APPROACH

A DLT Field Lab is delivered in two phases. In Phase 1, the key organisational challenges for the corporate sponsor are identified, and then a suitable technical partner is selected using a rigorous and competitive process. Phase 2 is the agile development phase, ensuring corporate stakeholder input and visibility throughout, and to maintain focus on the key objectives of the challenge. The development phase ends with real-world experimentation and business analysis to evidence the potential value of the solution, and proposed routes for its delivery.

Throughout both phases, Digital Catapult acts as a facilitator and advisor, providing independent input on technical approaches, suggestions for maximising the value of the experiment, guidance on agile methodology, and general advice to both the corporate sponsor and technical partner for maintaining a productive partnership.

Phase 1: Challenge framing and open call

The first phase of the Field Lab begins with Digital Catapult convening senior stakeholders from the corporate sponsor along with selected technical experts and innovators from trusted startups and scaleups. The aim is to collectively uncover, define, and prioritise shared organisational challenges, while the innovators demonstrate current technologies and work with our experts to assess what is practical and achievable. The output is a structured challenge or challenges.

Discussions with industry stakeholders around the multiple technical and operational issues that Sellafield faces led to the identification of two suitable challenges for the DLT Field Lab: **tracking nuclear waste and managing worker credentials.**

Digital Catapult then opens applications, inviting potential development partners to submit their technical approaches to address the challenges. This leverages our extensive network, reaching startups, scaleups, innovators and technology entrepreneurs. Shortlisted responses are judged via a rigorous competitive process in partnership with the corporate sponsor(s), through written applications and live pitches.

Phase 2: Agile development

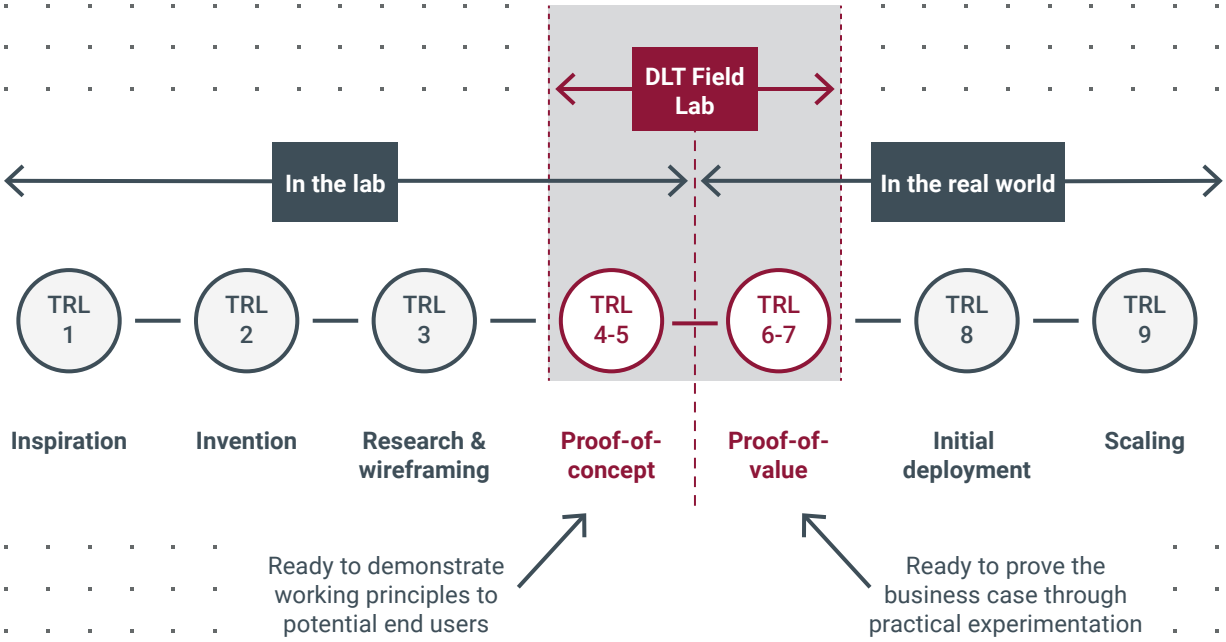
The second phase enables the selected technology partner(s) to develop and configure their product for a proof of value (PoV) experiment, based on requirements gathered from discovery workshops and direct feedback from the corporate sponsors. Proof of value extends beyond proof of concept, looking more deeply into the commercial and operational implications for adoption, and delivering a demonstration in a live or near-live environment.

Product development is undertaken using agile development – the ideal approach for building high-risk advanced digital technologies. This involves working in short cycles to build, demonstrate and collate feedback from the corporate sponsor, and iteratively release product increments at regular intervals.

By the conclusion of the DLT Field Lab, all parties should emerge with a more intimate understanding of the technology involved, a working demonstration system, and a business process analysis that describes the value of transformation and routes forward.

THE DLT FIELD LAB JOURNEY

DLT Field Labs are designed to accelerate corporate understanding and uptake, beginning at TRL 4 and aiming to demonstrate at TRL 6



COSTINGS AND TIMELINES

Indicative costing for the Sellafield DLT Field Lab

As Sellafield would be the sole client and contracting authority for this DLT Field Lab, they opted to make payments directly to the two selected startups following confirmation of adequate technical delivery by Digital Catapult. The total external investment for Sellafield would be approximately £500,000:

Digital Catapult:

£150k-£200k

Two challenge partners:

£250k-£300k, split evenly

Where there is a group of corporate sponsors, it is usual to pool funds to share risk and reward in the development of multi-party solutions, and we cascade payments to the successful startup/scaleup partners on behalf of the group.

Indicative timeline for the Sellafield DLT Field Lab

Initial discussions to contracting:

Two months

Phase 1:

Three months
(excl Christmas/New Year holiday period)

Open call:

Three months

Phase 2:

Nine to ten months

The Field Lab process and methodology has proven to be a safe and impactful way to explore the adoption of Distributed Ledger Technology for Sellafield.

Thanks to the constant support, guidance and technical expertise provided by the team at Digital Catapult, and the great work done by Condatis and RKVST, we have got useful results from these proofs of value, and a compelling business rationale to take this technology forward.

Edwin Matthews – Head of Technical & New Capability | Remediation, Sellafield Ltd

Sellafield DLT Field Lab: Phase 1

Challenge framing and open call

The challenge framing activities took place across two full-day in-person workshops, held in Manchester in January and March 2020. These were well-attended by representatives from across the nuclear industry, as well as selected UK DLT startups and scaleups.

The workshops were structured as a mixture of didactic sessions for each side to learn from the other, pitching sessions and demonstrations from the invited innovators to present context, and round-table sessions to dive more deeply into potential challenges and solutions.

From a range of potential challenges uncovered, discussed and collaboratively refined at these workshops, the two most relevant were selected to be taken forward into development based on a combination of factors, including:

- **Scale** – not so small as to be insignificant, but not too large to be unsolvable by a single company
- **Scope** – well understood by industry participants and realistically bounded
- **Proximity** – a problem being faced now, or in the near future, which needs addressing
- **Appropriateness** – is this a truly multi-party challenge that can benefit from the application of DLT, and not just an authoritative central database?
- **Technological readiness** – do DLT solutions that can be readily applied to address the challenge already exist, or are any under development?

CHALLENGE 1: NUCLEAR WASTE TRACKING

Sellafield is currently home to 80% of the UK's nuclear waste: all that is generated by the UK's 13 operational nuclear reactors, as well as 50,000 tonnes imported for reprocessing (mainly from Europe and Japan).

Over the next 120 years, Sellafield is committed to decommissioning and rendering safe an estimated 1.8 million tonnes of nuclear waste derived from facilities that date back to the 1950s, and although more than 90% by volume will be low-level waste (LLW) or very low-level waste (VLLW), this still requires meticulous handling and diligent record-keeping. Data from today will be essential information for nuclear workers in the twenty-second century and beyond.

Locating and tracking nuclear waste as it moves through the NDA estate requires significant effort, involving the manual coordination of multiple entities and actors across the nuclear waste management lifecycle, querying and updating information in dispersed data silos, and continually ensuring compliance in an evolving regulatory landscape.

The primary goal of the nuclear waste tracking challenge was to build a working prototype for a digital solution that would:

- Provide global waste asset visibility
- Ensure compliance with waste acceptance criteria
- Allow device-agnostic access
- Deliver continuous information assurance with accessibility, security, and resilience
- Integrate with industrial internet of things (IoT) sensors
- Result in cost savings and process improvements

CHALLENGE 2: NUCLEAR PASSPORTS FOR WORKER CREDENTIALS

Sellafield employs around 11,000 people; there are 600 job functions that require workers to be suitably qualified and experienced (SQEP); and over 2,000 different tasks require monitoring to ensure those completing them are suitably qualified.

Managing and verifying the credentials of diverse personnel across the nuclear estate and related supply chain is highly challenging, involving multiple independent partners, various reporting and issuing authorities, and continual updates to training and security profiles – all within a complex regulatory environment.

The primary goal of the nuclear passport challenge was to build a working prototype for a digital solution that would:

- Optimise staff onboarding and movement
- Provide secure and verifiable credentials
- Enable end-user control over personal data
- Integrate with and function across multiple NDA sites
- Result in cost savings and operational improvements

One in every five steps of the overall nuclear waste tracking process currently includes a paper form or manual traceability requirement. Indelible and persistent audit trails are critical for the long-term safety and security of the UK's nuclear waste.

THE OPEN CALL

The open call was issued in September 2020 (having been rescheduled in response to the pandemic), when the two challenges were posted on the Digital Catapult website and shared through social media and interpersonal channels.

The invitation to respond included detailed requirements, which included:

- A suitably experienced and resourced team
- The potential solution to be at or beyond TRL4[15] (key functional software components already validated in a laboratory environment)
- Technology suitable for a private enterprise deployment
- Not only relying on the pinning of data on a public blockchain

Response was positive, with hundreds of readers reached. The open call resulted in 32 long-listed applicants from four different countries, with businesses ranging in size from 2-10,000 employees.

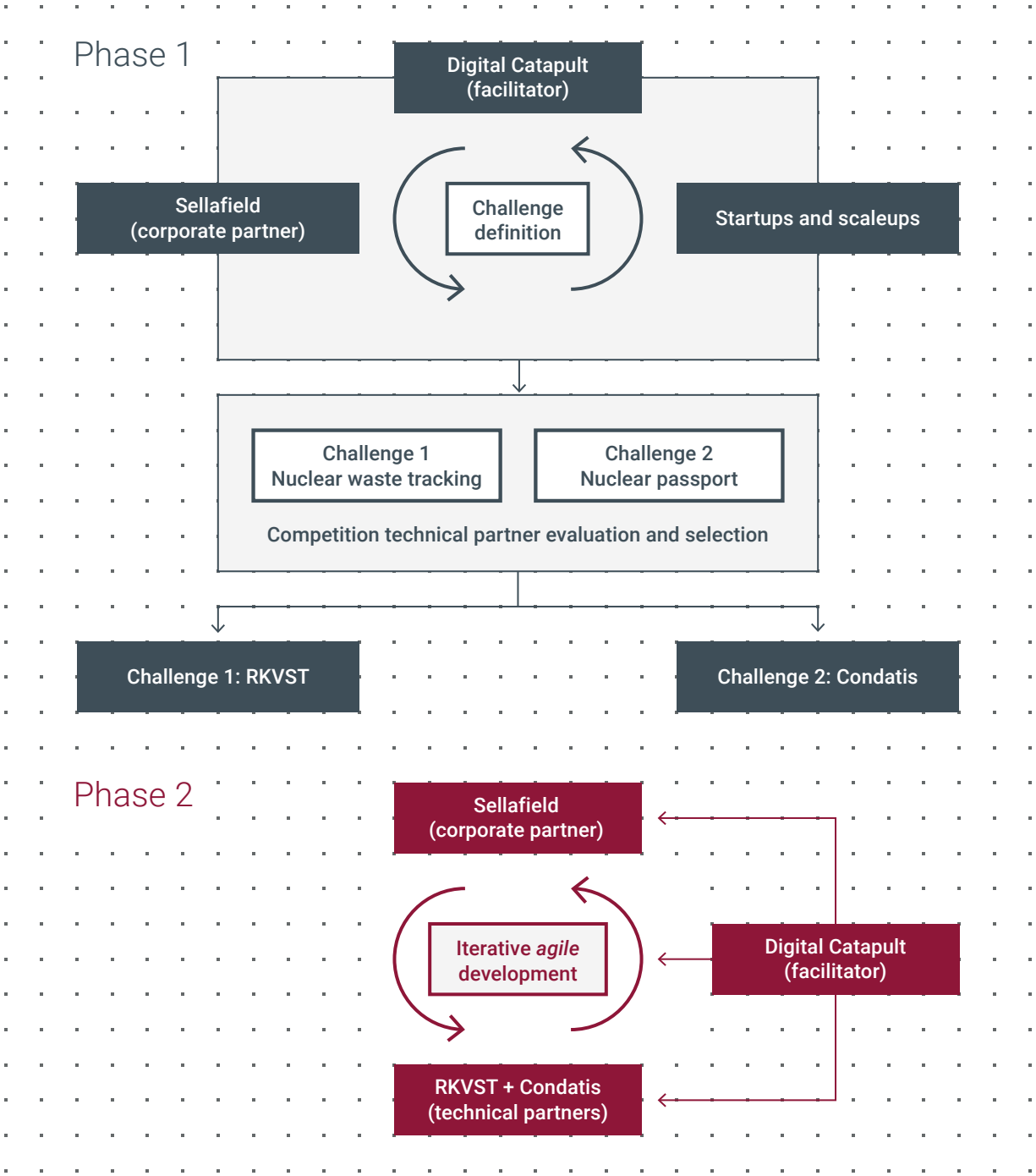
Following a formal review undertaken by Field Lab stakeholders from Digital Catapult and Sellafield, this was narrowed down to a shortlist of eight – four for each challenge. These eight companies were invited to present a live demonstration of their existing solutions to a panel of experts from Digital Catapult, Sellafield and external independent parties. Two from each group of four were then selected for a longer pitching and discussion session with Sellafield, which took place in November 2020.

The successful companies selected to build and demonstrate solutions to each challenge were:

- Nuclear waste tracking: RKVST Ltd
- Nuclear passport: Condatis, a trading name of Sitekit Systems Ltd

Following individual contracting between Sellafield and each of the winners, solution development began in January 2021 and ran until October 2021.

DLT FIELD LAB ACTIVITIES



RKVST Zero Trust Fabric

To know 'what's in the box', you need to trust data from deep within the supply chain.

RKVST's (pronounced Archivist) product is a Zero Trust fabric that boosts confidence in shared data for speeding critical decisions. RKVST combines cloud-based storage, identity and access management, and permissioned blockchain and to deliver continuous assurance in shared asset data.

It delivers verifiable digital trust between organizations through:

Security: The system is protected from unintended or unauthorized access, change, or destruction with confidentiality, integrity and availability.

Privacy: Individuals or groups can govern what information related to them may be processed, and by whom, and to whom that information may be disclosed.

Safety: RKVST enables stakeholders to exchange more high-fidelity operating information than ever before, leading to greater understanding of context and a greater capacity to make the right safety decision, even in novel situations.

Reliability: The system alerts users to changes in configurations and quickly delivers the right information to the right place to drive the critical decisions and avoid surprises and blind-spots.

Resilience: RKVST builds the foundation of multi-party data operations with continuous assurance that gives confidence to keep running even in degraded conditions.

All these attributes are underpinned by the system's provenance, governance and immutability guarantees that enable continuous assurance and can be relied upon to prove who did what when.

RKVST is SaaS, hosted on Microsoft Azure, which delivers the power of blockchain technology through a simple-to-consume API, integrating with any internet-accessible application through industry standard authentication and authorization.

RKVST is created in Cambridge, UK by a team skilled in cryptography, system security, SaaS, DevOps and blockchain.

RKVST.com
info@rkvst.com
linkedin.com/company/rkvst
@RKVST_inc

Enabling swift and secure staff mobility

Condatis is a UK leader for bespoke external identity solutions, and one of only four global Microsoft Gold Partners selected by Microsoft for Azure AD Verifiable Credential consultancy. They actively shape decentralized identity's strategic direction as members of the Sovrin Technical Governance Board, the Decentralized Identity Foundation and Open Identity Exchange.

Working with Sellafield and Digital Catapult, Condatis explored decentralized identity using their verifiable credential Staff Passport platform.

Staff movement and identity verification: Training credentials stored in an employee's digital wallet can be proved in a single interaction, saving time and costs.

Cryptographically secure: Ensuring sensitive personal information is stored securely and only accessible with explicit consent from the individual.

Interoperable: Offering vendor solution interoperability that allows clients to issue and verify credentials on a preferred technology stack.

Traceable: One in every five steps currently includes a form or manual traceability requirement – an immutable record can store information on a ledger and remove this need.

Easy to access: Empowering the right people in organizations to set, enforce and execute complex data sharing policies across enterprise boundaries.

condatis.com/did
info@condatis.com
linkedin.com/company/condatis
@CondatisUK
youtube.com/condatis

Working together, Condatis, RKVST and Sellafield have shown that distributed ledger technology is closer to industrial readiness than often perceived. The DLT Field Lab process helped define the right challenges to ensure relevance of this technology to be used for all or part of the solution.

DLT has huge potential outside of financial services in the wider market, and we hope that the use cases successfully trialled with Sellafield and partners will shine a light on this. We also hope this work raises interest from many other players to embrace distributed approaches to problem solving and data sharing, exploring new ways to improve their businesses and to keep innovating.

Rob Learney – Head of Technology | Distributed Systems, Digital Catapult

Sellafield DLT Field Lab: Phase 2

Building a software solution that relies upon DLT to arrive at a shared state of events between disparate stakeholders comes with unique challenges. Digital Catapult's technical expertise and market neutrality ensured fluent communication and collaboration throughout the agile software development process. Unlike traditional software engineering, which focuses on transforming a single organisation, the design of a decentralised solution must meet the needs of all potential user organisations.

Technical implementation

The technical design and implementation phases for each challenge were led in parallel by the winning start-ups, RKVST and Condatis. These teams began by running research, mapping and design workshops with stakeholders from Sellafield and the wider nuclear sector.

The DLT-based software solutions to meet each challenge were then developed following an agile project management framework (see Appendix 2). Agile software development is suited to situations when there are many unknowns, and is designed to cope with rapidly changing end-user requirements while continuously delivering functional and demonstrable results. It involves working in sprints to build, demonstrate results and collect feedback, continually iterating to work towards a viable solution to the challenge.

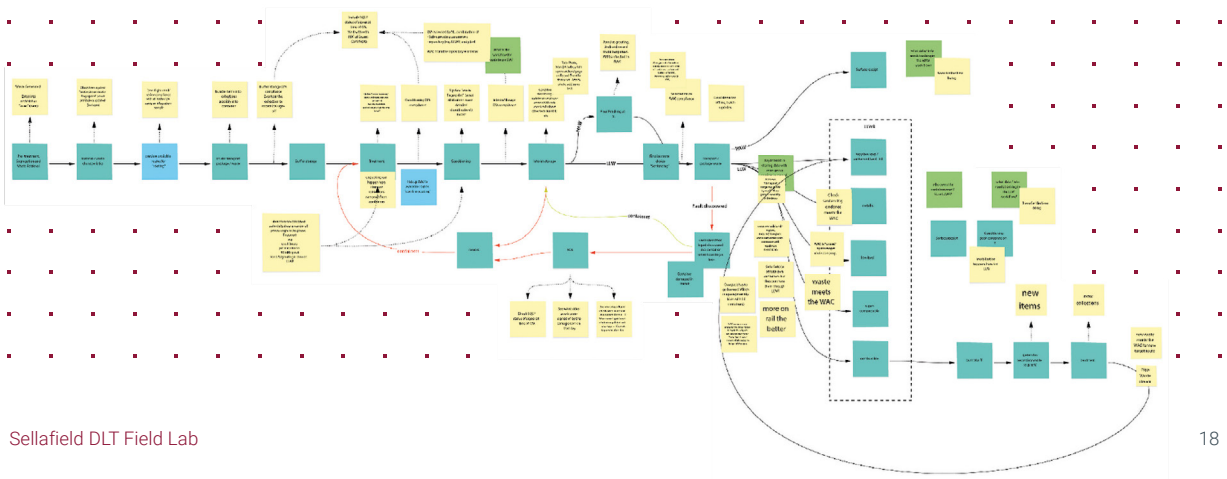
Challenge 1: nuclear waste tracking (RKVST)

DESIGN WORKSHOPS

RKVST's (pronounced Archivist) design workshops primarily studied the flows between stages in the lifecycle and events that surround low-level nuclear waste handling, highlighting the opportunities for their eponymous DLT-based platform to digitise and streamline activities and operations.

The workshops also explored the concept of an evolving waste acceptance criteria (WAC) document, looking at how it would drive compliance checks for waste assets through their lifecycle by defining conditions for acceptance (CfA), as well as the key points of data capture and communication between parties.

Identifying who is in custody of what at critical points in the waste lifecycle helped to define an ideal permission structure for digital records relating to waste assets.



TECHNICAL SOLUTION: THE RKVST PLATFORM

RKVST produce a self-titled software-as-a-service platform, which is hosted on Microsoft Azure cloud infrastructure. It behaves as a trusted data sharing system with a backend NoSQL database (Azure CosmosDB), with events relating to records anchored to transactions, which are batch-written to a privately hosted instance of the Quorum blockchain. Quorum is derived from the public Ethereum blockchain, but is highly customised for secure enterprise usage.

Blockchain records signifying real world assets on the RKVST platform are each represented by a unique digital twin, which is passed between actors to reflect that asset's live status. Each twin contains data attributes corresponding to data fields from a traditional record.

RKVST's user interface (UI), built with React.js (a JavaScript library), provides a simple and accessible front end through which users can add new information and query existing information. It uses attribute-based access control (ABAC) for managing permissions for records created and updated on the platform. This provides the discrete control suitable for a complex multi-party environment, enabling intricate and nuanced levels of privacy without the need for intrusive changes to each organisation's access control systems.

This avoids the laborious process of having to harmonize roles and policies across multiple independent stakeholders for role-based access control, which would hinder the adoption of a multi-party solution to this challenge.

Policies are created using four main sets of attributes that determine permissioning:

Subject: who is trying to access (their qualifications, clearance level, role and so on)

Action: what kind of access is required (such as read, write, view, approve)

Object: what is being accessed (such as a waste asset's location history)

Environment: any other dynamic factors affecting access (such as time or location)

Private keys relating to user access permissions are managed via Azure Key Vault and stored in a cloud NoSQL database (Azure CosmosDB). These are protected by standard enterprise cloud security features.

Quorum's Tessera transaction manager sends and retrieves the data to and from the secure database, and also handles private peer-to-peer communications and management of permissioning keys.

Technical review

Using Quorum as the underlying ledger technology supports the credibility of RKVST's solution. Public Ethereum is currently the most actively maintained and developed DLT project, which makes it more likely that it will continue being developed and supported long term, and as a derivative able to share large parts of the codebase, Quorum directly benefits from this. Support for Byzantine fault tolerant consensus and the Tessera private transaction manager also justify its implementation in an enterprise setting.

Choosing Microsoft Azure for RKVST hosting will also be a benefit to many clients already using Microsoft cloud services. Being SaaS makes it accessible from any connected infrastructure, including alternative cloud service providers and private servers.

All of the RKVST SDKs are open source. By providing client access through a web API, industry standard REST APIs, and supporting OpenID connect for authentication and access control, RKVST allows organisations to connect with their own choice of standard tools – without needing to install any code or agents within their own network.

FINAL DEMONSTRATION

Although the project took place during the COVID-19 pandemic and resulting lockdowns, a live demonstration of waste handling workflows using the RKVST solution was not necessary to be able to prove its success. Increased use of video conferencing meant that more people could participate in demonstration sessions and provide their input and review of the final prototype.

Key user stories (challenge-centric requirements) enabled by RKVST were demonstrated during remote sprint demos, and at a final group presentation to nuclear estate stakeholders from the NDA, Sellafield, and the LLWR.

Total nuclear estate view:

How assets across the estate could be visualised and queried at high-level; simulated access controls for different stakeholders.

Improved operations with digital twins:

- The ability to model a route and ensure compliance with CfA at each asset touchpoint, in advance of waste assets being physically packed and transported.
- Simulation of successful operations for a range of potential stakeholders, with digital records showing assets moving through the waste lifecycle in compliance with CfAs.

Personal performance improvement:

Staff and related operating processes can be highlighted for improvement or supplemental training.

Handling evolving standards:

The creation and administration of policies relating to an evolving waste acceptance criteria (WAC) document, and how it immediately updates records across the platform.

Fault-evident behaviour:

When something goes wrong during the waste handling lifecycle, the platform supports reconciliation of the issue, providing the functionality to prevent and mitigate coordination issues between potential stakeholders.

No 'shredding or blackouts':

The immutable DLT-based record prevents data loss or tampering.

Secure hardware integration:

How various internet of things (IoT) data sources could feed into the platform and be visualised.

Mobile integration:

How records can be easily accessed and recorded in the field, with non-specialist hardware for data and event capture.

SOLUTION SUMMARY

Using agile methodology, RKVST further developed their platform over a period of nine one-month sprints, facilitated by technical experts from Digital Catapult. They subsequently demonstrated the value of the platform by providing a digitalised workflow assured by the underpinning DLT element. In our estimation, the overall solution was delivered to a high standard, at TRL6[15] (prototype demonstration in an operational environment).

Based on the final deliverables produced, RKVST has clearly demonstrated the value of DLT in a nuclear waste setting. It has shown significant potential to simultaneously:

- Streamline LLW handling operations
- Boost confidence in data-driven decisions
- Optimise coordination between organisations across the nuclear estate through trustworthy real-time accessibility to waste records data
- Improve traceability and provenance of both physical assets and the processes in the waste handling lifecycle with immutable evidence.

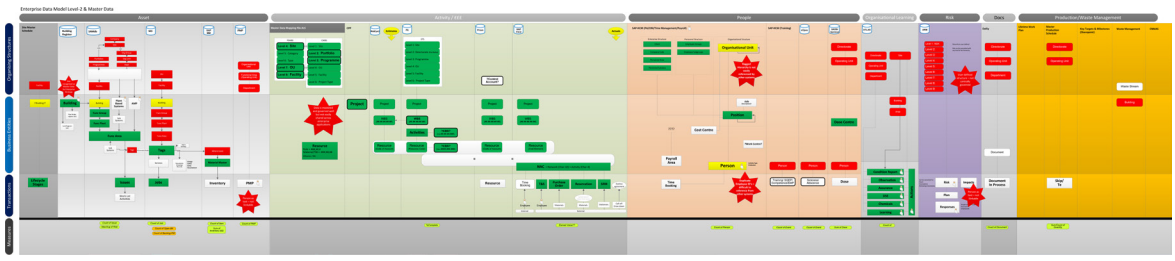
The nuclear waste tracking challenge managed under Digital Catapult's DLT Field Lab methodology has successfully demonstrated the value of DLT for asset handling in a highly regulated environment.

Challenge 2: nuclear passport (Condatis)

DESIGN WORKSHOPS

Condatis led a series of design workshops with Sellafield stakeholders to identify and define the cadence and style of work between the parties, as well as eliciting key success criteria for the final real-world experiments.

Two further sessions were undertaken specifically to identify the requirements of key Sellafield personnel involved in worker credentialing and training. The first focussed on journey mapping, capturing the various activities staff must undertake to meet and (prove they meet) the necessary training requirements, and the associated processes that drive these activities. The second was to develop a knowledge board (figure below), identifying gaps in domain knowledge on both sides and how to fill them over the development period. It was after this second session that the product backlog (list of development tasks) began to emerge, covering end-user activities and desirable product features.



TECHNICAL SOLUTION

Condatis developed their credentialing solution using agile scrum methodology. The work was divided into seven two-week sprints over a period of five months, grouped into three main configurations of the evolving product. The gaps between configurations were designed to allow feedback to be gathered and analysed from user trials to inform the subsequent configuration.

The team deployed their Condatis Credential Gateway technology to enable the demonstration of Sellafield's identity and training use cases. They used two parallel self-sovereign identity (SSI) software stacks, and interaction with existing data sources within a simulated Sellafield and wider NDA trusted framework.

The first stack focused on data-oriented design, using a cloud-based centralised 'identity hub' (or encrypted data vault) for storing credentials. It relies on Microsoft's SSI stack (the Microsoft Azure Active Directory Verifiable Credentials platform), which uses their open source Identity Overlay Network (ION)[5] to store records on the public Bitcoin (in theory, it could use a different blockchain if required). The Sidetree protocol[6], designed to be easy to integrate with Microsoft Active Directory, is used for writing and interacting with these records.

The second stack used Evernym's Verity credentialing platform[7], in a decentralised agent-oriented approach, where software agents acting on behalf of an individual exchange data with direct peer-to-peer messaging. This is built upon the Sovrin blockchain network[8], using nodes maintained and managed by a consortium of publicly known and reputable organisations (stewards), including SITA, Deutsche Telecom, MITRE and NEC.

For both solutions, the major features to be delivered were the ability to issue, review, and revoke SQEP credentials; the ability for users to store credentials on a mobile wallet; and for them to selectively disclose credentials. Condatis also built methods to individually verify the sub-components of a SQEP credential, and cumulatively confirm current SQEP status,

Sellafield's need for issuing and verifying credentials was modelled using web-based interfaces, with end-users holding their credentials in mobile phone-based digital wallets. However, Condatis also produced a report summarising the security advantages of SSI identity and potential options for non-mobile phone digital wallets, including NFC chip/cards, and paper-based QR code-verifiable credentials.

Technical review

SSI implementations can vary, but there are two fundamental approaches that may impact the end user and the governance of the deployed solution. In international SSI discussion groups, these appear as two different schools of thought, with subtle technical differences. One focuses on the DIDComm messaging protocol which organisations such as Evernym and Sovrin have been promoting for direct peer-to-peer connections. The other is based upon SIOP-DID which extends OpenID Connect with the concept of an OpenID Provider that is within the end-user's local control. Both of these are decentralised agent-oriented approaches, where software agents act on behalf of an individual to exchange data with direct peer-to-peer messaging.

Condatis is a bespoke integration partner for Microsoft's decentralised identity solution, which has been championing the SIOP-DID based approach.

Table 1: Comparison of data-oriented vs. agent-oriented SSI stacks

ELEMENT	SIOP-DID	DIDCOMM
SSI model	Microsoft, Digital Bazaar, Decentralised Identity Foundation	Evernym, Sovrin, Linux Foundation
SSI protocol	ION / Sidetree	Hyperledger Indy / Aries[9]
Communication protocol	SIOP-DID (Self-Issued OpenID Provider)	DIDComm over TLS
W3C verifiable credentials	Yes	
W3C decentralised identifiers[10]	Yes	
Decentralised identifier resolver	DIF Universal Resolver[11] (centralised)	Sovrin identity register (decentralised)
Keys + credential storage	Secure mobile wallet	
Implementation bias	Enterprise/service provider	End-user (holder of credentials)
Governance	No formal processes	Consortium agreements (stewardship)
Censorship resistant	No	Yes
Privacy protection	No	Yes
Scalability	Limited (records on Bitcoin network, high fees)	Highly scalable private network

FINAL DEMONSTRATION

Although the project took place during the COVID-19 pandemic and resulting lockdowns, a live demonstration of the Condatis nuclear passport solution was not necessary to be able to prove its success. Increased use of video conferencing meant that more people could participate in demonstration sessions and provide their input and review of the final prototype.

Key features of the Condatis solution were trialled remotely during sprint demos, and in a larger remote group setting with nuclear estate stakeholders from the NDA, Sellafield, and the LLWR.

User-centricity:

Solution ensures that sensitive personal information is stored securely and only accessible with explicit consent from the individual.

Process improvements:

The ability to issue credentials directly and instantaneously to an individual's mobile wallet. Intrinsic auditability for issuance and usage.

Portability:

Simplifies staff on-boarding and verification across sites. Also able to support credentials across multiple end-user systems.

Engaging entire nuclear estate:

Solution considers multiple user journeys and use cases across different SQEP functions.

Reduces costs, time and effort:

Instantaneous issuance and verification of credentials, automating SQEP verification and potentially eliminating manual paper-based assessments.

Cloud-based security:

Breaking negative stereotypes around 'the Cloud' from a security point of view.

SOLUTION SUMMARY

Employing agile software development practices, Condatis elicited requirements for issuing and verifying dosage and SQEP credentials. They delivered a system at TRL6[15] over a period of seven two-week sprints, supported by technical experts from Digital Catapult. The final prototype was successfully trialled with Sellafield site staff and with wider nuclear estate partners.

The SSI approach to nuclear passports was found to offer the potential to reduce paperwork and manual processing of staff credentials while drastically reducing the time involved in verifying credentials. With mobile phones configured to host digital wallets, the stored credentials are highly portable, improving staff mobility. Staff credentials can now accompany the staff member and be verified on demand when they move from one location to another across the nuclear estate.

The nuclear passport challenge managed under Digital Catapult's DLT Field Lab methodology has successfully demonstrated the value of DLT-based self-sovereign identity for worker credentialing in a highly regulated environment.

Business impact assessment

Digital Catapult delivered business case analysis and impact assessments alongside the development and demonstration of the two solutions by RKVST and Condatis.

NUCLEAR WASTE TRACKING

Improving traceability:

With one in every five steps of the overall nuclear waste tracking process currently including a paper form or manual traceability requirement, introducing indelible and persistent audit trails will be critical for the long-term safety and security of the UK's nuclear waste. Cryptographically protected records provide traceability and information integrity of nuclear waste assets both in transit and in storage at various sites.

With a DLT-based system, these events are evidenced by an assured, auditable log of historic events which is an irrefutable and immutable record of what has happened, when it happened, and who was responsible for the event[12].

All records are automatically saved and locked for posterity as new data is added, and the database can be queried at any time, allowing for asset provenance to be determined efficiently, and building trust and confidence between parties.

Process automation and compliance:

Twenty-five percent of current information workflows around nuclear waste handling have a high potential for automation, removing the need for manual work. Using a shared ledger to automate stage-gate processes and compliance with regulations as waste moves through the various Sellafield and wider NDA estate sites would help streamline and accelerate processes. This would be achieved by eliminating the unnecessary compilation and cross-checking steps characteristic of paper-based processes (printing, signing, and scanning, communication), and could allow employees to focus more on value-adding tasks.

With a shared ledger, key asset information can be accessed quickly and seamlessly across multiple organisations, enabling stakeholders at all levels to make interventions as early as possible, resulting in process optimisation through faster, assured decisions in planning, scheduling and re-routing.

Productivity gains:

The combined effect of removing manual data entry, automating processes with machine-to-machine communications, and integrating data auditability could improve more than 55% of the current process steps that occur during nuclear waste logistics. As a result, the nuclear industry would directly benefit from implementing a DLT solution for nuclear waste tracking in the near term.

Enhanced security:

Attributed-based access controls enforced by a DLT-based record system, as demonstrated by RKVST, can empower the right people to set, enforce and execute complex data sharing policies across enterprise boundaries. Appropriate digitisation has the potential to reduce information mismanagement by 90%[13]. It also addresses the challenges of real-time information retrieval from scattered and localised silos, providing the relevant authorised stakeholders from the NDA and wider estate with access to information. Such a system can be used to inform and drive key decisions around governance and create a mechanism for auditing user access credentials autonomously, and with minimal effort and cost.

NUCLEAR PASSPORT

Baseline:

Verifying employee SQEP status is currently a time-consuming manual activity, and the process of issuing credentials is currently estimated to take between three weeks and three months per employee. These credentials are currently paper-based, siloed and non-portable.

This project has demonstrated the capability of a DLT-based self-sovereign identity (SSI) credentialing approach to issuing employees with security and training credentials, to be stored in their digital wallets, powered by decentralised identity principles.

Time savings:

Using an SSI credentialing solution offers the potential to reduce the time needed for employee onboarding and offboarding[14] by up to 80%. Automating the digital administration of expiring or expired credentials will also save employees time by providing early notification of the need for refresher training, while supporting continued site safety.

Training credentials can be issued each time a new course is completed without the need for in-person paperwork. Using an employee's digital wallet, SQEP status can be proven via a single digital interaction, saving time and costs.

Transparency with privacy:

The principles behind SSI ensure that sensitive personal information is stored securely and is only accessible with explicit consent from the individual. Employees can present any attributes they have been issued for verification at different checkpoints at their own organisation, and to external parties as required.

Enhanced security:

Using a biometric-secured mobile digital wallet (such as modern mobile phone) to hold credentials has the potential to improve security beyond current paper-based or identity card solutions. There are also options for mobile-free sites.

SSI can allow an organisation to build permissioning systems based on collections of credentials to prove an employee's security clearance level, which is particularly important for the nuclear sector where such verification is required regularly for accessing documents and visiting secure areas.

The use of cryptographically secure and verifiable credentials can also enable the formation of a trust framework between estate sites and external parties (for example, The Ministry of Defence).

All 60,000 nuclear personnel working across the UK could benefit from the implementation of SSI-based credentials.

This project has also helped us transform our ways of working internally, to be more adaptable and ready to work with innovators we are not used to count as our suppliers, while demystifying adoption of emerging technologies such as distributed ledger ones for us and our close stakeholders.

The benefits go beyond the very valuable experimentations themselves, and we seek to repeat this type of project to address other challenges and technologies.

Richard Thompson – Enterprise Data Manager, Sellafield

Challenges and opportunities

Leveraging the benefit of objectivity, and expertise.

Any organisation, or group of organisations, interested in the transformative power of distributed ledger technology and wider distributed systems approaches should be aware of the potentially fraught nature of the innovation journey. Anticipating and minimising challenges often requires new skills and approaches, so it's no surprise that engaging with technology innovation is still seen as a high-risk activity, and a distraction from primary business undertakings.

Yet without transformation, more nimble competitors or newcomers that embrace greater digitisation can rapidly take the lead within a sector.

Even organisations with protected or dominant market status can potentially realise significant cost savings and operational efficiencies from appropriate experimentation with, and deployment of, advanced digital technologies.

As the UK's leading authority on advanced digital technology, we provide organisations with the expertise, facilities, programmes and objectivity they need to succeed in their transformation.

PROJECT COMMENCEMENT

From frequent engagements across multiple industry segments, we have identified the major issues that arise when embarking on novel high-risk innovation within an organisation. These are compounded when the project tackles multi-organisational or ecosystem challenges, such as those facing the nuclear industry.

Examples of challenges that need to be addressed before project commencement include:

- Achieving senior stakeholder buy-in
- Identifying and securing sufficient budget, and/or operating within appropriate budget cycles
- Developing a business case for innovation activities
- Identifying who will pay for shared transformation and how funds will flow
- Sharing sufficient information with project partners to uncover common challenges, potentially revealing painful truths
- Aligning interests across parties to agree a common course of action
- Agreeing on technical project management (timetables, communications, governance)

Digital Catapult's independence takes the pain out of these early activities, helping you to identify and reduce the risks of commencing a highly technical project.

ENGAGING INNOVATORS

Companies typically look for off-the-shelf (turnkey) solutions to existing challenges. Yet in many cases, challenges that extend beyond the borders of a single organisation have no existing technological solutions. Under these circumstances, it may be necessary to engage with professional developers.

We have proved that the UK's startup and scale-up community is rich with talent, experience, and novel approaches to solving real-world industry challenges. Identifying and engaging with the most appropriate party under appropriate terms can be difficult in a marketplace full of competitors jostling for opportunities to demonstrate their capabilities.

Digital Catapult's neutrality ensures that technically complex projects are delivered by the best-in-market innovators available.

AGILE DEVELOPMENT

Agile is a widely used, yet often abused term in non-software-native organisations. This is completely understandable, given its recent emergence in the field of project management, its novel jargon, and unique practices that can seem anathema to highly regulated and managed sectors. Yet agile software development approaches can be highly appropriate for delivering prototypes that meet end-user needs while simultaneously navigating high levels of uncertainty. It is designed to cope with rapidly changing requirements and technological instability.

NASA's Technology Readiness Level (TRL) scale[15] is a useful guide to understanding the typical evolution of high-tech solutions, from project conception (TRL1), through initial prototyping (TRL3-4), in-field testing and demonstration (TRL6-7), and finally real-world deployment and post-marketing improvements (TRL9).

Agile accepts that innovative technology development follows a journey, and that nobody jumps to a final working solution after the first iteration (see Appendix 2).

As an agile-native organisation, Digital Catapult helps companies understand and engage with this methodology where appropriate along the innovation journey.

EXPERIMENTATION

Every successful project needs a 'definition of done' – a target that enables teams to recognise when original goals have been met. In the case of prototypes built to explore advanced digital technologies, it is essential to demonstrate appropriate delivery with practical real-world experimentation. This automatically places a solution at TRL 6 or higher, engages relevant end-users, and can readily prove the value of the novel approach.

A well-designed experiment should convince senior stakeholders that their initial fears and uncertainties around technology, spend, and transformation have been allayed, paving the way for subsequent scaling and adoption.

Digital Catapult's technical expertise helps teams to focus on designing appropriate experiments with pre-defined criteria against which success can be objectively measured.

Concluding remarks

Using our approach to structuring and managing demand-side acceleration, Sellafield was able to work with two innovative UK startups to explore the potential benefits of applying distributed ledger technology to challenges in the UK's nuclear sector.

The winning UK startups, RKVST and Condatis, delivered several highly innovative elements. Subsequent review and/or trial of their prototype solutions at TRL6+ demonstrated positive business cases, with potentially significant cost and time savings arising from:

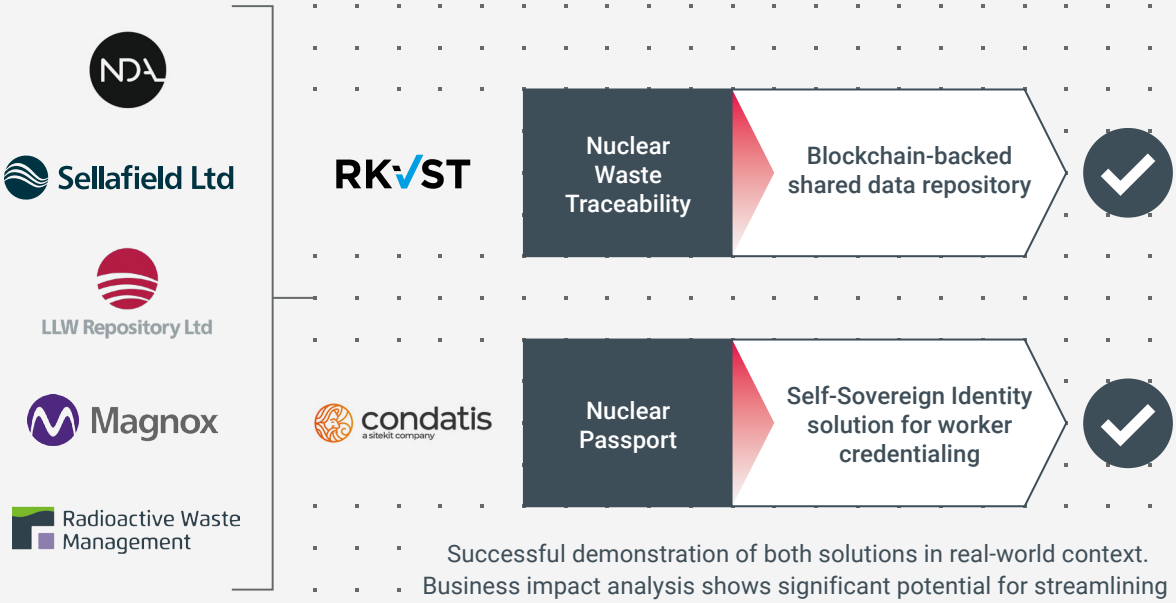
- Improved data transparency and multi-party coordination
- Improved item-level traceability
- Intrinsic digital auditability
- Automated compliance with regulations
- Enhanced digital security

A number of potential future directions became apparent during development, including:

- Enhancing item-level traceability with direct machine-to-machine Internet-of-Things communications linked to a ledger
- Enhancing the security, auditability, and control of the nuclear waste tracking solution by consuming credentials from the nuclear passport solution

RKVST and Condatis are now exploring a potential collaboration to combine the power of both of their solutions to link worker credentialing to waste management data access in the highly regulated nuclear environment.

SELLAFIELD DLT FIELD LAB



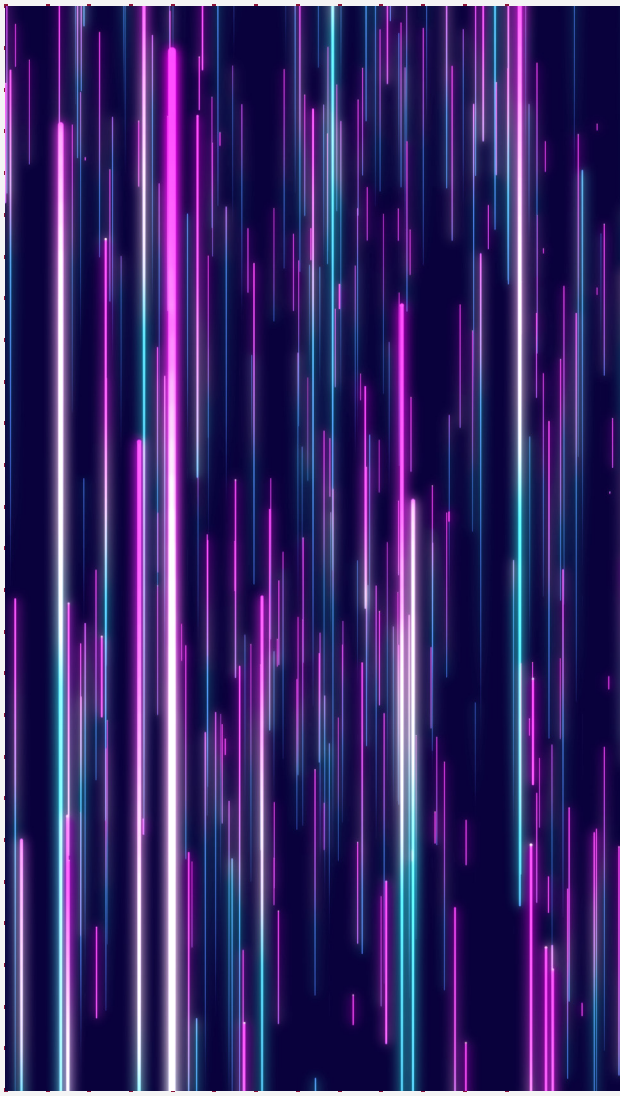
Successful demonstration of both solutions in real-world context. Business impact analysis shows significant potential for streamlining operations and saving costs. Parties in further discussions.

Digital Catapult's DLT Field Labs enable businesses to engage with highly innovative UK startups to enhance their operations and streamline digital transformation at low risk and low cost.

Key considerations

Organisations reading this report should consider the following:

- Demand-side acceleration is an under-served business need in the UK economy. Digital Catapult's DLT Field Labs provide a low-risk, high-reward methodology for organisations to engage with digital innovation and agile software development.
- Where no off-the-shelf solution exists for a business challenge, it is important to consider the need for innovative approaches. Digital innovation is still perceived as high risk with uncertain rewards.
- Identifying the appropriate challenges for collective action requires commitment from a diverse range of industry partners. Gaining this level of commitment from across company borders can be difficult.
- There are still significant challenges to adopting digital innovations from less mature (startup or scaleup) companies, where the most innovative solutions reside.
- Agile development practices are often poorly understood and poorly implemented within non-software-native organisations, yet they are most suited to delivering software solutions in the face of uncertainty and instability.
- Development projects for cutting-edge technological propositions benefit from an integrated in-field trialling period. Experiments must be carefully designed and implemented to prove business value.
- Remote working technologies present new opportunities to gather insights from more users during the product development process.
- There are significant opportunities to grow the UK economy by reconnecting businesses through the appropriate use of distributed systems.



Appendix 1

Distributed systems and DLT

Digital Catapult is actively exploring industrial applications of distributed ledger technology (DLT), self-sovereign identity (SSI), peer-to-peer data exchange and privacy preserving data sharing and computation.

Digital solutions to industry challenges should be driven by matching end-user requirements to appropriate technologies. Recognising and exploiting the potential value of DLT to the UK economy has been hindered by a number of factors.

These technologies have the potential to dramatically improve the fundamental coordination challenges that underlie multi-stakeholder operations in the nuclear sector and beyond. But as a radical proposition, DLT faces many barriers to widespread adoption, particularly in this highly regulated and necessarily cautious sector.

These include:

- Misunderstandings and misconceptions around the technology
- Technological instability and rapid evolution
- Lack of visible deployments
- Absence of transparent deployment and experimentation case studies
- Absence of information of business uplift or ROI

'TRAGEDY OF THE COMMONS'

Many organisations struggle with effectively communicating information and sharing data across organisational boundaries. This is particularly prevalent in settings such as in supply/value chains, where frequent interactions occur between different entities, where the operations of one business may be dependent on another, and bottlenecks result in inefficiencies or less productive output for others.

Because organisations are singular entities with their own goals and objectives, even if they exist within a larger ecosystem, they are incentivised to act in their own self-interest and mitigate any risk to themselves. This is often reflected in how their processes, systems and people are managed, and still manifests even in heavily regulated industries or close-knit chains (such as the Sellafield site) where a central authority (the NDA) dictates processes and criteria.

The result is a tragedy of the commons: organisations organically prioritise individual objectives over collective objectives, to the detriment of the wider ecosystem (and beyond). The sub-optimal coordination across entities involved in the nuclear waste life handling lifecycle and worker credentialing and the resulting inefficiencies are immediately present examples of this.

DATA SHARING

Tragedies of the commons in the digital world are primarily challenges of data sovereignty and data sharing. Owning and sharing data across organisational boundaries can be challenging.

Security, privacy, and trust

Concerns around security, privacy, and trust dictate decisions around corporate policies and processes. Organisations instinctively aim to reduce risk and limit any liability where possible, and managers will often want assurances around how data is managed, stored, and shared. This often results in an external by exception mentality, making intra-organisational data sharing easy, while sharing externally becomes more cumbersome. The appetite for risk, and uncertainty around potential productivity benefits, versus how strict these data sharing policies are will naturally vary across organisations. Numerous factors will determine how sensitive the business of the organisation is, who they're interacting with, the size and shape of the organisation and how difficult it is to manage external interactions.

Data silos

Data silos describe repositories of data which are inherently cumbersome to access, such as paper documents stored at a local site, or digital files saved on a local machine. Such silos are almost universal across organisations and form organically over time, from legacy systems and from historic established processes that haven't been updated and digitised effectively.

Even when organisations embark on a digitalisation journey to upgrade older systems, the issue of interoperability and compatibility (how easily computer systems can speak to one another) can often create new data silos due to incompatibilities. For this reason, even in cases where organisations have overcome the risk barrier, they may find themselves in a position where they physically can't share information.

Standardisation

For collaborating entities to effectively coordinate with an ecosystem, a common mechanism for sharing must exist which defines:

- The agreed language of data and its structure (specific ontologies, taxonomies, hierarchies around data description)
- The method by which it's shared (transfer/ dissemination and file formats)

Without established best practices, organisations will naturally define many of these characteristics themselves, tailor them to specific contexts, and inevitably make definitions less generalisable or applicable across groups of organisations.

To overcome this, a standardised approach for data qualification is required. An example might be a certificate, receipt or other document that provides relevant useful information about an asset moving through a supply chain to other organisations. A standardised approach reduces the need for human intervention to extract relevant meaning, and enables automation while eliminating redundant duplicate activities across the ecosystem.

DLT'S VALUE PROPOSITION

Distributed ledger technology (DLT) provides a technological mechanism through which organisations within a multi-party ecosystem, like the nuclear estate, can share information through a decentralised and multi-owner system, allowing them to be more productive.

Most modern IT infrastructure, whether cloud or local, typically uses a single set of administrators to manage systems for an organisation. In a fully distributed system, each individual entity retains its own management processes, but there is a mechanism for storing and managing time-sequenced records of communal benefit as a digital 'shared good'.

- Cryptographic consensus processes ensure organisations can be confident in a single source of truth that is added to whenever any change is made, simultaneously ensuring data uniformity and standardisation of processes
- The same computational tools engender trust, as the indelible digital signatures attached to actions recorded within the system cannot be forged, and are traceable back to the originating organisation
- Mathematical consensus ensures that no single party can invisibly erase or unilaterally amend critical records
- Individual organisations can set out access policies regarding which other organisations or specific people are able to see or edit data at a granular level
- The ledger of data, and process of agreement around its state at any given time, is controlled collectively by all participating entities, rather than a singular superuser

DLT and self-sovereign identity

One of the most widely understood applications of DLT is the sharing of critical records between multiple parties in a trustless and verifiable manner. It is worth explaining some of the principles behind self-sovereign identity and why distributed ledgers are attractive for solving issues of worker credentialing.

SOLVING THE 'PHONE HOME' PROBLEM

In its simplest form, a credential is a qualification, achievement or fact about an entity, person or an organisation. Credentials can include:

- Identity and identity attributes (such as photo, name, date of birth)
- The issuing authority (such as government, institution or business)
- The type of credential (such as passport, licence or examination certificate)
- Evidence of how the credential was established (such qualification or verification)
- Constraints of its release (such as expiry date, applicable location)

Credentials have limited use unless they can be verified and known to have been authentically issued. Within all credentialing systems, a 'trust triangle' is formed between the issuer, holder, and verifier of the credential (Figure overleaf).

Paper credentials, such as driving licences, certificates and passports, are usually stamped or signed by the issuer to confirm authenticity. This means that a third-party verifier must either trust the stamp or signature, or contact the issuer to confirm veracity. This is typically referred to as the 'phone home' problem – the verification process can take anything from hours to weeks, and there is often no easy way to contact the original issuer. This is compounded where forged, borrowed, or expired credentials are a possibility.

However, the phone home problem can be solved by using a shared and trustless record of fact, in the form of a distributed ledger, combined with verifiable credentials.

VERIFIABLE CREDENTIALS

Using new standards emerging from the W3C[16], it is now possible to issue digital credentials in a format called a verifiable credential[17]. These are digitally signed with cryptographic keys, and owing to the mathematical properties of the cryptography used, it is not possible to 'hack' or pass off inauthentic keys, thus making it possible to instantaneously verify the credentials, rather than to trust them.

However, to enable instantaneous verification of credentials, the cryptographic keys will have to be in a location where they can be readily accessed by any verifier. A distributed ledger held collectively by relevant parties in the nuclear ecosystem readily satisfies this requirement.

SELF-SOVEREIGN IDENTITY

Self-sovereign identity (SSI) is a collection of technologies, including verifiable credentials and a shared DLT-based verifiable data registry[18], that inverts the balance of power over credentialing data, giving end-users the ability to manage their own records. SSI allows individuals to control how much personal information is revealed when meeting minimum requirements to unlock desired services. For example, if date of birth verification is all that's needed, there's no need to provide all the other information that would be contained in a passport or driving licence.

SSI credentials can be issued to user-controlled mobile wallets, enabling seamless verification for users moving between domains within an ecosystem (such as different departments on the Sellafield site), as all domains can be party to the same shared register.

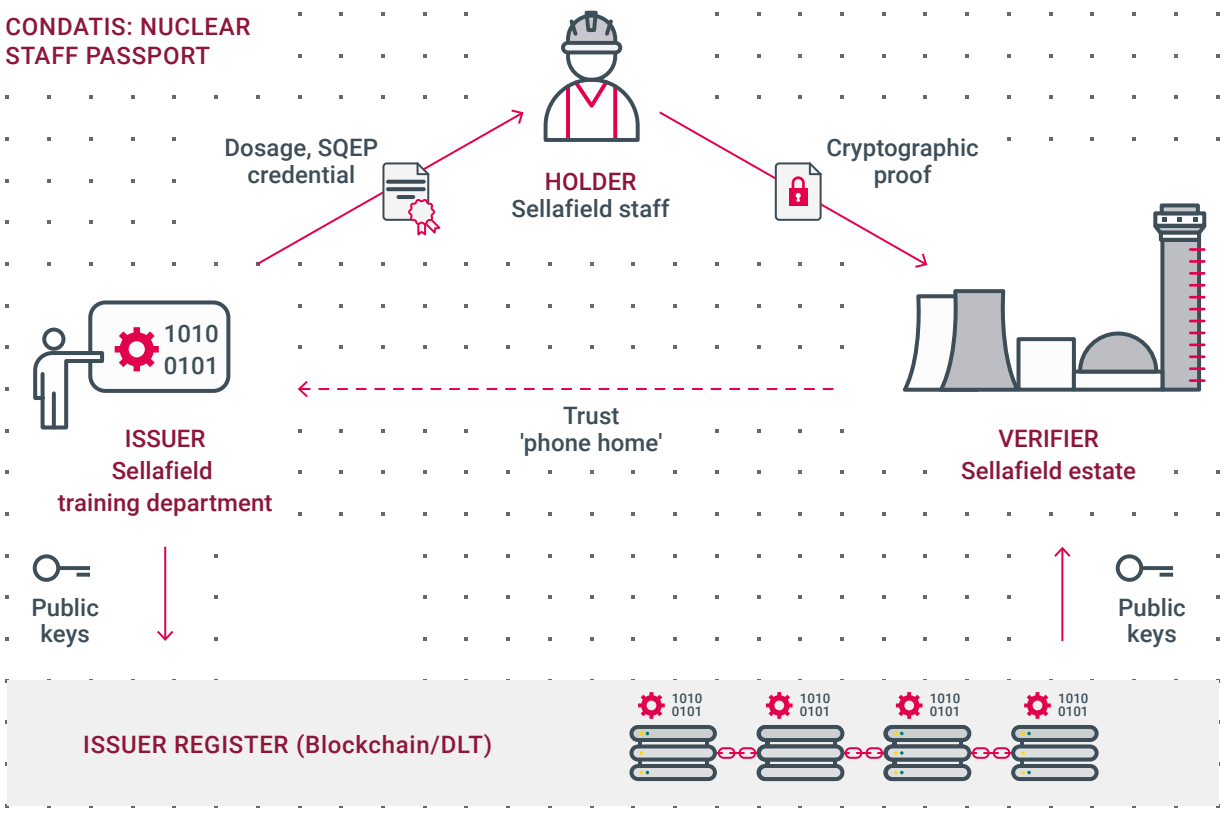


Figure: The trust triangle of credentialing

Appendix 2

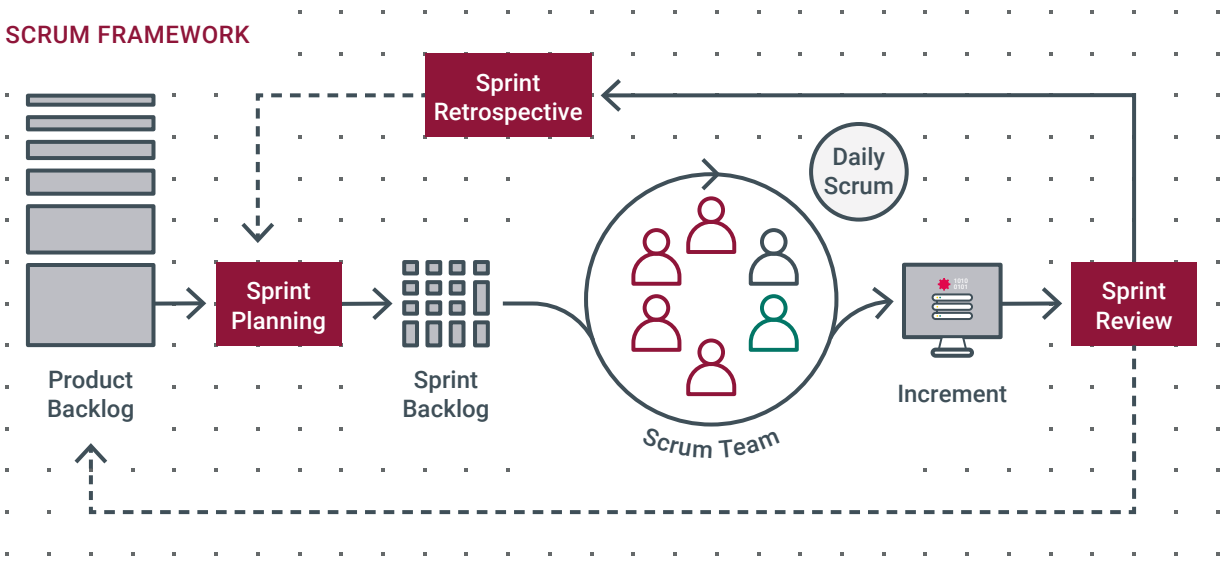
Agile software development

Taking a traditional waterfall approach to development means investing time and effort in developing and codifying precise specifications at the outset of a project, followed by the build. Such a specification-led approach valuable for physical engineering processes and other mature environments, where there is a good level of certainty about what is involved, and flexibility is not needed.

Agile software development is an alternative approach for situations when there are high levels of initial uncertainty, such as when the appropriate solution architecture, desired user experience or most suitable components are – as yet – unknown. This approach places importance on working results over documentation, people and interactions over rigid processes, embracing change over making concrete plans, and customer collaboration over contract negotiation.

Agile methodologies (of which there are many) are designed to cope with rapidly changing end-user requirements while continuously delivering functional and demonstrable results and are based on working in short cycles (sprints) to build, demonstrate results and collect feedback, continually iterating to work towards a viable solution to the challenge.

Sprints are regular, usually 2-4 weeks each, and challenge-centric requirements – known as user stories – are described in behavioural terms rather than imperatives. For example: "*As an administrator, I want to be able to deactivate accounts so old users can no longer log in*". User stories are collated as a backlog of tasks against which the engineering team delivers, and epics are the collections of user stories required for the overall solution . Each sprint allows end-users to review, comment, and potentially have the backlog amended or reprioritised for delivery.



About Digital Catapult

Digital Catapult is the UK authority on advanced digital technology.

Through collaboration and innovation, we accelerate industry adoption to drive growth and opportunity across the economy. We bring together an expert and enterprising community of researchers, startups, scaleups and industry leaders to discover new ways to solve the big challenges limiting the UK's future potential.

Through our specialist programmes and experimental facilities, we make sure that innovation thrives, and the right solutions make it to the real world. Our goal is to accelerate new possibilities in everything we do and for every business we partner on their journey – breaking down barriers, de-risking innovation, opening up markets and responsibly shaping the products, services and experiences of the future.

Visit **digicatapult.org.uk** for more information.

References

1. Sellafield Ltd. Annual Report (Oct 2020)
2. Sellafield Ltd. Enterprise Strategy 2020
3. Future Waste Arisings – 2019 NDA Waste Report (Dec 2019)
4. Industrial Strategy – Nuclear Sector Deal (2018)
5. https://github.com/decentralized-identity/ion
6. https://identity.foundation/sidetree/spec/
7. https://www.evernym.com/products/
8. Based upon the Hyperledger Indy blockchain https://www.hyperledger.org/use/hyperledger-indy
9. https://github.com/hyperledger/aries
10. https://www.w3.org/TR/did-core/
11. https://dev.uniresolver.io/
12. Stimson Center – Complementing the Padlock: The prospect of blockchain for strengthening nuclear security (June 2020)
13. NIST Cybersecurity Research Centre – Shifting the Human Factors Paradigm in Cybersecurity (March 2018)
14. McKinsey Global Institute – Digital Identities (April 2019)
15. https://www.nasa.gov/pdf/458490main_TRL_Definitions.pdf
16. The World Wide Web Consortium – the main international standards organization for the World Wide Web
17. https://www.w3.org/TR/vc-data-model/
18. And decentralised identifiers (DIDs), see: https://w3c-ccg.github.io/did-primer/

Sellafield DLT Field Labs Team

DIGITAL CATAPULT

Pierre Baisle – Head of Innovation Artificial Intelligence / Distributed Systems

Will Bryan – Head of Innovation Immersive Technologies

Shivam Chauhan – Innovation Partner

Ian Crawford – Project Manager

Amar Dhokia – Technologist – Distributed Systems

Katy Ho – Head of Innovation Future Networks

Rob Learney – Head of Technology Distributed Systems

Ross McWhirter – Innovation Delivery Manager

Keerthi Thomas – Technologist – Distributed Systems

Alessandra Venier – Policy, Research & Engagement Manager

Steven Wood – Senior Commercial Manager

Alastair Yool – Project Manager

SELLAFIELD LTD

Edwin C Matthews – Head of Technical & New Capability | Remediation

Richard C Thompson – Enterprise Data Manager

Simon Kennedy – IT Systems Improvements | Remediation

NUCLEAR DECOMMISSIONING AUTHORITY

Dave Clark – Asset Management & Continuous Improvement Manager

NUCLEAR WASTE SERVICES

Gareth Garrs – Head of Waste Inventory & Compliance

RKVST

Robert Brown – VP Marketing & Co-Founder

Jon Geater – CTO & Co-Founder

John Hartley – VP Engineering

CONDATIS

Alasdair Murray – Chief Product Officer

Mikko Vuorinen – Lead Developer

Richard Astley – Lead Solutions Architect

Rob Gathergood – Senior Business Analyst

If you would like further information on Digital Catapult and the DLT Field Lab, please visit our website.

digicatapult.org.uk