DECaDE

Research Outcomes and Impact

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CATAPULT Digital

UKRI Engineering and Physical Sciences Research Council

Digital Economy Transforming Business and Society

DECaDE

Centre for the Decentralised Digital Economy

DECaDE is the UKRI Centre for the Decentralized Digital Economy; a National Reserach Centre exploring how emerging data centric technologies, such as Distributed Ledger Technology (DLT) and Artificial Intelligence (AI), could transform our future digital economy through decentralised platforms.

DECaDE was launched in October 2020 by the University of Surrey, the University of Edinburgh and Digital Catapult. It is funded by £10million of support from industry (£6million) and from the UK Research & Innovation (UKRI) through the Digital Economy programme (£4million) – EPSRC grant reference EP/T022485/1.

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FOREWORD

DECaDE is the UKRI Next Stage Centre for the Decentralised Digital Economy



Prof. John Collomosse, DECaDE Centre Director

Since DECaDE was founded in 2020, the world has experienced profound societal and technological change. The global pandemic reshaped how we work, trade, and create. The war in Ukraine underscored the importance of information integrity. The rise of generative AI has transformed how digital content is produced and consumed.

Cutting across all of these developments is a common challenge: the risk of fake news and misinformation—exacerbated by the increasing power of creative tools and the unprecedented ease with which content can be shared. How can we build trust in an increasingly decentralised information supply chain, where anyone can generate highly plausible content at scale?

We are proud of the contribution DECaDE has made to address this challenge through the publication, commercial licensing, and open-source release of media provenance technologies co-created with our industry partners. As one of the earliest partners of the Adobe-led Content Authenticity Initiative, DECaDE researchers have helped to shape international standards, generating impact both through creative products and through broader thought leadership on the use of media provenance to strengthen media integrity.

In 2024, more than two billion people voted in public elections worldwide, with AI-generated content at the forefront of public concern. By 2025, policy attention had shifted toward copyright and the fair use of creative works in AI training—redefining relationships between creators, platforms, and AI developers.

DECaDE has contributed substantively to this debate by reframing copyright and AI as a digital supply chain challenge. Building on our early technical work on durable media provenance, we have explored how provenance can provide digital infrastructure to support control, consent, and compensation for the reuse of creative content at scale. Our contributions to open standards and policy discussions—including the *Time to ACCCT* report—reflect our commitment to ensuring that innovation in AI proceeds alongside fairness, transparency, and sustainable value creation across the decentralised creative economy.

This is exemplified by DECaDE's multi-year exploration of digital marketplaces for creative exchange. Through projects such as `A Token Gesture', we conducted some of the earliest user studies of media tokenisation. Project EKILA showed how tokenisation could be combined with media provenance to support fairer decentralised markets and ORAgen interrogated how value should be defined and exchanged within them. In today's debate around copyright and AI, this supply chain perspective resonates even more strongly. DECaDE's ContentARCs framework provides tangible pathways towards decentralised data marketplaces that leverage media provenance to embed consent, attribution, and compensation into content reuse at scale, aligning with the UK Government's ambition to develop Creative Content Exchanges for AI training.

DECaDE's impact has extended beyond the creative industries into wider business ecosystems and public policy. We have contributed evidence to government consultations, testified before select committees, and engaged with All-Party Parliamentary Groups, helping shape thinking on digital governance and emerging technology regulation. DECaDE researchers collaborated with the Cabinet Office and HMRC on Reduced Friction International Trade (RFIT), informing aspects of the 2025 UK Border Strategy. Our work on distributed ledgers, digital credentials, and provenance-enhancing technologies has demonstrated how the same principles of trust, transparency, and interoperability apply not only to media, but also to electronic trade documents, cross-border logistics, and physical supply chains — from bills of lading to agricultural goods such as cocoa and wine.

> **DECaDE's impact has extended beyond the creative industries into wider business ecosystems and public policy.**

The common thread throughout DECaDE has been the design of decentralised digital infrastructure for supply chains—infrastructure that embeds trust and accountability through provenance. As this brochure marks the culmination of the DECaDE programme, it also highlights a set of enduring questions. How can value be created and shared more equitably in decentralised systems? How should digital infrastructure be governed? And how can trust be sustained in an era of accelerating technological change?

At a deeper level, DECaDE has demonstrated the importance of working across social, technical, economic, and governance disciplines to address these questions. The work presented here offers not only emerging solutions, but also new playbooks and methodologies for undertaking this kind of cross-disciplinary thinking about the complex challenges that will shape the decentralised digital economy in the years ahead.

Prof. John Collomosse, March 2026.

OUR CENTRE

DECaDE's multidisciplinary team brings together technologists, designers, business scholars, legal experts, and cybersecurity researchers from the Universities of Surrey and Edinburgh, in collaboration with the Digital Catapult's DLT Field Labs. This unique collaboration enables DECaDE to translate foundational research into meaningful real-world impact.

OUR TEAM



The Centre for Vision, Speech and Signal Processing (CVSSP) at the University of Surrey was founded in 1986 and remains one of the largest academic centres for Computer Vision and Artificial Intelligence – with over 170 researchers exploring how to create machines that can see, hear and understand the world around them. CVSSP's contribution to DECaDE is led by Principal Investigator Professor John Collomosse focused on media provenance, computer vision and distributed ledger technology.

The Surrey Centre for Cyber Security (SCCS) consolidates research activities in cyber security across the University of Surrey. Since 2014, SCCS has been one of the UK's gold-level NCSC-recognised Academic Centres of Excellence in Cyber Security Research (ACE-CSR). Co-Investigator Professor Steve Schneider leads the DECaDE contribution from SCCS focusing upon self-sovereign identity and privacy preserving techniques.





The Surrey Business School (SBS) is a global leader in impact-driven business research and education, with a focus on digital transformation and AI, innovation, analytics, sustainable and resilient organisations, and the future of work. SBS contributes its expertise in supply chain and digital business transformation to DECaDE's activities led by DECaDE Co-Investigator Professor Glenn Parry.

The Institute for Design Informatics (IDI), University of Edinburgh develops prototypes, exhibitions, and workshops that enable creative professionals and the public to critically engage with emerging technologies. Within DECaDE the IDI also researches design and user experience of new approaches to media ownership and attribution. The contribution is jointly led by Co-Investigators Dr Chris Elsden and Dr Caterina Moruzzi.





Edinburgh School of Law (SCRIPT) is the Scottish Research Centre for IP and Technology Law, exploring the intersection of law, technology, and society. The Centre supports the University of Edinburgh's digital strategy by connecting legal academics with research in computer science and design informatics. SCRIPT's contribution to DECaDE is led by Co-Investigator Professor Burkhard Schäfer.

Digital Catapult (DC) collaborates with our academic centres to transform breakthrough technologies into practical, real-world solutions. By supporting the delivery of DECaDE's innovative DLT Field Labs, Digital Catapult accelerates the translation of research into deployment, advancing innovations to higher Technology Readiness Levels (TRLs). The DC contribution to DECaDE is led by Dr Robert Learney, Head of Technology, Distributed Systems.



OUR MISSION

DECaDE: Shaping the Future of the Decentralised Digital Economy

DECaDE is the UKRI Next Stage Centre for the Decentralised Digital Economy. Our mission is to create the tools, techniques, and governance models that will shape how work and value are created in the future digital economy—ensuring it is prosperous, safe, and inclusive for all.

Today's digital economy is increasingly peer-to-peer. Individuals now act as both producers and consumers of digital goods and services, from ride-sharing platforms to news and creative content. Yet these interactions largely take place on centralised digital platforms, with centralised governance that is often opaque and operates in isolation of its stakeholders.

DECaDE explores how emerging data technologies - particularly Distributed Ledger Technologies (DLT) and Artificial Intelligence (AI) - can transform the digital economy through decentralised platforms in order to support fairer governance, greater transparency, and new ways to create value across digital supply chains.

A central focus of DECaDE's work has been the Creative Industries, among the earliest sectors to experience large-scale decentralisation of content creation and consumption, yet one in which centralised platforms such as Instagram, YouTube and TikTok continue to dominate our news and entertainment. In this creative supply chain, issues of media provenance, rights and authenticity are paramount. DECaDE has contributed tools to trace provenance facts, such as who made an image and how to help users make decisions on rights and attribution. In other words, to ensure trust in the creative supply chain.

DECaDE has also examined the application of decentralised technologies to physical supply chains and business ecosystems. From reducing friction in cross-border trade and informing government policy, to bridging the digital–physical divide in supply-chain tracking—including the use of digital twins for goods such as wine and cocoa—DECaDE's research has translated into practical impact through policy engagement and commercial collaboration.

A Translational Centre for Societal Impact

Through its research themes, DECaDE brings together insights from diverse application domains, ranging from physical goods and supply chains to creative assets such as images, video, and AI training data. Working across these verticals, we develop shared design patterns for trust, accountability, and value creation in decentralised systems.



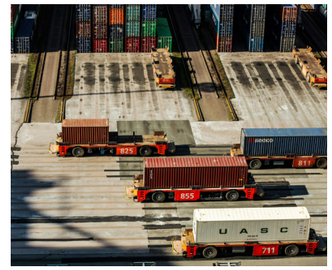
OUR IMPACT FACTS

35
COMMERCIAL PARTNERS

OUR IMPACT THEMES

1. Misinformation and Content Authenticity
2. Content Supply Chains and the Creative Economy
3. Supply Chain, Digital Trade, and Borders
4. Identity, Reputation, and Privacy
5. Methodology for Cross-Disciplinary Research
6. Policy and Regulatory Impact

A multidisciplinary approach is essential to DECaDE's mission. We combine technological innovation with expertise in business models, design, cybersecurity, and law. DECaDE studies how these disciplines intersect to shape digital supply chains - and how they can be deployed in trustworthy, scalable ways to support fair governance, sustainable business models, and societal benefit.



PROJECT TIMELINE

October 2020

DECaDE Centre founded.

2021

January
DECaDE gives evidence to APPG Blockchain on media provenance.

February
First DECaDE Field lab kicks off 4x industry-led scoping workshops on the Decentralized Creative Economy.

March
First public auction of an NFT at Christies (Beeple, $84.3M - the most expensive NFT in history).

June
DECaDE publishes the first work on content fingerprinting for image and video provenance (CVPR, ICCV, CMVP).

July
COVID National Lockdown lifted.

September
First public release of the C2PA media provenance standard (v0.7).

2022

March
Token gesture, a public NFT experience ran in Edinburgh.

March
Outcomes of first Field lab on Privacy Preserving Image Sharing.

March
Report published on trust findings from the RFIT project.

April
DECaDE gives evidence to APPG Blockchain on Government, Democracy and Voting.

August
Outreach webinars on Blockchain for SMEs, via the EU Blockstart project.

October
The Ecosystem of Trust evaluation report published, citing DECaDE.

November
Three patents on fingerprinting and watermarking licensed to commercial partner.

2023

January
Series of 4 UK Cabinet Office workshops on Digital Borders run by DECaDE.

January
Blockchain and Beyond Paper published on Interaction Design for Blockchain.

March
DECaDE inputs to three public consultations on tokenised assets and digital identity.

June
EKILA published at CVPR - proposing ORA, the first framework for creator recognition and reward for AI training.

July
DECaDE cited in the UK Law Commision's Digital Assets report.

October
ORAgen media tokenisation prototype developed and trialled.

November
DECORAIT - the first use C2PA and Blockchain for AI opt-in/out published at CVMP winning best paper prize.

November
Open Source release of TrustMark, a free watermarking technology for media provenance.

December
Evidence given to APPG Blockchain on Blockchain in Government.

2024

January
Supply Chain Management journal paper published on outcomes of the RFIT project.

January
Second DECaDE field lab on Media Tokenization

February
Case study on supply chain provenance for conflict minerals published.

March
DECaDE presents at Lord Holmes of Richmond Round Table on Blockchain for the Public Good, at the House of Lords.

March
DECaDE presents at 3 APPG meetings, on Blockchain and on Metaverse.

April
Paper published on the outcomes of the Token Gesture study.

May
The Three Pillars of Provenance framework is published by IEEE - the basis of Durable Content Credentials (C2PA).

June
DECaDE led organisation of the Digital Next Stage Symposium (DE-Nexus) with 5 other EPSRC Next Stage Centres during London Tech Week.

September
'ORAgen Fables' is presented as part of the 'Doors Open Day' in Edinburgh.

December
DECaDE gave oral evidence to the UK House of Lords Property (Digital Assets) Special Public Bill Committee.

December
ICC/DECaDE report on 'Reimagining the way we trade' published.

2025

January
ORAgen: Emerging Futures for Tokenisation and Digital Media Rights' report published, as outcome of second field lab.

February
Formal response submitted to the UK Government consultation on Copyright and AI.

February
ORAgen Fables: a collective story writing interactive experience tours the UK.

April
Third DECaDE field lab on Decentralized Supply Chain Reputation.

May
DECaDE co-authors consultation response on UK Digital Trade Opportunity for Growth, with ICC/IC4DTI.

May
DECaDE/CoSTAR release 'Time to ACCCT' framework leveraging DECaDE's provenance research to address the Copyright & AI challenge.

June
Contribution to the Tony Blair Institute and IC4DTI report on cross-border trade (ICC/IC4DTI) response.

July
DECaDE policy work and Content ARCs framework presented at CADE 2025.

September
DECaDE runs 'Enhancing trust and verifiability within supply chain operations' webinar.

December
DECaDE presents at House of Lords Communications and Digital Select Committee's inquiry on AI and copyright.

December
White Paper 'Governance Framework for the Evolution of a Cross-Border Trade Ecosystem' is released.

December
DECaDE provides evidence to Scottish Government on Scottish Digital Assets Bill.

Publication
Gov/Policy
Tech
Field lab
External event



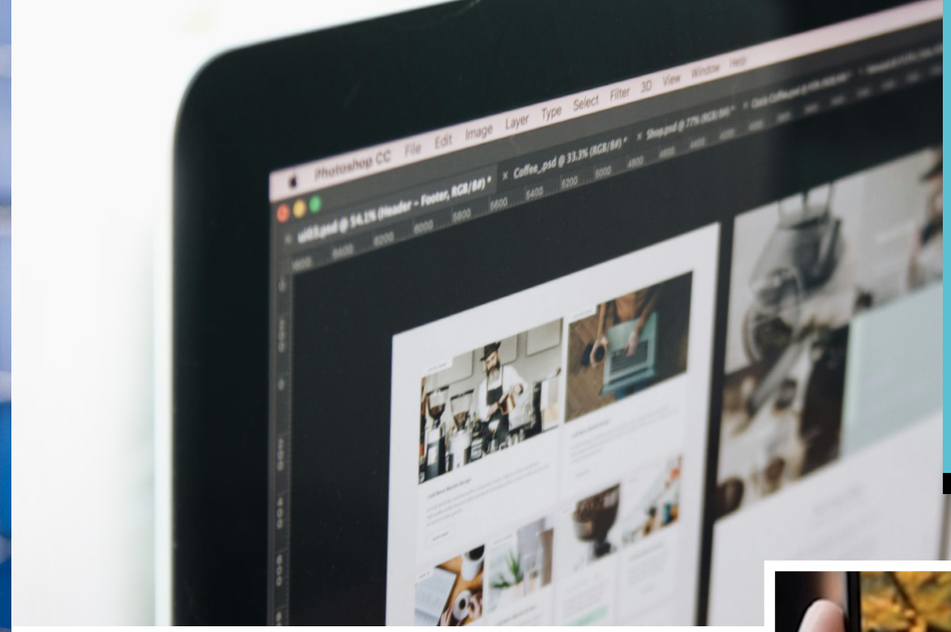
FIGHTING FAKE NEWS

MISINFORMATION AND CONTENT AUTHENTICITY

Fake news and misinformation present major societal challenges. Provenance facts, such as who created a piece of media and how it was produced or modified, can provide valuable context to help people make more informed trust decisions about visual content.

Digital forensics offer one response to visual misinformation, through tools such as deepfake detection that identify synthetic or AI-manipulated media. However, misinformation and manipulation only partially overlap. Much misleading content consists of unaltered images reused out of context to tell a different story, while authentic storytelling and editorial workflows now routinely involve AI tools. As a result, AI detection approaches can address only a subset of misinformation and are engaged in a continual cat-and-mouse game with the rapid advances in generative AI.

Tools that explain the provenance of visual media, rather than attempting to decide its authenticity, place users in a more informed position to make their own trust judgements. DECaDE has therefore focused on media provenance as foundational infrastructure for trust in digital media. For example, a user encountering a photograph on social media may be presented with information about who captured it, when, and how it was modified. This additional context, likened to a 'digital nutrition label', supports more informed, transparent, and resilient trust decisions.



OUR IMPACT FACTS

3

PATENTS JOINTLY FILED ON PROVENANCE TECHNOLOGIES

Beyond Metadata: Three Pillars for Durable Media Provenance

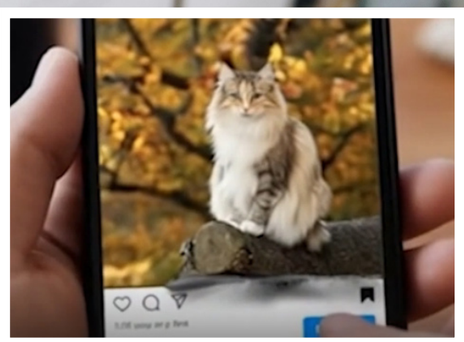
DECaDE researchers have worked closely with the Adobe-led Content Authenticity Initiative to develop provenance-enhancing technologies and to inform the emerging Content Credentials technical standard for media provenance developed by the Coalition for Content Provenance and Authenticity (C2PA). DECaDE researchers have played leading technical roles within C2PA, including chairing working groups on watermarking and on the integration of distributed ledger technologies.

A key area of contribution has been addressing a fundamental weakness of metadata-based provenance: metadata carrying the provenance signal can be easily stripped from media assets, including by most social media platforms. To mitigate this, DECaDE researchers have combined AI techniques with distributed ledger technology to develop more durable provenance mechanisms that persist as content circulates online.

New content fingerprinting and invisible watermarking techniques developed through DECaDE, enable media that has been separated from its metadata to be reliably re-linked to a trusted provenance record, for example one stored on a distributed ledger. In the IEEE paper *To Authenticity and Beyond...* DECaDE introduced a 'three pillars' approach to provenance, combining C2PA metadata, watermarking, and fingerprinting to create Durable Content Credentials that can survive common platform transformations.

DECaDE also co-developed the TrustMark watermarking technology with Adobe. TrustMark has been open-sourced under an MIT licence to enable commercial adoption and is now widely used in industry to reinforce C2PA-based provenance. TrustMark is designed to coexist with other watermarking approaches and has supported interoperability between watermarking technologies within C2PA, helping to broaden adoption of durable provenance infrastructure.

Research Team: Tu Bui, Alexander Black, John Collomosse



"DECaDE's collaboration with Adobe and the Content Authenticity Initiative has played an important role in accelerating innovation in media provenance technologies. This partnership has resulted in the translation of research into practice, contributing to the development of technology that supports authenticity and value creation across the creative ecosystem, which we believe is essential to the future of art and media.

Andy Parsons, Global Head of Content Authenticity, Adobe

Designing Provenance People Can Trust

Alongside technical advances in content provenance, DECaDE has focused on making provenance information understandable and usable beyond specialist circles. This human-centred perspective is essential if provenance is to support creators, journalists, educators, and the general public.

DECaDE research translates technical metadata carried within standards like C2PA, into the kinds of questions people actually ask: What information do different audiences need? When do labels build trust, and when can they fuel suspicion? How can provenance communicate creative intent, context, and usage rights, rather than reducing authenticity to a simplistic “AI versus human” distinction?

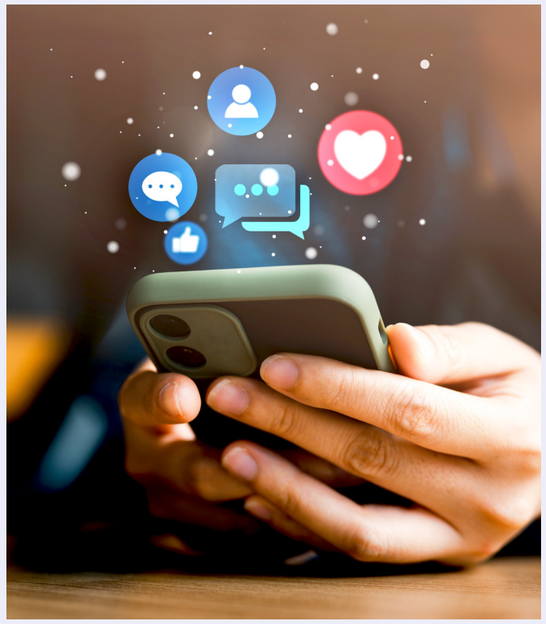
These questions underpin *Content Authenticities: A Discussion on the Values of Provenance Data for Creatives and Their Audiences*, awarded Best Paper at ACM Creativity and Cognition 2025. Drawing on workshops that brought together participants from across the creative media supply chain, this work proposes thinking in terms of multiple forms of authenticity, enabling provenance tools to support attribution, context, and rights enhancing resilience to misinformation.

DECaDE has harnessed advances in large language models (LLMs) to help explain provenance at scale. In *ImProvShow: Multimodal Fusion for Image Provenance Summarisation*, an LLM is trained to concisely summarise provenance information into a few simple explanatory sentences, combining C2PA metadata with image difference analysis to explain how an image has changed over time.

DECaDE has convened a wider community through public talks, cross-sector events, and creative engagement supporting reflection on the role of transparency in content authenticity. Follow-on support through the AHRC BRAID programme is taking this work in new directions: *Embracing the Complexity of Authenticity*, is scaling this work to inform the next generation of provenance-aware experiences; *Performance, Participation, Provenance and Reward in Responsible AI* is exploring the value of provenance in music performance.

Research Team: Caterina Moruzzi, Alexander Black, John Collomosse, Ella Tallyn

> **DECaDE has convened a wider community through public talks, cross-sector events, and creative engagement supporting reflection on the role of transparency in content authenticity.**



Provenance of Narrative

Understanding the provenance of narratives is critical for contextualizing information and addressing misinformation. Yet, emerging provenance technologies and standards, including C2PA, are focused at the level of media (where a photo was taken, how it was edited) rather than the narratives described by media itself.

With the widespread disbanding of social media fact-checking teams in recent years, there is greater reliance upon corroboration of facts with community sourced notes and reconciliation of multiple (often conflicting) online sources in order to verify narratives. This is common practice in journalism where so called ‘open source intelligence’ (OSINT) often cross-checks facts with multiple internet sources.

DECaDE has explored narrative-level tracking, identifying where stories come from, how they propagate, and the evidence that supports or contradicts them. By integrating Large Language Models (LLMs) with Retrieval-Augmented Generation (RAG), it becomes possible to retrieve external information from the internet and contextualize it within the narrative being fact-checked.

In collaboration with the University of Oxford, DECaDE researchers have developed two prototype systems *MAD-Sherlock* (a prize winning paper at the ICML conference), and *CRAVE*. A key insight has been the use of multiple LLMs that debate one another to reach a conclusion as to which facts of a story are supported, or refuted, by external sources.

Research Team: Arka Dey, Georgia Channing, Christian Schroeder de Witt, Phil Torr, John Collomosse

Managing Emotion and Legitimacy After a Fake News Attack

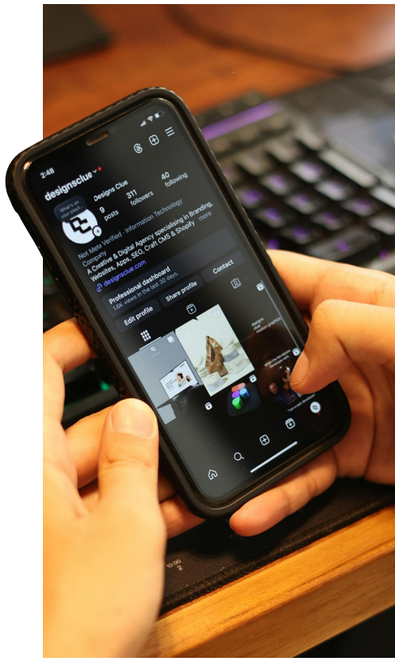
With the growing prevalence of fake news and online trolling, organisations increasingly find themselves subject to sustained and emotionally charged public attacks. DECaDE researchers examined this challenge through studies of vaccine hesitancy, focusing on a longitudinal case study of the Irish Health Service Executive (HSE) between 2014 and 2019.

During this period, the anti-vaccination group REGRET mounted a coordinated fake news campaign targeting the human papillomavirus (HPV) vaccine, contributing to a fall in vaccination rates to 40% within two years. A critical turning point came when Laura Brennan, a 25-year-old Irish woman suffering from terminal cervical cancer caused by HPV, became a patient advocate and the public face of the pro-vaccination campaign. By sharing her personal story through social media, she helped restore public confidence, raising vaccination rates to 74% nationally and to over 90% in her home county.

The research demonstrated that scientific evidence alone is insufficient to counter viral disinformation. A purely rational “facts-are-facts” approach often lacks the emotional resonance required to respond effectively to highly emotive fake news attacks. Instead, effective responses depend on what the research terms emotional legitimacy management.

Rather than communicating at a distance through institutional messaging alone, organisations must identify and support credible advocates who can build legitimacy through shared personal experience. These advocates connect emotionally with audiences, countering moral shock with narratives of empathy and hope. In practice, this requires organisations to provide advocates with both robust technical information and sustained emotional support. By humanising institutions and enabling trust to flow from advocates back to organisations, responses can move beyond reactive debunking towards inclusive engagement that restores long-term public legitimacy.

Research Team: Itziar Castello, Marie Joachim, Glenn Parry



> **Effective responses to fake news depend on emotional legitimacy, not facts alone.**



CREATING A FAIRER CREATIVE ECONOMY

CONTENT SUPPLY CHAINS AND THE CREATIVE ECONOMY

The rise of generative AI has exposed a structural gap in today's digital economy: creators lack practical ways to control how their work is used by AI systems, to signal consent, and to receive fair compensation when value is created downstream.

Beyond its initial application in addressing fake news, DECaDE has pioneered the use of media provenance technologies to support ownership, rights, and legitimate re-use of creative works. As with content authenticity, this challenge is best understood as a supply chain problem. Creative works move across platforms, are remixed and transformed, and are now increasingly ingested into AI systems at scale.

> **Establishing the provenance of work not only enhances creative attribution, it conveys better agency over how work is re-used, and even opens the door to new licensing models and pathways for creators to generate value from the work in the age of generative AI.**

Provenance as Infrastructure for the Creative Economy

Equitable re-use of creative content for AI training requires interoperable, machine-readable markers that can communicate rights, licensing terms, and conditions of use. Establishing such mechanisms depends on open technical standards that enable signals to persist and be understood at scale.

DECaDE pioneered the use of media provenance as infrastructure for addressing this challenge and has worked closely with international standards bodies to develop and inform open, interoperable approaches to rights signalling.

Building on our three pillars model for durable provenance — combining C2PA metadata, watermarking, and fingerprinting — DECaDE developed DECORAIT (2023), the first decentralised registry for AI opt-in and opt-out signalling. DECORAIT leveraged opt-out markers within the first version of the C2PA standard (the specification of which DECaDE researchers contributed to) storing creator preferences on a distributed ledger and enabling machine-readable expression of consent for AI training reuse.

Concurrently, DECaDE introduced EKILA, the first end-to-end system proposing automatic compensation for creators whose work is used in AI training. A central contribution of the work was the *ORA (Ownership, Rights, Attribution)* triangle, a framework that integrated C2PA (describing provenance of creation) with NFT-based mechanisms (describing provenance of ownership). The paper also proposed early data attribution techniques to identify training data influencing specific AI-generated outputs, enabling micropayments to be issued automatically to rightsholders.

The ORA framework informed subsequent technical proposals, including DECaDE's collaboration with UCL on a technical proposal to the JPEG Media Tokenization group in early 2024, which contributed to JPEG's draft proposal on extensions of C2PA for licensing. DECaDE further evolved ORA into demonstrators and practice-led studies such as ORAgen and ORAGen Fables, and into the broader ContentARCs technical framework. Together with innovations in privacy-preserving decentralised search, this work underpins DECaDE's vision and technical prototypes for a Decentralised Creative Content Exchange and has informed policy discussions on copyright and AI, including the Time to ACCCT report.

Going forward, DECaDE's innovations have advanced thought around media provenance beyond media integrity to a digital infrastructure that could support a more equitable future for the creative economy in the age of AI.

Research Team: Kar Balan, Junaid Awan, Andrew Gilbert, John Collomosse

A Token Gesture: Engaging Critically with NFTs

In the wake of the global pandemic, non-fungible tokens (NFTs) gained widespread adoption as creatives turned to decentralized digital marketplaces. NFTs captured mainstream media attention, sparking widespread debate and speculation that peaked around 2021. Engaging critically with such a hyped technology at its peak can be challenging. Looking beyond wild financial speculation, this project explored the more fundamental promise of NFTs: creating digital scarcity and offering a sense of ownership and property for digital things.

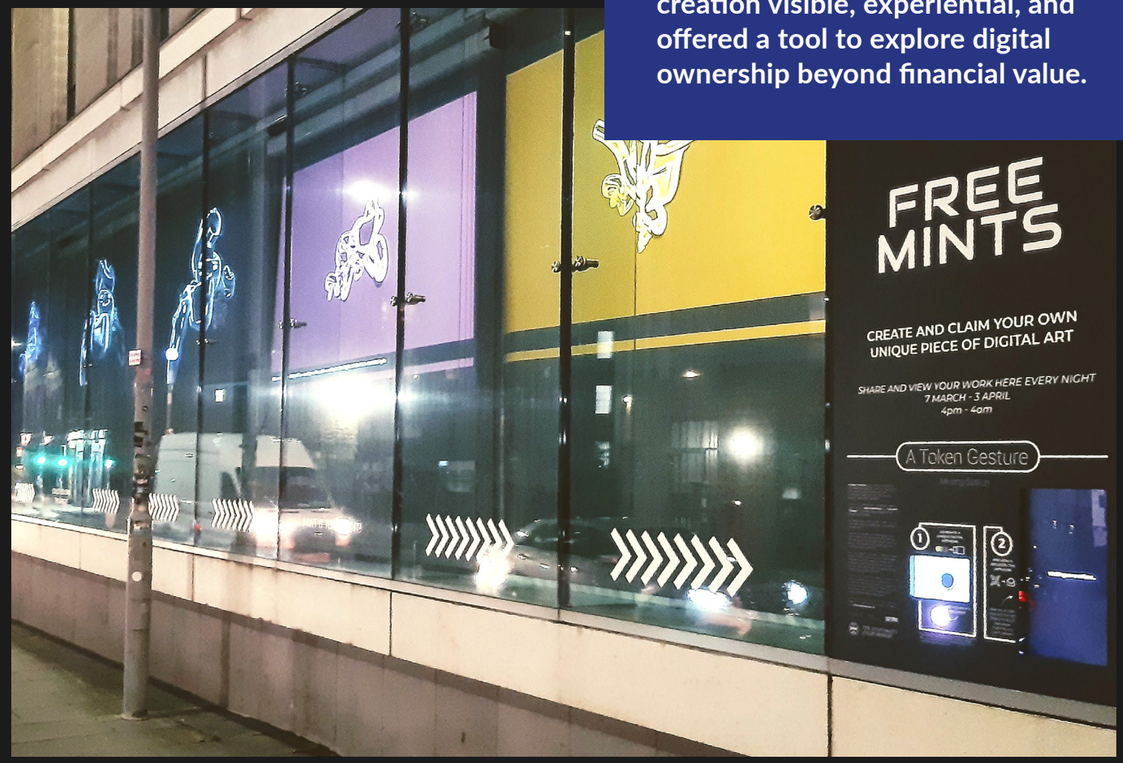
Exploring NFTs Through A Token Gesture

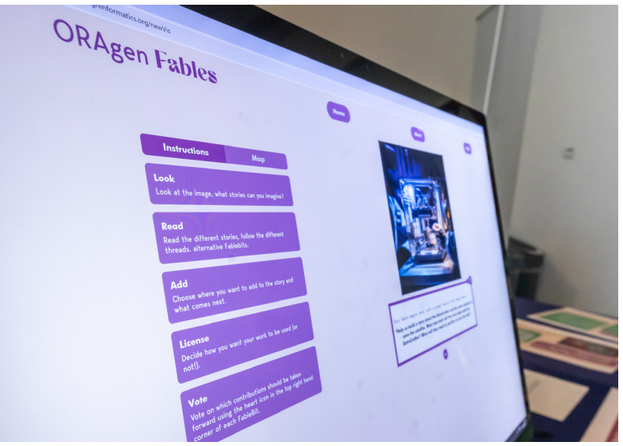
DECaDE researchers also sought both to demystify NFTs, and to make generative art creation tangible and accessible to the general public.. Using a Research through Design approach, we developed A Token Gesture–a large-scale, public, generative art exhibition, where passers-by at street level could co-create generative artworks, and mint a non-fungible-token (NFT) in real time.

The exhibition engaged two local generative artists and 229 participants who created artworks, which led to the production of 69 NFTs. Crucially, these NFTs were designed to be non-transferable – meaning they could not be bought or sold – and instead served as a 'proof of participation'. Supported by a series of talks and events, this study and exhibition fostered a more critical conversation about the meaning and design of 'owning' digital things, beyond their short-term economic value to questions of participation, authorship and design in the digital economy.

Research Team: Evan Morgan, Martin Disley, Ella Tallyn, Suzanne Black, Burkhard Schafer, Chris Elsden

> **Through generative art and public participation, DECaDE made NFT creation visible, experiential, and offered a tool to explore digital ownership beyond financial value.**







ORAgen: Evaluating Agency, Rights, and Attribution for Creators

In today's online landscape, cultural and creative professionals face multiple challenges and concerns regarding the management of ownership, rights, and attribution in creative content. DECaDE's ORAgen project and subsequent ORAgen Fables interactive, build on the ORA protocol—Ownership, Rights, and Attribution—an innovative framework developed by DECaDE and its industry partners to license media content. ORA combines the C2PA open standard (for creation provenance) with media tokenization and distributed ledger technologies (for ownership provenance) and open standards for rights (ODRL).

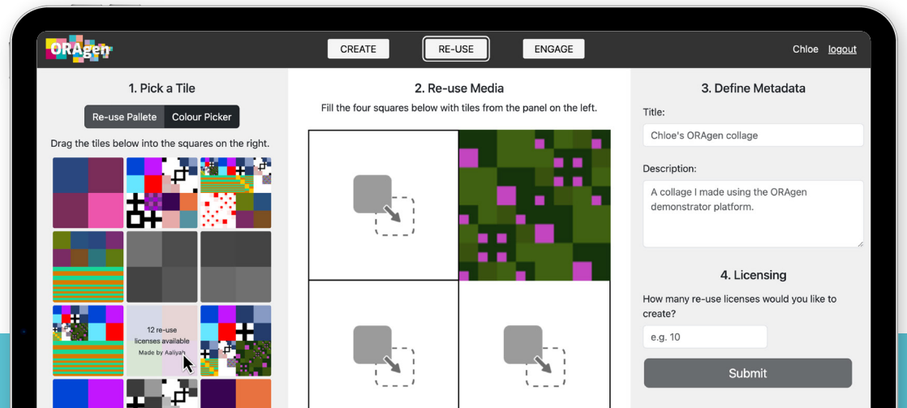
The ORAgen demonstrator enables users to interact and critically engage with the ORA protocol by creating and remixing simplified colour collages. In January 2024, Digital Catapult facilitated Field Lab 2 to examine the ORA framework in relation to managing the rights of online creators. The field lab invited 30 creative professionals from a wide range of backgrounds to test and feedback on the ORA protocol through the demonstrator. This was combined with a 'media licensing mapping' exercise where participants could implement ORA via paper prototyping to explore complex licensing challenges with their own media and content.

Insights from Field Lab 2 provided valuable insight into the potential of ORA as a tool for creatives, across a wide sector of industries, in the creation, sharing and reuse of media and content, particularly with the growth of generative AI and the scraping of media for AI training. These findings informed the report *ORAgen: Emerging Futures for Media Tokenization and Digital Media Rights* published early 2024.

DECaDE's pioneering work in tokenised media offers a promising solution by embedding ownership, rights, and attribution data directly into digital files, helping to protect creators' rights and support fair monetisation in the digital era.

Research Team: Frances Liddell, Evan Morgan, Billy Dixon, Ella Tallyn, Kar Balan, Theodore Koterwas, Martin Disley, Caterina Moruzzi John Collomosse, Chris Elsden

"The ORAgen demonstrator enables users to interact and critically engage with the ORA protocol by creating and remixing simplified colour collages.



Time to ACCCT - Access, Control, Consent, Compensation and Transparency

DECaDE teamed up with the UKRI CoSTAR National Lab and law firm Sheridans to run a series of creator-focused workshops in the wake of the 2025 UK Government Consultation on Copyright and AI. The consultation sparked a highly polarized public debate around copyright reform and AI training consent. On one side, an argument to make lawful the use of content for AI training unless rightsholders 'opt-out'. On the other, a belief that such use should be explicitly consented via 'opt-in'. The positions seemed irreconcilable.

We found that creators not only wanted both, but they wanted it in a granular form. A 'no' should mean 'no' and stick with content as it is distributed. A 'yes' should also be specific, with uses and conditions attached including payment. ACCCT argued that media provenance is the solution, and building upon DECaDE's multi-year research proposed a number of technical and policy recommendations around Copyright and AI.

A key insight was to progress solutions beyond 'control' (blunt access controls via 'robots.txt' and similar anti-scraping mechanisms) to one of granular 'consent' and, importantly, mechanisms for 'compensation' (the 3 C's of the ACCCT acronym). Rather than pursuing another doomed cycle of Digital Rights Management (DRM) technologies, media provenance should instead be employed as a basis for communicating content rights and licensing, reinforced by policy drivers. For example, a UK AI kitemark is suggested that could be conveyed through a transparent auditing of compliance with markers carried by asset provenance.

In addition to prototypes that proved the workability of this solution, the report generated substantial policy impact and DECaDE researchers engaged extensively with the Government, Civil Service and the House of Lords to address the Copyright and AI conundrum.



"Licensing only works at internet scale when rights become machine-readable. DECaDE's research points to open, free standards like C2PA and ODRL as the key.



ENABLING DIGITAL TRADE AND OPERATIONS

SUPPLY CHAIN, DIGITAL TRADE AND BORDERS

DECaDE delivers impact across physical and digital supply chains, with a particular focus on cross-border trade and digital infrastructure at borders.

Our research spans early-stage supply chains such as fish and cocoa, through to collaborations with HMRC and industry partners on digital trade, customs processes, and regulatory innovation. We explore how decentralised technologies, digital twins and data sharing mechanisms can reduce friction, improve traceability, and increase trust between stakeholders.

By addressing the fragmented nature of global supply chains—where upstream actors are often invisible to downstream consumers—DECaDE's work helps expose environmental and human-rights risks, prevents document tampering, and supports evidence-based policy and commercial decision-making.

Advancing the UK's Digital Trade Strategy

Researchers from DECaDE provided independent evaluation support to HM Revenue & Customs (HMRC) to assess the UK's trade digitalisation strategy. An external evaluation of HMRC's ETDA Technical Demonstrator was conducted to test the real-world benefits of digital trade documents for both industry and government.

The evaluation used a mixed-methods approach, combining a meta-analysis of academic and institutional studies on digital trade and a quantitative case study for one participating customs service provider. Economic impacts were assessed across cost and efficiency gains in international trade, trade volume and export growth, and wider macroeconomic effects.

Policy and Strategic Significance

The case study demonstrated that participating customs brokers could achieve: 85–95% reduction in processing costs through automation and digital document submission. The findings provide robust evidence supporting the UK Government's Trade Strategy objectives for reducing trade frictions, promoting digital innovation, and positioning the UK as a leader in global digital trade.

Research Team: Felipe Merlano, Mike Brookbanks and Glenn Parry



Trade is a team sport. Customs officials, logistics firms and technology providers all want goods to move safely and quickly, but they are working to different goals and standards. Our framework sets out how an honest broker could bring these interests together, co-create solutions and manage the digital platforms that sit behind a modern border.

Glenn Parry,
Professor of Digital Transformation, University of Surrey

How Can the UK Build a Resilient, Trusted Digital Border?

The adoption of blockchain and Industry 4.0 technologies presents a major opportunity to transform the UK border, but evidence from DECaDE research shows that fragmented pilot schemes are not enough. Without a coordinated governance approach, innovation risks remaining fragmented, limiting both resilience and trust.

Despite some claims to the contrary, blockchain does not remove the need for trust; rather, it facilitates trust-building processes. Blockchain, particularly when integrated with Internet of Things (IoT) technologies, enables trust-building by creating a single, secure, immutable, and trusted source of data across supply chains. In practical applications, such as wine importation, this technology enables trust building between parties by providing a transparent record of a product's journey, reducing manual data entry errors and data duplication. Industry 4.0 technologies further enhance supply chain resilience by enabling faster responses to disruption and reducing the "ripple effect" of border delays.

Historically, there has been a structural tension at the UK border, where industry prioritises efficiency and speed, while government departments prioritise control and risk management. This divergence has led to a fragmented ecosystem with asymmetric information, low trust and reliance on hierarchical governance models.

Evolution of the UK Border Ecosystem

To resolve these systemic frictions, researchers at DECaDE propose a Collaborative Governance Framework that moves beyond purely technical solutions to address the socio-technical challenges of multilateral coordination.

The proposed framework includes:

- **Strategic Vision and Orchestration:** A single, trusted "honest broker," can bridge the gap between industry and government to align legislation, policy, and end-to-end supply chain processes.
- **Institutional Governance:** Updating legislation (such as the Electronic Trade Documents Act) and adhering to international standards (e.g. UN/CEFACT) to ensure international interoperability.
- **Innovation and Design Rules:** The framework advocates modular, scalable architectures that enable independent specialists to contribute through independent but compatible subsystems.
- **Balancing Openness and Control:** Effective governance requires an equilibrium between a structured regulatory framework and the flexibility needed to support for industry innovation.
- **Co-Creation and Value Management:** The framework enables all stakeholders to generate solutions that meet societal needs while improving the efficiency of state action.

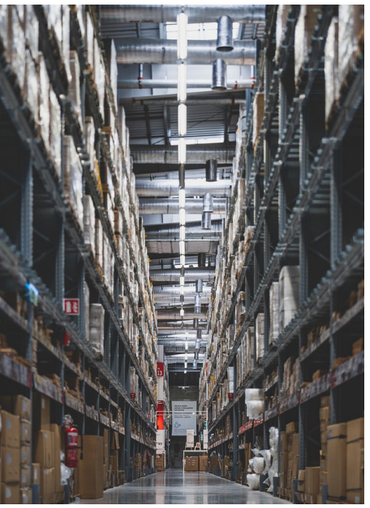
In conclusion, to remain internationally competitive the UK must shift from hierarchical control to a collaborative approach in the adoption and maintenance of blockchain systems that facilitate border management. Accelerating the progress toward a resilient digital border requires recognition that the system will necessarily evolve. An adaptive, incremental supply chain system adoption and delivery programme is needed, where feedback mechanisms and shared incentives co-create and develop a "digital silk road" for trade. Ultimately, the goal is an integrated trade innovation hub that aligns industry operational goals of the private sector with the regulatory requirements of the UK Government.

Research Team: Glenn Parry, Mike Brookbanks, Carla Bonina



Without a coordinated governance approach, innovation risks remaining fragmented, limiting both resilience and trust.





> **DECaDE research has generated empirical evidence on how blockchain technologies can enhance supply chain visibility.**

Strengthening Supply Chain Transparency and Compliance

DECaDE research has generated empirical evidence on how blockchain technologies can enhance supply chain visibility (SCV) supporting regulatory compliance, ethical sourcing, and risk reduction across global supply chains.

Using innovative scientific and technological methods, Rogerson and Parry (2020) demonstrated through case studies in the food industry that blockchain acts as an enabler of supply chain visibility by providing verifiable provenance and protection against counterfeit goods, while also acknowledging challenges at the digital-physical boundary. Building on this research, Lafargue et al. (2021) investigated the use of “biomarkers” in cocoa supply chains, creating a DNA library to trace chocolate back to individual farms. This work introduces biological identifiers as a robust solution to the limitations of physical tags in blockchain based supply systems.

More recently, Tuladhar et al. (2024) analysed a blockchain-enabled mineral tracking solution provided by Minespider GmbH, showing how improved information processing and data transparency can reduce uncertainty and support compliance with mandatory regulations on conflict minerals.

Enhancing Supply Chain Visibility

These studies advance supply chain visibility from passive traceability to active, verifiable transparency. The research offers frameworks for organisations to meet legal and ethical obligations through verifiable proof of product origins, helping address critical issues including fraud, child labour and conflict minerals in global supply chains.

Research Team: Glenn Parry, Mike Rogerson, Pedro Lafargue, Alisha Tuladhar, Juliette Engelhart, Birgit Altrichter





OUR IMPACT FACTS

15
WORKSHOPS WITH UK GOVERNMENT

5
GOVERNMENT PROGRAMMES ADVISED ON

2
ACTS OF PARLIAMENT CONTRIBUTED TOWARDS

> **DECaDE’s research has made an important contribution, particularly through its support of the RFIT research, Ecosystem of Trust (EOT) and ETDA Reliable systems pilot, providing research demonstrating how innovative technologies reduce friction in supply chains, directly supporting the UK Government’s Border Strategy.**
>
> The Lord Holmes of Richmond MBE



ENHANCING TRUST AND REPUTATION

IDENTITY, REPUTATION, AND PRIVACY

As work becomes more decentralised, identity and reputation become central to how value is created and recognised.

DECaDE's research explores self-sovereign identity (SSI), photo and data ownership, and privacy-preserving mechanisms across digital supply chains. We study how identity and reputation systems can support trust, enable fair participation in decentralised labour markets, and protect individuals' rights in the data-driven future digital economy.

Enabling Trust in Complex Supply Chains

Modern supply chains are global, complex and fragile. A major challenge within this complexity is developing and maintaining trust between partners across the supply chain. Traditionally trust relationships are built through repeated interactions and testimonials, but modern supply chains can reconfigure and establish relationships between partners who may have little or no shared history more rapidly.

However, there is a tension between the desire to share information to develop trust, and the need to withhold and control information. While sharing information about past performance and partnerships can help establish trust more quickly, organisations must also protect commercially sensitive data, including details about suppliers, customers, and contractual relationships. This creates a persistent trade-off between transparency and confidentiality.

Enabling Trust by Design

To address this challenge, DECaDE researchers developed a decentralised solution around Self-Sovereign Identity (SSI) and selective disclosure methods. SSI is a digital identity framework that gives users complete control over their own credential data, allowing them to decide what information is shared, with whom and under what conditions.

Within the framework, suppliers collect digital, tamper-proof credentials from their trusted partners and from certification or audit authorities, such as signed receipts or certification records—and store them in a secure digital wallet. This ensures that a supplier possesses evidence of past performance and compliance while protecting the sensitive information within it.

Using selective disclosure mechanisms within SSI, suppliers can prove key facts about their transactions with others without revealing the finer details of their relationships. The framework is designed to be adaptable across a wide variety of supply chain contexts. It enables suppliers to build confidentiality and trust, regulators and buyers to assess compliance and auditors and certifiers to issue certificates for properties such as warehouse resilience or compliance around issues such as ESG organic compliance, or with respect to modern slavery legislation.

DECaDE's research demonstrates how SSI technology can be used to align the various interests of all supply chain stakeholders, supporting trust, compliance and collaboration for all involved.

Research Team: Steve Schneider, Abubakar-Sadiq Shehu, Rob Learney and Tim Wood

> **By resolving the tension between transparency and confidentiality, DECaDE research enables trust in complex supply chains while preserving data control.**

How Can Creators Prove Ownership Without Revealing Their Identity?

While professional photographers are keen to be visibly associated with their work, others such as citizen journalists, activists or whistleblowers may wish to create and publicise pictures while remaining anonymous. In these contexts, anonymity can be essential for those exposing wrongdoing or highlighting a cause or sensitive issue, without risking personal repercussions if their identity is tied to the image.

To address this need, DECaDE developed an approach built on Self-Sovereign Identity (SSI) enabling individuals to share images anonymously while retaining control over their rights and the information they disclose. Through minimal disclosure mechanisms, credentials can be verified without revealing the identity of the wallet holder, exposing only the necessary information for a given transaction.

Verifiable Credentials (VCs) underpin this model within SSI, enabling trusted digital assertions to be exchanged directly between issuers and holders, without reliance on centralised databases.

The project developed an SSI based proof-of-concept implementation for privacy-preserving image sharing through the first DLT field lab—a collaborative project between DECaDE and partners including Sony, BBC, Consult Hyperion, Evolution Equity, photographers and freelancers. Using Hyperledger Aries, photographers were able to share images, assert their rights over images, and verify credentials while remain anonymous.

In line with DECaDE's decentralised approach, relationships between producer and consumers are brokered directly, without reliance on third-party organisations. This allows creators to retain control over their privacy without the need to trust any external parties; while ensuring they can be recognised as the legitimate authors of their content.

The solution demonstrates how SSI technologies can be used to achieve privacy, provenance and trust and align the various interests of all stakeholders involved.

Research Team: Ashley Fraser, Steve Schneider, Nick Frymann, Paul Haynes, Abubakar-Sadiq Shehu, Rob Learney, Nastasha Velasco.

> **Self-Sovereign Identity enables anonymity and authorship to coexist.**





Watch a demo of the technology here:

Decentralised Reputation and the Future of Work

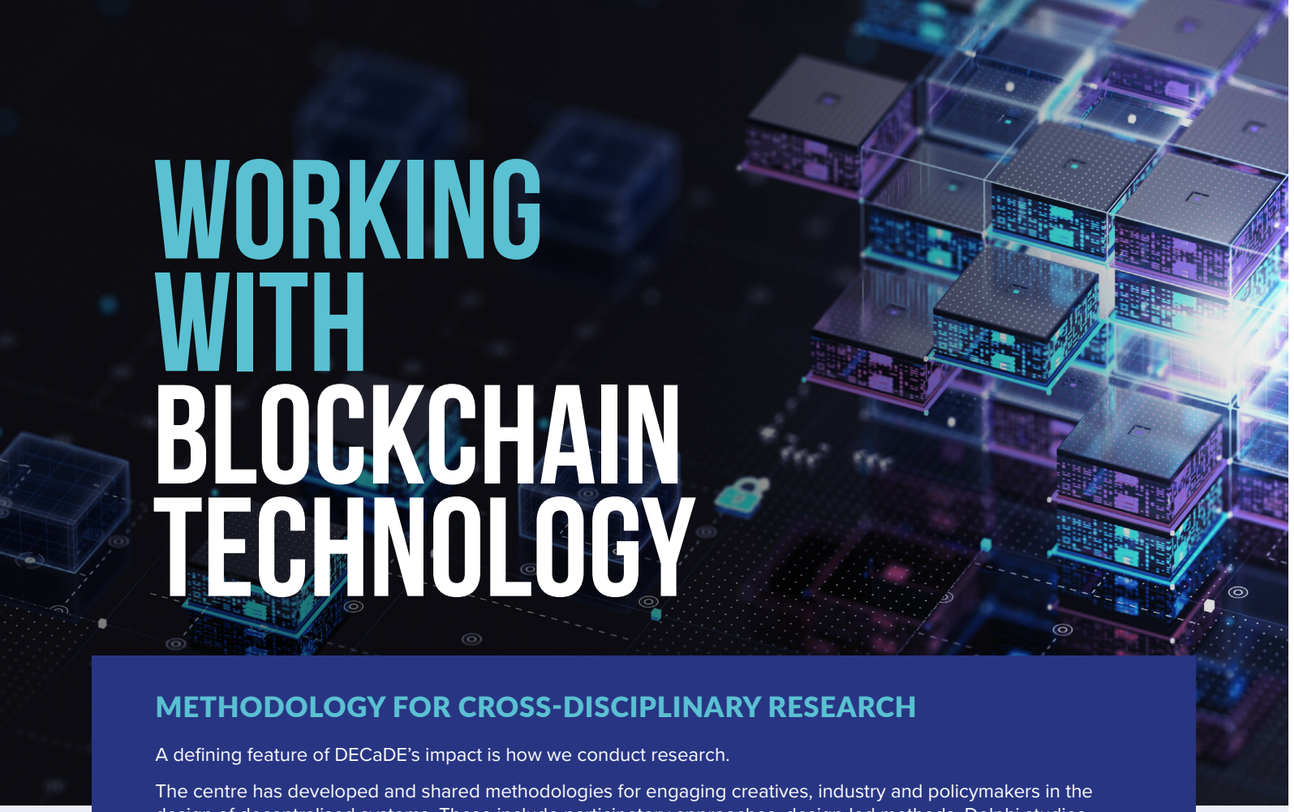
DECaDE research has advanced the understanding of how privacy-enhancing digital technologies can empower workers in a labour market increasingly impacted by the rise of artificial intelligence (AI). As gig economy work expands, workers face growing vulnerability due to fragmented, platform-controlled reputation systems that limit transparency, portability and individual control.

DECaDE researchers address this challenge by proposing a blockchain-based decentralised framework that combines self-sovereign identity (SSI), immutable reputation registries, and zero-knowledge proofs to enable privacy-preserving credential sharing. Drawing on empirical evidence from a sample of gig-economy workers, the study finds that current reputation management is highly fragmented across platforms, with nearly 50% of workers reporting limited control over information held by previous employers.

By combining Signalling Theory and the Unified Theory of Acceptance and Use of Technology, the research demonstrates that performance benefits are the strongest predictor of adoption intentions, with the model explaining 85% of the variation in behavioural intention or acceptance of the technology.

The findings inform digital identity policy development, including the UK's Office for Digital Identities and Attributes (OfDIA) strategy and the European Digital Identity framework. By demonstrating how decentralised systems can shift reputation from a centralised, platform-controlled data model to a portable, worker-owned digital asset, the framework supports policy approaches that balance innovation, data protection and labour market resilience in the future of work.

Research Team: Felipe Merlano, Glenn Parry, Abubakar-Sadiq Shehu and Steve Schneider



WORKING WITH BLOCKCHAIN TECHNOLOGY

METHODOLOGY FOR CROSS-DISCIPLINARY RESEARCH

A defining feature of DECaDE's impact is how we conduct research.

The centre has developed and shared methodologies for engaging creatives, industry and policymakers in the design of decentralised systems. These include participatory approaches, design-led methods, Delphi studies, and structured expert engagement across academia and industry.

DECaDE's playbooks and frameworks translate complex technologies into accessible tools for stakeholders, ensuring that decentralised innovation is grounded in real-world needs, lived experience, and inclusive design practices.

How Can Design-Led Research Shape the Future of Digital Creativity?

DECaDE's approach combines advocacy with participatory, design-led research methods, creating spaces where creative professionals and the public can explore critical questions: What does authenticity means in practise? Which provenance signals really matter? And what are the real challenges of creating, sharing, and remixing digital media online?

Through expert workshops spanning the creative media "supply chain"—from production to distribution to consumption—DECaDE researchers generate detailed evidence about how expectations shift across context, platform, and purpose. Participation is treated as research, not just dissemination. Through experiential, artist and design-led approaches we invite audiences to explore and critically reflect on emerging technologies and principles such as NFTs, digital ownership, provenance data, and tokenised licensing and attribution.

A key example is ORAgen Fables, a collaborative story-writing interactive exhibited across four venues in Edinburgh in 2025. This prototype was designed to provide a simple walk-up, hands-on interaction where members of the public could explore the ORA licensing protocol through co-creating stories.

The project engaged 128 members of the public, including children, and was followed up with in-depth interviews that provided insights into public perceptions of licensing and attribution when sharing media and content online.

These participatory approaches not only play an important role in engaging diverse audiences but also generate valuable evidence about what emerging technologies may mean for society, informing both research and policy while strengthening public understanding of digital ownership and creative rights.



Decentralised Service Design: Co-Creation in Action

Throughout the DECaDE centre, we have continued to develop new innovative co-creation methods and workshops to critically explore the implications of Distributed Ledger Technology with diverse communities. Building on the Institute for Design Informatics' long-standing expertise in public engagement methods we have developed an open and accessible toolkit – the Decentralised Service Design Playbook (DSD).

Developed in partnership with Orange, the DSD Playbook enables practitioners beyond academia to develop and run their own co-creation workshops and design activities, to explore how services may evolve in a decentralised digital economy. Having gained additional support from a £20K ESRC Impact Acceleration grant (IAA), DECaDE has engaged a range of industry partners and experts – across supply-chains, manufacturing and finance sectors – to help shape the playbook and test it out in different live contexts.

Beyond the DSD playbook, DECaDE also collaborated with AI4People, the Brussels-based think tank, to develop a separate playbook on AI ethics. This was presented to the Commission, Industry and NGOs at a workshop in December 2025. The AI4People Playbook breaks down AI ethics into actionable steps, and it includes instructions and practical material to support capacity-building activities, empowering its users to put principles into practice effectively.

By translating bespoke academic design research methods into clear, adaptable design tools, DECaDE fosters more thoughtful, creative and critical dialogue about when, where and how decentralised services can be effective. Importantly the playbook enables non-experts and those without technical expertise to participate meaningfully in their design and debate.

Research Team: Ella Tallyn, Frances Liddell, Chris Elsden, Burkhard Schafer, Adam de Linde

DECaDE's DSD Playbook turns academic research into practical tools, enabling anyone—experts and non-experts alike—to co-create and design decentralised services.



'If This, Then What? The Playbook's tangible logic-builder for exploring automated services'.

The Decentralised Service Design Playbook helps organisations discover the opportunities and challenges of decentralised digital services and ecosystems. Using flexible, creative and generative design methods, the playbook offers tools and guidance to enable diverse stakeholders to collaborate and identify value in decentralised technologies.



The DSD Playbook includes full walkthroughs, slide-decks and worksheet packs, adaptable for both in-person or online workshops.

Field Labs: Delivering Practical Impact

To understand DECaDE's impact and stakeholder engagement in the real-world, we run Distributed Ledger Technology (DLT) Field Labs, facilitated by Digital Catapult to translate research into real-world experimentation. Bringing together industry, policymakers, technologists and creatives, these labs move beyond theory to deliver practical DLT based solutions.

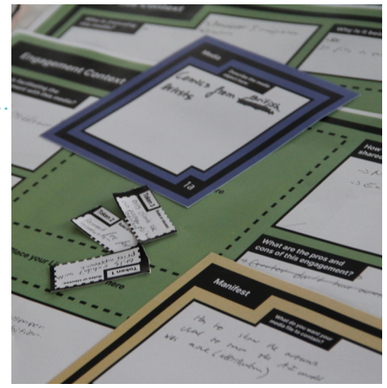


Field Lab 1 – Privacy Preserving Image Sharing

The first DLT Field Lab developed a proof-of-concept system for privacy-preserving image sharing using Self-Sovereign Identity. Working collaboratively with partners including Sony, BBC, Consult Hyperion, Evolution Equity and creative practitioners, the lab demonstrated how creators can prove image ownership and organisational membership without revealing their identity. Using Verifiable Credentials and Hyperledger Aries—an SSI toolkit that supports the minimal disclosure principle—the system enabled trusted rights verification while protecting anonymity, supporting use cases from professional photography to whistleblowing and activist reporting.

Field Lab 2 – Tokenised Media and Creative Rights

The second Field Lab explored "tokenised media" to embed ownership, rights and attribution data directly into digital files, supporting verifiable records and machine-readable licensing. The workshop engaged 30 participants from a broad range of of creative backgrounds to test the ORA framework and ORAgen demonstrator developed by DECaDE, as a solution for managing the rights of creators online. The ORAgen framework combines the C2PA provenance standard with non-fungible tokens (NFTs) to track assets on a blockchain and uses smart contracts to manage interactions between the two enabling the assertion of rights and content licensing. Valuable insights were gained addressing concerns around GenAI and web scraping tools, and the importance of protecting brand identity and exploring new monetisation pathways.





Field lab 3: Reputation in the Decentralised Supply Chain

The third Field Lab explored new ways in which reputation can be established for parties in decentralised supply chains, where agents need to develop trusted relationships. The lab developed a working demonstrator highlighting the application of advanced cryptography for the selective disclosure of private information in a coffee supply chain scenario. This explored how parties in a supply chain can share testimonials and evidence of strong business practices while controlling the information they disclose. This demonstrator was presented through an interactive webinar with supply chain stakeholders and experts, and now forms the basis of a workshop developed out of the DLT Playbook to highlight and explore the benefits and potential of this approach.

Explainer video: Privacy-Preserving Supply Chain Framework

> **"The DECaDE Field Labs show how research can be fast-tracked into commercially relevant solutions. By bringing industry, innovators and policymakers together in one space, they reduce risk, accelerate adoption and help turn emerging technologies into practical tools for the creative economy.**
>
> **Dr. Robert M. Learney, Head of Technology - Distributed Systems, Digital Catapult**

Bridging Blockchain's Paradox

DECaDE investigated the inherent contradictions that arise when implementing blockchain technology within organisational and supply chain contexts. Drawing on paradox theory, DECaDE researchers examined how blockchain's foundational promises of decentralisation and transparency frequently clash with practical requirements for governance, control and accountability.

Drawing on expert interviews and Delphi studies, the research identifies specific tensions around data privacy, trust, and sustainability, creating challenges for blockchain adoption. The findings show that blockchain paradoxes often form complex, nested and interdependent tensions that require nuanced, context-specific management. Technological advancements may resolve certain frictions, but they often generate new interdependent tensions within the socio-technical system. For organisations navigating the evolving digital landscape, managers should avoid treating paradoxes as simple binary choices, instead adopting an ambidextrous "both/and" approach when navigating competing demands.

The research positions blockchain as critical infrastructure, comparable to transport networks, highlighting the need for standardisation to protect smaller firms. To reduce risks arising from the misrepresentation of smart contracts, commercial protocols can be adopted to transform automated code into legal agreements. Effective management requires continuous adaptation—treating paradoxes as flexible trade-offs rather than fixed contradictions.

Additional research in business to business (B2B) environments, specifically within the wind turbine industry, further explores why blockchain technologies often fail to deliver their transformative potential. By applying paradox theory, DECaDE researchers identified how blockchain's features—such as decentralisation and immutability—create inherent tensions at individual, organisational, and collaborative levels. The study highlights tensions between operational experiences and long-term strategic commitments, as well as transparency and competitive confidentiality.

By understanding how paradoxes can be balanced, managers can bridge the gap between blockchain's promise and its practical reality reaping the benefits for their organisation.

Research Team: Glenn Parry, Birgit Altrichter, Mike Rogerson, MariaLaura Di Domenico, Rene Goduscheit, Stelvia Matos, Kristoffer Holm, Yu Xiong

Enabling Trust and Adoption in Blockchain Systems

To understand the slow adoption of blockchain technology by organisations, DECaDE has identified adoption factors across technological, organisational, and environmental dimensions, which further classified as barriers, enablers, and ambiguous factors. This study has led to the development of the BEnA framework which helps organisations access their readiness for blockchain adoption.

Through expert interviews, the research also examines how organisations build and sustain trust in blockchain projects, highlighting six key antecedents: cultural values, business value, governance architecture, precedent spillovers, informative signalling, and leadership engagement.

The research also examines how different interpretations in value of privacy influences individuals' willingness to disclose personal data and adopt blockchain-based systems. A survey of 483 UK participants demonstrates that framing privacy as a right, a private commodity or a social asset significantly shapes privacy-related decision-making. Recognising privacy's social value increases privacy concern, reduces disclosure intentions and strengthens preferences for blockchain-enabled data protection systems.

DECaDE research provides practical pathways for enabling blockchain adoption in complex, multi-tier supply chains where trust, traceability, and cross-organisational coordination are persistent barriers. Drawing on synthesis of 87 supply chain studies, the work shows how blockchain reshapes the drivers of technology adoption and demonstrates why established lenses approaches often need refinement for decentralised, shared-data ecosystems.

In particular, this research identifies a shift from firm-centric control and linear diffusion models toward ecosystem governance, shared standards, and trust-by-design, including mechanisms such as smart contracts and immutable audit trails.

Together, this body of work provides evidence-based insights for policymakers, business leaders, and supply chain managers. It demonstrates how blockchain can be implemented responsibly, how trust and privacy can be enhanced, and how organisations can prepare for adoption within complex, multi-party ecosystems.

Research Team: Ying Zhang, Xiaotian Xie, Mahdi Tavalaei, Peng Zhou, Glenn Parry



IMPACTING POLICY

POLICY AND REGULATORY IMPACT

DECaDE studies decentralised infrastructure and its potential to transform impact in the digital economy. DECaDE's perspectives on economic, governance, and societal issues as much as technical innovation, has positioned us to engage directly with policymakers at moments of rapid technological change.

DECaDE has done so through oral evidence to House of Lords Select Committees, written submissions to government consultations, and direct engagement with All-Party Parliamentary Groups (APPGs) and government departments – notably DCMS, DSIT, HMRC, and the Cabinet Office.

We contributed evidence to the regulation of crypto-assets in the aftermath of NFTs; to the role of distributed ledger technologies in reducing friction in cross-border trade following Brexit; and to data governance surrounding the rise of generative AI, including online harms and the debate on copyright and opt-out for AI training.

Shaping the Future of Digital Assets

When the digital economy transformed the way we interact as customers, in the early 1990s, it was widely hoped that digital technologies would disintermediate traditional economic exchanges. By connecting producers and consumers – whether as customers, creators, 'prosumers' or platforms – the promise was to facilitate free and voluntary exchanges, thereby creating value by removing the unnecessary costs of involving resellers as intermediaries.

This initial hope quickly faded, and new players swiftly "reintermediated" the digital markets. They were aided in this process by a notable legal absence – the disappearance of property law in a digital economy that instead relied on Intellectual Property, data protection, and contract law, none of which could replicate the normative values and structural functions traditionally safeguarded by property law. Now, with the decentralised digital economy and Web3 again creating hopes for a disintermediated digital economy, the question remains whether property law will also make a return.

In England and Scotland, Law Commissions and governments have recognised the importance of property law for the future digital economy and have initiated legislative steps to establish a property law framework specifically for digital objects. DECaDE supported these efforts by integrating academic expertise with industry experience to inform and strengthen the reform process.

Evidence for Digital Asset Legislation

Our research combined outward-facing seminars, industry workshops, and comparative legal evaluations of existing and proposed legal changes abroad to inform responses to consultations and evidence sessions at committee meetings in the House of Lords and the Scottish Parliament. Combined with findings from the ORAgen project, an attribution and rights management tool developed by DECaDE researchers, the team probed public understanding and reception to the concept of media tokenisation and rights.

> "Our evidence informed parliamentary debate in England and Scotland, supporting digital property reform while redefining what it means to 'own' a digital asset.



DECaDE's evidence strongly supported the proposed legislation, and urged that transferability of assets should not be included within the definition of ownable digital assets. Instead, the potential to extend the concept to digital objects currently excluded should be explored, ideally through more structured and ongoing collaboration from policy makers, academia and industry.

Prof. Burkhard Schafer gives witness testimony on Digital Assets to the Lords Special Public Bill Committee (2024)

Making AI Training Fair

DECaDE has played a sustained and influential role in shaping policy debate at the intersection of copyright and AI. The broad adoption of generative AI has raised new questions about the fair use of data, particularly in the Creative and Cultural Heritage sectors, where content is frequently scraped and used to train AI models without explicit consent. In its response to the UK Government's 2025 consultation on Copyright and AI, DECaDE reframed this challenge as a content supply-chain problem, arguing that technologies for establishing media provenance provide a viable route to resolution.

DECaDE's response urged a move beyond the polarised opt-in versus opt-out debate, arguing how open standards for content provenance—specifically C2PA—enable rightsholders to indicate consent clearly and at scale. Crucially, such standards can underpin a decentralized solution for content licensing, allowing data rightsholders to be identified and compensated for the re-use of their work. In this model a 'no' can truly mean no, but a 'yes' can offer new opportunities for lawful reuse and value creation.

The response drew on DECaDE's published research on the ContentARCs and ORA frameworks, alongside implementations including DECORAIT, EKILA, and ORAGen. Together these projects demonstrate that fair and accountable data use in AI systems, is technically achievable through media provenance.

Building on this work, DECaDE partnered with the CoSTAR National Lab to publish the *Time to ACCCT* report, combining technical insight with stakeholder engagement across the creative industries and AI sector. The report set out actionable policy and technical recommendations with the ACCCT framework subsequently referenced in parliamentary debate. This led to DECaDE's participation in the Department for Culture, Media and Sport (DCMS) technical working group on Controls and Technical Standards, and in the Innovation working group of the DCMS Creative Industries Council (CIC).

DECaDE has further contributed its expertise through invited briefings on copyright and AI opt-out—including at the Oxford AI Ethics Institute, the House of Lords and the European Commision—and through oral testimony to the House of Lords Communications and Digital Select Committee on Copyright and AI. The report published by the Select Committee cites several of DECaDE's published works on media provenance and licensing.

OUR IMPACT FACTS

6
APPG EVIDENCE SESSIONS

6
GOVERNMENT CONSULTATION RESPONSES

2
ORAL TESTIMONIES TO HOUSE OF LORDS SELECT COMMITTEES

> "In AI training, a 'no' should mean no—but a 'yes' should create value. DECaDE's work shows how media provenance can deliver both.



Online Harms

DECaDE has developed influential new technologies and insights to support the fight against online disinformation and misinformation. Through the Royal Society, DECaDE researchers were embedded within the Department for Science, Innovation and Technology (DSIT) disinformation capability team, contributing evidence on how media provenance can support trust in digital media.

DECaDE researchers have played a leading role in the founding and development of the C2PA international standard for media provenance, shaping key aspects of the standard relating to decentralisation and the durability of signals through watermarking. C2PA has since been widely referenced in legislation and policy discussions on online harms, as well as in reports by the NSCC/NSA and the World Privacy Forum, which cite DECaDE's published research on media provenance.

DECaDE's provenance research has also informed reports on election misinformation produced by Ofcom and the CeTAS, alongside policy reports for the Home Office and DCMS. DECaDE researchers have provided expert evidence and technical insight to DCMS, DARPA's Semafor project, and the US National Academy of Sciences—contributing alongside world-leading academics such as Professor Hany Farid—on the role of media provenance in countering deepfakes and wider online harms.

Prof. John Collomosse gives witness testimony on Copyright and AI to the Lords Communications and Digital Committee (2025)

THE NEXT GENERATION OF DIGITAL ECONOMY RESEARCHERS

Through its multidisciplinary team and its commitment to training the next generation of postdoctoral researchers, DECaDE continues to generate lasting impact - advancing innovation at the forefront of the decentralised digital economy.

Dr Alex Black



Alexander Black graduated from DECaDE with a PhD in Computer Vision and Machine Learning in 2024 and now holds a valuable position as a Research Scientist in the AI Theory Group at Huawei Research UK.

Through his thesis, which focused on media provenance, he achieved notable research milestones. His work on image fingerprinting was among the first visual matching technologies designed to trace and compare images to establish their provenance, helping to combat fake news and misinformation. He went on to win the Best Paper Prize at CVMP 2022 for his work on video fingerprinting. More recently, Alex presented *ImProvShow*, a novel AI-based approach for summarising the provenance and edit history of digital images, at the British Machine Vision Conference (BMVC) 2025.

Through DECaDE's partnership with Adobe, Alex also completed a successful internship as a Research Scientist, resulting in work on scalable video fingerprinting published at ICCV 2023.

With a focus on making a positive impact on the digital world, DECaDE's wide-ranging research programme enabled him to contribute to a broad spectrum of projects addressing a major societal; tackling fake news and misinformation.



Dr Ashley Fraser

Ashley Fraser joined the EPSRC Centre for the Decentralised Digital Economy (DECaDE) as a research fellow in cyber security in 2021. Her research focused on decentralised digital identity management models, specifically security and privacy properties of self-sovereign identity (SSI) systems. During her time as a research fellow in DECaDE she developed security models for, and analysed the security of protocols that are implemented in SSI systems.

Following her time at DECaDE, Ashley transitioned to a position as Lecturer in Security and Protection Science at Lancaster University. She continues her research on the analysis of real-world protocols, with a particular focus on decentralised identity management systems, the security and privacy of cryptographic primitives and schemes, and self-sovereign identity systems.

"Through DECaDE I have enjoyed the challenge of applying my knowledge of cyber security to novel and emerging decentralised technology. As an interdisciplinary research centre, DECaDE offers the opportunity to explore research directions beyond the purely technical – in particular, working with industry and public sector partners to investigate the requirements of SSI systems, distinguishing such systems from other digital identity management models.

Kar Balan

Kar is a final year PhD student within DECaDE. With a diverse background initially rooted in the film and animation industries, Kar conducts research at the intersection of computer vision and blockchain technologies with a focus on the potential of content provenance to address issues of consent and creator compensation for AI training.

Due to the interdisciplinary nature of working at DECaDE, which offers the opportunity to engage with the wider creative and cultural industries, Kar successfully secured two internships. The first, at Digital Catapult, a deep tech innovation organisation and partners for the DECaDE centre. During his three-month internship at Digital Catapult, Kar's work centred on cryptographic tools for verifiable AI systems designed to increase transparency and trust in machine learning pipelines.

The second placement took place in Brussels as part of the Blue Book Traineeship programme, a five-month internship offered by the European Commission, providing hands-on experience in EU policymaking and administration. His internship working as Policy Officer coincided with a historic moment: the rollout of the EU AI Act, where considerations of AI labelling and provenance intersect strongly with his PhD work at DECaDE.



"DECaDE has given me a unique PhD experience. The mix of disciplines and expertise is truly special—legal scholars, technologists, designers—all working together. That dynamic has led to real impact, far beyond what I expected when I started.

I've built real-life demonstrators, spoken on panels, travelled to present our work, and developed work that's meaningful not just in academic terms, but also in practical, societal ones.



Dr Birgit Altrichter

As Research Fellow within DECaDE, Birgit Altrichter brought insights from Surrey Business School focusing on business models in the decentralised digital economy.

Her research explored paradoxical tensions that emerge within distributed technology applications and the control-collaboration paradox of blockchain implementation in supply chains. Through the DECaDE project, she has presented key findings at international conferences and to stakeholders working in international trade technology development and adoption for the UK Government.

A notable achievement was winning the best paper award at CADE 2025, the International Conference on AI and the Digital Economy with her paper "*The Centralization–Decentralization Governance Paradox of Blockchain in Supply Chains*". Building upon this experience, Birgit has now transitioned to a permanent position as a lecturer (assistant professor) at Surrey Business School, inspiring the next generation of digital economy researchers.

"Through DECaDE, I have presented my work on paradoxical tensions that emerge with decentralised technologies at leading academic conferences, to industry experts and policymakers. DECaDE has enabled me to translate my research into real-world impact, and I now carry this work forward in my academic role, helping to shape the future of digital economy research.

OUR IMPACT FACTS

5
RESEARCHERS TRANSLATED TO FULL TIME ACADEMIC POSTS

5
RESEARCHERS EMPLOYED IN INDUSTRY R&D & PUBLIC POLICY

THE FUTURE OF DECaDE

As governments, industry, and society grapple with the implications of generative AI and an increasingly decentralised digital economy, the need for interoperable standards, accountable governance, and fair value exchange will become ever more important. From creative content markets to cross-border trade, digital supply chains will require infrastructure that balances efficiency with integrity—without relying on a single centralised point of trust.

At the heart of this transformation lies provenance: the ability to establish trusted data, verify origin, and trace the lifecycle of digital and physical assets alike. Whether safeguarding media authenticity, enabling transparent AI training data reuse, or tracking goods across borders, provenance provides the connective tissue between actors in the digital supply chain.

DECaDE's work shows that decentralisation is not an end in itself, but a design challenge — one that demands coordination across technical systems, legal frameworks, and social norms. Crucially, trust cannot be retrofitted. It must be designed into systems from the outset — through open standards, durable provenance, transparent governance, and mechanisms that ensure accountability alongside innovation. The supply-chain lens that has shaped our research offers a durable framework for navigating this transition.

Although, after six years, the DECaDE programme now concludes, the challenges it has addressed are only beginning to scale. The ideas, technologies, and policy frameworks developed through DECaDE provide foundations for a digital economy in which creators retain agency, markets operate transparently, and trust can endure even as technology accelerates.

Delivering these advances will require the kind of deeply multidisciplinary collaboration exemplified by the UKRI Digital Economy programme, and embodied by the next generation of socio-technical researchers trained by translational centres like DECaDE. The future of decentralisation will depend not only on what we build, but on how we choose to govern and sustain it.

> **The ideas, technologies, and policy frameworks developed through DECaDE provide foundations for a digital economy in which creators retain agency, markets operate transparently, and trust can endure, even as technology accelerates.**

> It has been a privilege to Chair the Independent Advisory Board for the DECaDE programme. I have seen first-hand how the DECaDE team has combined rigorous research with real-world engagement, addressing not only the technical application of emerging digital technologies to how we contract, transact and interact, but also the wider societal challenges they raise—around privacy, legitimacy and security.
>
> DECaDE has delivered impressive results and, crucially, demonstrable impact. Its work has informed commercial practice and directly influenced policy thinking, showing how research-led innovation can shape decision-making across government and industry. The programme's work is already influencing approaches across government and industry, with tangible benefits for trade, regulation and the operation of modern supply chains.
>
> **Nick Davies, Director, International Centre for Digital Trade and Innovation & former Innovation Lead, HMRC**

DECaDE acknowledges the support of its partners and collaborators across industry, government and the public sector. Their collaboration has enabled the development of bold, forward-looking research that is helping to shape the evolution of the digital economy and the future of work and value creation.



SELECTED PUBLICATIONS

Provenance & watermarking technologies (vision/AI)

On the Coexistence and Ensembling of Watermarks. A. Petrov, S. Agarwal, P. Torr, A. Bibi and J. Collomosse. Intl. Conf. Neural Information Processing Systems (NeurIPS). 2025.

TrustMark: Robust Watermarking and Watermark Removal for Arbitrary Resolution Images. T. Bui, S. Agarwal and J. Collomosse. IEEE International Conference on Computer Vision (ICCV). 2025.

MAD-Sherlock: Multi-Agent Debate for Visual Misinformation Detection. K. Lakara, G. Channing, J. Sock, C. Rupprecht, P. Torr, J. Collomosse and C. Schroeder de Witt. Intl. Conf. on Machine Learning Workshops (CFAgentic). 2025.

ProMark: Proactive Diffusion Watermarking for Causal Attribution. V. Asnani, S. Agarwal, T. Bui and J. Collomosse. Computer Vision and Pattern Recognition (CVPR). 2024.

EKILA: Synthetic Media Provenance and Attribution for Generative Art. K. Balan, S. Agarwal, S. Jenni, A. Parsons, A. Gilbert and J. Collomosse. CVPR Workshop on Media Forensics (CVPRW). 2023.

Deep Image Comparator: Learning to Visualize Editorial Change. A. Black, T. Bui, H. Jin, V. Swaminathan and J. Collomosse. CVPR Workshop on Media Forensics (CVPRW). 2021.

Moving Beyond 'Facts are Facts': Managing Emotions and Legitimacy after a Fake News Attack. M. Joachim, I. Castello and G. Parry. Business & Society. 65(2), pp. 389–429. 2024.

Fact-Checking with Contextual Narratives: Leveraging Retrieval-Augmented LLMs for Social Media Analysis. A. Dey, Md. J. Awan, G. Channing, C. Schroeder de Witt, J. Collomosse. IEEE Transactions on Computational Social Systems (IEEE TCSS). 2026.

Provenance infrastructure for consent & compensation

Content ARCs: Decentralized Content Rights in the Age of Generative AI. K. Balan, A. Gilbert and J. Collomosse. International Conference on AI and the Digital Economy (CADE). 2025.

Time to ACCCT: Providing Creative Industries and AI Developers with a Copyright Framework of Access, Control, Consent, Compensation and Transparency. J. Bennett, J. Collomosse, R. Gregory-Clarke, J. Jones, L. Love, M. Lycett and W. Saunders. CoSTAR/DECaDE Technical Report. 2025.

Decentralized Creative Copyright Exchange in the Age of Generative AI. M. Awan, K. Balan and J. Collomosse. Intl. Conf. on Visual Media Production (CVMP). 2025.

To Authenticity, and Beyond! Building Safe and Fair Generative AI upon the Three Pillars of Provenance. J. Collomosse and A. Parsons. IEEE Computer Graphics and Applications. 2024.

DECORAIT - DECentralized Opt-in/out Registry for AI Training. K. Balan, A. Black, S. Jenni, A. Gilbert, A. Parsons and J. Collomosse. Intl. Conf. on Visual Media Production (CVMP). 2023.

Identity, reputation and privacy

Privacy-enhancing decentralised reputation systems: a future of work perspective, E. F. Merlano, G. Parry, A. S. Shehu, S. Schneider, International Conference on AI and the Digital Economy. 2025.

Reputation Opportunities in Decentralised Supply Chains, A. S. Shehu and S. Schneider, 26th Pan-Hellenic Conference on Supply Chain. 2025.

On the role of blockchain for self-sovereign identity, A. Fraser and S. Schneider, Competitive Advantage in the Digital Economy. 17-21 (CADE). 2022.

Blockchain, trust & supply chains

Blockchain technology through a paradox lens: Bridging the gap between promise and reality?. R. Goduscheit, G. Parry, S. Matos, K. Holm and Y. Xioang. Technovation. 2025.

Blockchain for compliance: An information processing case study of mandatory supply chain transparency in conflict minerals sourcing. A. Tuladhar, M. Rogerson, J. Engelhart, G. Parry and B. Altrichter. Supply Chain Management. 29(4), pp. 755–777. 2024.

The Centralization-Decentralization Governance Paradox of Blockchain in Supply Chains". B. Altrichter, M. Rogerson, G. Parry and M. DiDomenico. IET CADE. 2025.

The impact of Industry 4.0 technologies on the resilience of established cross border supply chains. M. Brookbanks and G. Parry. Supply Chain Management. 29(4), pp. 731–754. 2024.

Evolution or involution? A systematic literature review on blockchain adoption factors from an organisational perspective". Y. Zhang, M. Tavalaei, G. Parry and P. Zhou. Technological Forecasting & Social Change. Vol. 208, Article 123710, pp. 1–18. 2024.

Perspectives on 'Good' in Blockchain for Good. G. Parry and J. Collomosse. Frontiers in Blockchain. 2021.

Identity, security & formal methods

Decentralised Supply Chain Reputation: A Privacy and Self-Sovereign Identity Perspective. A. S. Shehu and S. Schneider. IEEE European Symposium on Security and Privacy Workshops (EuroS&PW). 2025.

A Formal Security Analysis of Hyperledger AnonCreds. A. Fraser and S. Schneider. EuroS&P. pp. 822–844. 2025.

Privacy-Preserving Photo Sharing: An SSI Use Case. A. Fraser, A.S-Shehu, N. Frymann, P. Haynes and S. Schneider. Intl Conf. on Information Systems Security (ICISS). 2024.

Law, ethics & regulation of AI

The AI4People playbook: Implementing proportional approach to ethical AI requirements. P. Chazerand, V. Ghiara, A. Horzyk, R. Kennedy, C. Leclère, X. Liu, F. Massucci, B. Schafer, J. L. Slosser and N. Tschap. AI4People. 2025.

Ownership and control in the creative economy. M. Terras, B. Schafer and A. Favreau. Data-Driven Innovation in the Creative Industries. pp. 156–175. 2024.

When Brand Distinctiveness Is in the AI of the Beholder. M. Amstalden and B. Schafer. New Zealand Yearbook of International Law. Volume 18, pp. 51–84. 2022.

Design, HCI & the creative economy

Interrogating the ORA Framework: Implications of Tokenized Licensing in the Cultural Economy. F. Liddell, C. Elsden, E. Tallyn, C. Moruzzi, E. Morgan, K. Balan, J. Collomosse, M. Disley, T. Koterwas and B. Dixon. Journal of Cultural Economy. 2026.

Building Trust and Developing Value between Creative Rightsholders and GenAI through Tokenised Licensing and Content Authenticity Tools. C. Elsden, F. Liddell, C. Moruzzi, B. Schafer, E. Tallyn, E. Morgan, B. Dixon, K. Balan and J. Collomosse. The Paris Journal on AI & Digital Ethics (PCAIDE). pp. 126–139. 2025.

Content Authenticities: A Discussion on the Values of Provenance Data for Creatives and their Audiences. C. Moruzzi, E. Tallyn, F. Liddell, B. Dixon, J. Collomosse and C. Elsden. Proceedings of the Conference on Creativity and Cognition (C&C '25). pp. 128–140. 2025.

ORAgen: Exploring the Design of Attribution through Media Tokenisation. F. Liddell, E. Tallyn, E. Morgan, K. Balan, M. Disley, T. Koterwas, B. Dixon, C. Moruzzi, J. P. Collomosse and C. Elsden. Designing Interactive Systems Conference. pp. 229–233. 2024.

A Token Gesture: Non-Transferable NFTs, Digital Possessions and Ownership Design. C. Elsden, E. Morgan, E. Tallyn, S. R. Black, M. Disley, B. Schafer, D. Murray-Rust and C. Speed. ACM Human Computer Interaction (CSCW), Article 25. 2024.

Understanding Blockchains Through Prototypes and Public Engagement. D. Murray-Rust, C. Elsden, B. Nissen, E. Tallyn, L. Pschetz and C. Speed. ACM Transactions on Computer-Human Interaction. Issue 4. 2023.

Crypto Collectibles, Museum Funding and OpenGLAM: Challenges, Opportunities and the Potential of Non-Fungible Tokens (NFTs). F. Valeonti, A. Bikakis, M. Terras, C. Speed, A. Hudson-Smith and K. Chalkias. Applied Sciences. Issue 21. 2021.

Please visit our website to find out more about our research and latest news.

decade.ac.uk

DECaDE

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