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Forging Futures: Indigenous Nations Information and Place Tracing through Cutting-Edge Science and Collaboration

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Executive summary

This Indigenous-led research project designed and implemented a research prototype of a secure, Indigenous Nation-linked data infrastructure system that made Indigenous Nation and place visible across the food supply chain. The prototype moved beyond conventional ingredient-centric provenance by ensuring that Indigenous Nation itself was carried and recognised along the chain, including where foods and raw ingredients were planted, nurtured and harvested on Nation, together with the time that 'things' existed on Indigenous places prior to refinement and/or consumption. To ground traceability in verifiable location evidence, the system design supported capturing geospatial information (including GPS coordinates where appropriate) and linked it to Indigenous territories and Nation contexts associated with producing areas and distribution routes.

A second core contribution of the research project was the development of a user-facing graphical user interface (GUI) that made the prototype operational and usable for different stakeholders. The GUI enabled guided exploration of Indigenous Nation-linked provenance, supported controlled upload and curation workflows for Indigenous contributions under agreed protocols, and presented traceability narratives and visualisations bounded by authority-based permissions and policy controls.

The final contribution of this project was the implementation of a blockchain-based token architecture that is coupled with the Indigenous Nations coordinate system for location-aware information tracing of activities. Research investigated the use of smart contracts for the automation of rewards to Indigenous Nations based on economic contribution and impact.

Building on a completed kick-start feasibility study with Miimi & Gambang Trading Company Pty Ltd, a 100% Aboriginal-owned business, the project extended that foundation by expanding stakeholder engagement and implementing a governance-constrained architecture aligned with Indigenous Cultural and Intellectual Property (ICIP) and Indigenous Data Governance (IDG). The project explored a new domain for use-case application which includes environmental, social and governance (ESG) tracking.

The prototype integrated blockchain or ledger mechanisms, an Indigenous Nation-linked knowledge model informed by regional cultural information and community preferences, and AI-enabled discovery and explanation capabilities, while ensuring Indigenous communities retained ownership, control and autonomy over Indigenous information throughout the work.

The project was validated through two completed scenario demonstrations:

1. A food supply chain scenario showing place-first provenance from growth through production and distribution to end users.
2. An ESG scenario demonstrating how the same governed infrastructure and interface supported transparency and reporting needs without undermining Indigenous authority or cultural safety.

This report documents the project's scope, methodology, findings and outcomes. Beyond its technical contribution, the project supported cultural preservation and strengthened non-Indigenous understanding and engagement with Indigenous places in the context of food systems. The prototype was designed for secure deployment with a clear authority model, so no third party could access Indigenous data without approval, protecting confidentiality, integrity and cultural safety. The GUI, generative user interface (UI) capabilities, blockchain infrastructure and token mechanisms should be understood as enabling technologies supporting the broader objective of Indigenous Nation-linked information tracing and governed access to Indigenous place-based knowledge.

1 Introduction

1.1 Purpose

This report introduces and summarises a completed Indigenous-led research project that extended a foundational kick-start feasibility initiative with Miimi & Gambang Trading Company Pty Ltd, a 100% Aboriginal-owned business. It describes the project rationale, the system scope, the governance commitments applied, and the outcomes achieved across two strands of work:

1. An Indigenous Nation-linked food supply chain traceability prototype with stakeholder workflows and user interfaces.
2. An ESG token architecture demonstrating how the same governed infrastructure supports contribution incentivisation and auditability.

1.2 Background

Food traceability systems commonly emphasise ingredients, compliance and logistics – answering 'Where was this produced?' and 'What happened to it along the way?'. In Indigenous contexts, this approach is incomplete because it fails to represent Indigenous Nation and place as central, enduring entities with cultural meaning and stewardship responsibilities. It also tends to treat geospatial and route information as operational metadata rather than as place-linked information that may be culturally sensitive and therefore must be governed.

This project addressed that gap by designing and implementing a prototype in which Indigenous Nation and place are treated as first-class entities across supply chain events. The prototype supports capturing geospatial evidence (including GPS coordinates where appropriate) and linking it to Indigenous Nations' boundary and coordinate representations so that producing areas and distribution routes can be traced and visualised in a location-aware and auditable manner.

Existing traceability tools

GS1 standards provide a common global language to identify, capture and share supply chain data through barcodes, identification keys and tags. They help industries work together and trace products.

1.3 Project scope and system overview

The project delivered a secure, governed data infrastructure system (known as the Indigenous Nations Information Tracing System (INITS)) that links:

- product and crop information and the places where they were grown and harvested
- supply chain activities and movements across Indigenous Nation-linked routes
- user-facing interaction points (for example, QR-code scanning) that made traceability usable and visible to stakeholders.

The system design combines:

- a traceability data layer capturing supply chain events and associated location information
- an Indigenous Nations boundary and coordinate system used to represent and audit where activities occurred
- blockchain and smart contract mechanisms enabling tamper-evident tracing and automated acknowledgement/reward processes
- a GUI exploration enabling stakeholders to interact with the system under governance controls.

1.4 Problem statement

Conventional approaches commonly fall short in four ways that matter for Indigenous place-based supply chain tracing:

- Indigenous Nation is not represented as a first-class entity. Provenance is limited to commodities, vendors and facilities instead of meaningful attribution to Indigenous Nation and place.
- Governance controls are weak or absent. Communities lack sufficient mechanisms to control how place-linked information, including producing areas, boundaries and routes, is recorded, accessed, interpreted and reused.
- Time-aware place context is poorly supported. Many systems cannot represent ‘what existed on the Nation, and when’, prior to refinement and consumption.
- Recognition and equity mechanisms are missing. Conventional tracing rarely supports transparent acknowledgement or mechanisms to reward Indigenous contribution and impact in ways aligned to community preferences.

1.5 Governance implemented: ICIP and IDG

Because the prototype explicitly handles supply chain data that intersects Indigenous Nations and Indigenous territories – including geospatial locations, boundary-linked coordinates, and route information – governance is treated as a primary design requirement. Two commitments shape what data are captured, how it is represented and how it gets disclosed.

Indigenous Cultural and Intellectual Property (ICIP) is treated as encompassing rights and interests in Indigenous cultural heritage, knowledge and traditional cultural expressions. Accordingly, Indigenous Nation, boundary-linked place information, and route visibility are not treated as neutral ‘metadata’. Where place-linked traceability information constitutes or implies culturally significant knowledge, it was handled under authority and consent settings, including recognising that some Indigenous knowledge is regarded as restricted and not intended for general disclosure.

Indigenous Data Governance (IDG) is implemented as an operational requirement: Indigenous authority shapes decisions about what place-linked data is collected (including what geospatial detail was appropriate), who can access data, and how it is stored, represented and used. This

directly informs stakeholder workflows, interface design, and disclosure rules for traceability narratives, acknowledgements and contribution/reward mechanisms.

1.6 Report structure

This report follows this structure:

- **Section 2** presents the architecture design, including component descriptions, the Indigenous Nations boundary and coordinate system, and blockchain and smart contract mechanisms, while also analysing stakeholder requirements across the food supply chain, including farmer and consumer flows (for example, crop upload, GS1 interaction, acknowledgements, donation-related interactions) and additional stakeholder roles (such as manufacturer, logistics, retailer).
- **Section 3** documents UI design and generative UI, including stakeholder-specific interfaces and a flight case study focused on onboarding, passengers as stakeholders, and QR-code entry points.
- **Section 4** presents the blockchain-based token architecture for ESG contribution incentivisation in INITS, including a data hierarchy model, ESG metrics, database-to-blockchain integration, geospatial auditability, and the end-to-end process flow per geolocation.
- **Section 5** discusses the potential social and economic impacts of INITS and the generative UI system on Indigenous communities and broader society.

2 System requirements and design

This section analyses the needs and roles of key **stakeholders** across the **food supply chain**, including farmers, food consumers, manufacturers, logistics providers and retailers. It identifies how each stakeholder group interacts with the INITS, including how they contribute data, access traceability information, receive acknowledgement, and participate in financial contribution or incentive mechanisms.

It also outlines the core system requirements that informed the prototype design. These include:

- investigating heterogeneous datasets and databases relating to Indigenous Nations and peoples
- exploring the problem domain of Indigenous knowledge tracing across food supply chain activities
- designing an architecture that can link products, places, activities and contributions
- demonstrating the feasibility of INITS and its potential social and economic benefits through illustrative case studies.

2.1 Overview of stakeholder requirements

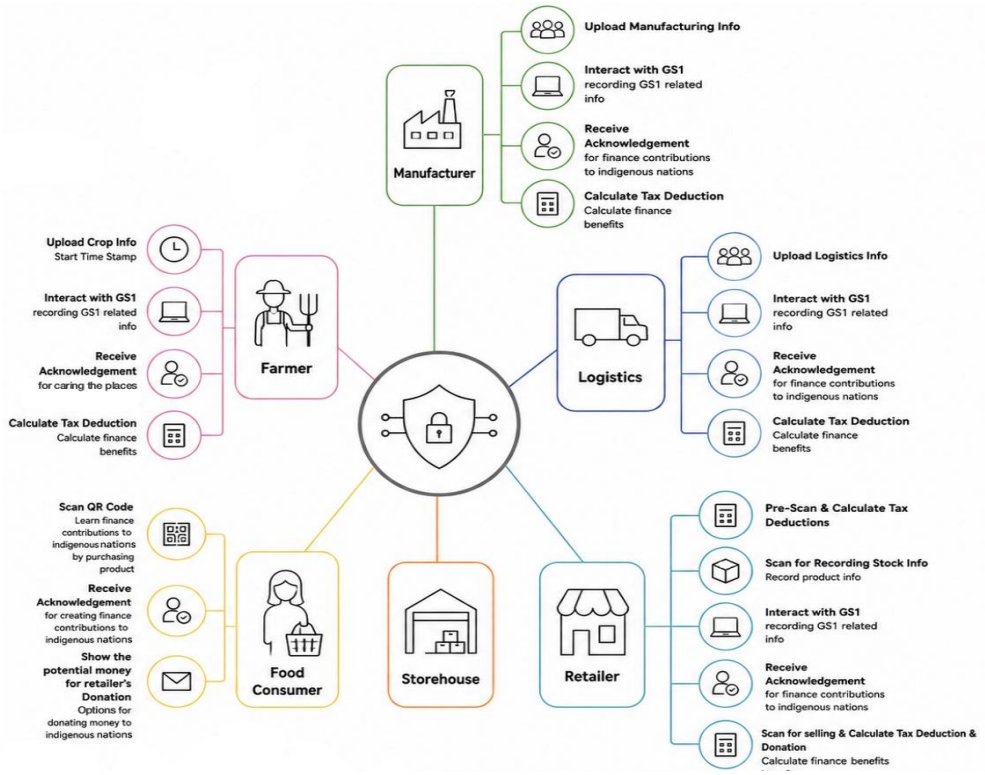


Figure 2.1. Stakeholder chart

The INITS prototype was designed for a multi-stakeholder food supply chain involving farmers, food consumers, manufacturers, logistics providers and retailers. Each group interacts with the

platform differently by contributing data, accessing traceability information, receiving acknowledgement or participating in financial contribution mechanisms.

Farmers, manufacturers and logistics providers need functions to upload operational data, align with GS1 traceability standards and receive acknowledgement for verified contributions connected to Indigenous Nations. **Retailers** need tools to record stock, support point-of-sale traceability, facilitate donations and track contribution-related activity. **Food consumers** need simple QR-code access to product information, contribution pathways and donation options (Figure 2.1).

The following subsections describe the specific requirements for each stakeholder group. The stakeholder requirements were derived to address the challenges identified in Section 1.4, particularly making Indigenous Nations visible in traceability workflows, supporting governed access to information, capturing temporal and spatial context, and enabling recognition of Indigenous contributions.

Stakeholder: Farmer

For farmers, the system's key functions focus on transparent crop traceability, formal recognition of contribution and access to potential financial benefits. Specifically, farmers need to:

- **upload crop information** – record and timestamp crop details at the source, ensuring transparency and traceability from the earliest stage of the supply chain
- **interact with GS1 standards** – integrate and record GS1-related product information to align with recognised traceability protocols
- **receive acknowledgement** – gain formal recognition for caring for the land and contributing to Indigenous Nations, helping to build trust and social value.

These functions address both operational needs, such as data recording and compliance, and broader value-driven needs, such as recognition and economic participation.

Stakeholder: Customer

Food consumers interact with INITS primarily through QR-code scanning at the product level. Their core requirement is simple access to traceability information that explains where a product or its ingredients come from, how the product is connected to Indigenous Nations, and what contribution or donation pathways are available.

This consumer-facing model builds on the kick-start stage of the project, where QR-code interaction with a popcorn product was used to demonstrate how product information, ingredient origins, and Indigenous Nations map visualisations could be presented to customers. In the current stage, the focus has expanded from cultural awareness to verified economic connection, showing how products and purchases may support tangible contribution pathways to Indigenous Nations.

For food consumers, the system's essential functions need to allow them to:

- **scan a QR Code** – access product-level information, including traceability details and contribution-related information connected to Indigenous Nations
- **receive acknowledgement** – receive recognition for supporting products or purchases linked to Indigenous contribution pathways

- **view potential retailer donation** – see potential donation amounts or contribution opportunities associated with retailer participation
- **see donation options** – access options to make direct contributions to Indigenous Nations through the platform, where enabled.

These features help consumers make informed purchasing decisions, understand the social impact of products, and participate in contribution pathways where appropriate.

Stakeholder: Transport and distribution providers

For transport and distribution providers, the system's key functions focus on recording the movement of goods, supporting traceability across routes and enabling acknowledgement of verified contributions. Specifically, these stakeholders need to:

- **upload transport information** – record and update shipment details, routes, locations and timestamps to support accurate tracking across the supply chain
- **interact with GS1 standards** – capture and integrate GS1-aligned logistics and movement data to support interoperability with recognised traceability frameworks
- **receive acknowledgement** – gain recognition for their role in enabling traceable supply chain activity connected to Indigenous Nations.

These functions address operational requirements, such as transport recordkeeping and traceability, while also supporting acknowledgement and contribution-related mechanisms within the INITS ecosystem.

Stakeholder: Retailer

For retailers, the system's primary functions centre on managing inventory traceability, facilitating consumer awareness and enabling financial contribution tracking. Specifically, retailers need to:

- **pre-scan products** – scan goods when they enter the retail environment to record product information and support traceability
- **record stock information** – capture product and inventory details, including batch numbers, origins and related traceability information
- **interact with GS1 standards** – record GS1-aligned product data to support integration with supply chain and traceability systems
- **receive acknowledgement** – gain recognition for enabling product-level visibility and financial contribution pathways connected to Indigenous Nations.

These functions allow retailers to act as the consumer-facing link in the traceability chain, connecting product sales, stock movement, donation pathways and contribution-related reporting.

2.2 System overview

Figure 2.2 provides an overview of the system architecture. The system connects food supply chain stakeholders, Indigenous Nations information, geospatial and temporal data, ESG-related data, blockchain-based records, smart contract mechanisms and customised UIs. Its purpose is to

support traceability across products, activities, places and contribution pathways while maintaining controlled access to Indigenous place-linked information.

At the centre of the architecture is the INITS, which coordinates data flows between stakeholders, the generative UI component, the private blockchain, smart contracts, application program interfaces (APIs) and supporting databases. The diagram shows how different types of information, such as geospatial and temporal data, Nation reward records, interactive user data and ESG data, move through the system and are presented through role-specific interfaces.

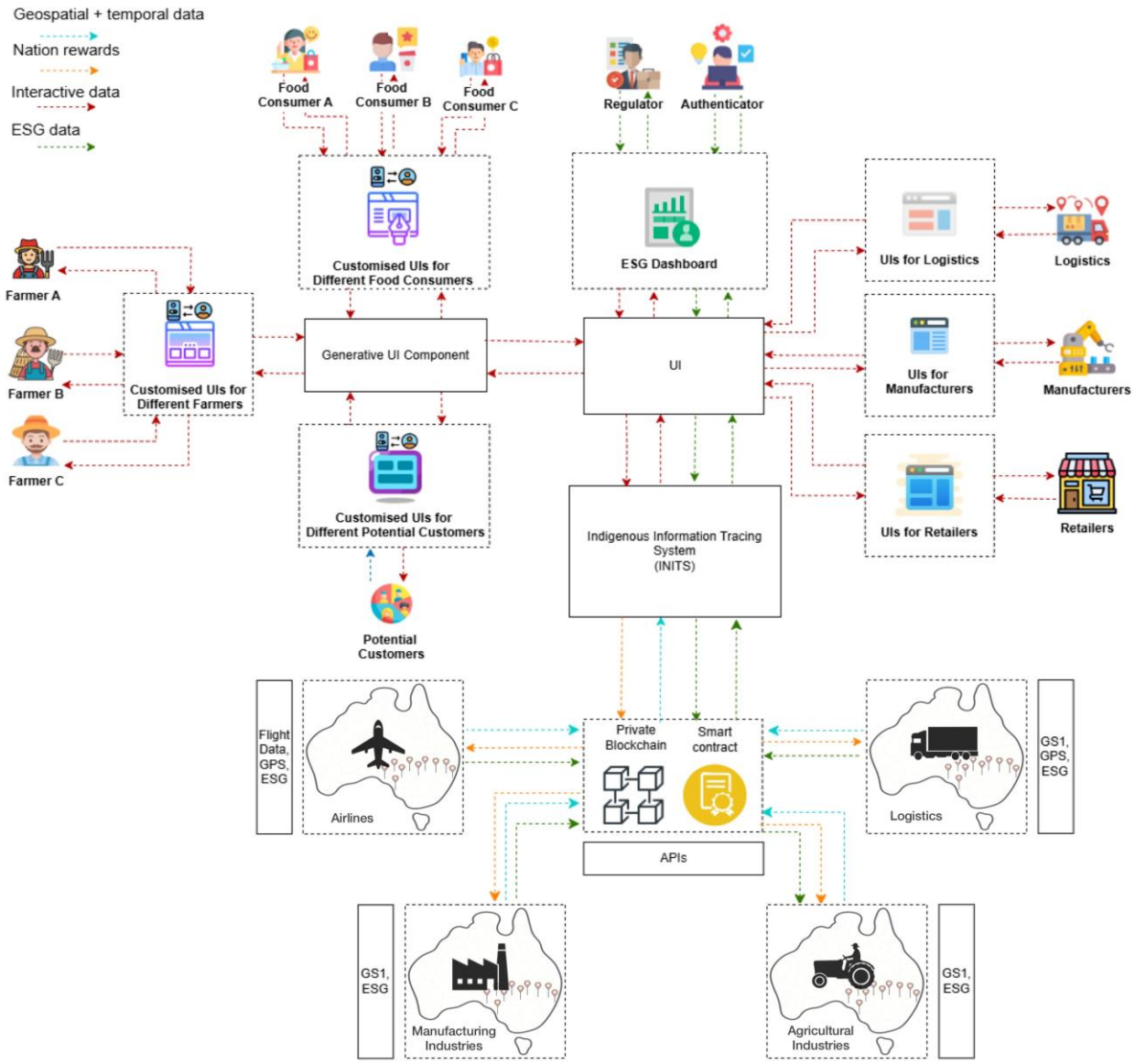


Figure 2.2. Overview of the system architecture design

2.3 Component description

The INITS architecture consists of three core components:

- the Indigenous Nations boundary and coordinate system
- the blockchain and smart contract layer

- the generative UI layer.

These components work together to support place-aware traceability, auditable activity recording, contribution tracking and stakeholder-specific interaction.

Indigenous Nations boundary and coordinate system

The Indigenous Nations boundary and coordinate system provides the location-aware foundation of INITS. It links GPS coordinates to Indigenous Nations map representations, so that food supply chain, transport, distribution and ESG-related activities can be traced in relation to time and place. This component forms the foundation of the architecture because it enables all subsequent traceability, governance and reward-allocation mechanisms to be linked to Indigenous Nation and place.

By overlaying product movements, routes and activity records onto Indigenous Nations areas, the system can identify where an activity occurred, when it occurred, and how long a product or service remained within or passed through a particular Nation area. This enables Indigenous Nation-linked traceability and supports contribution-related measures such as time on Indigenous Nation, activity attribution and potential monetary impact. Where geospatial information is culturally sensitive, its capture, storage and disclosure remain subject to Indigenous governance, permissions and access controls.

Blockchain and smart contract

Blockchain is used to record spatial and temporal activities that happened in each Nation. To demonstrate the feasibility of location-aware tracing and reward allocation, a prototype implementation was developed using a private blockchain environment.

This is a private blockchain deployed to log the trip data of goods and services. Ganache[1] is used for the blockchain deployment demonstration, where a blockchain was created and the trip data (timestamp and coordinates per timestamp) of flights from CASA[2] was uploaded. The flight trip data are adopted because of the availability of temporal (travel time) and spatial (GPS coordinates) components that are precise and accurate (Figure 2.3). Hence, the calculation of time taken to travel within and between the Nations is traceable (Figure 2.4). The advantages of using blockchain technology in activity tracking include transparency and immutability, providing a record that is auditable and cannot be tampered.

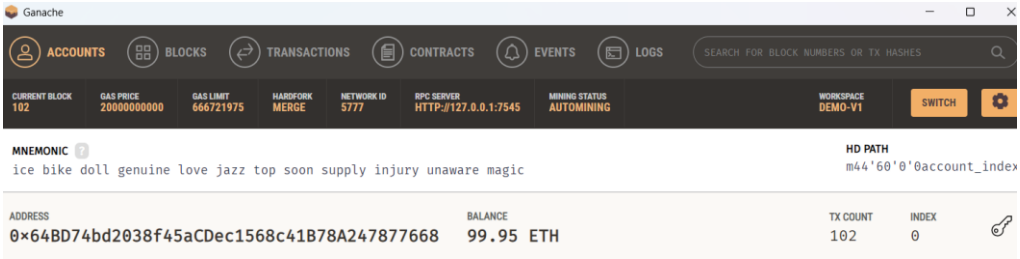


Figure 2.3. Blockchain address on Ganache

[1] https://archive.trufflesuite.com/docs/ganache/

[2] https://www.casa.gov.au/

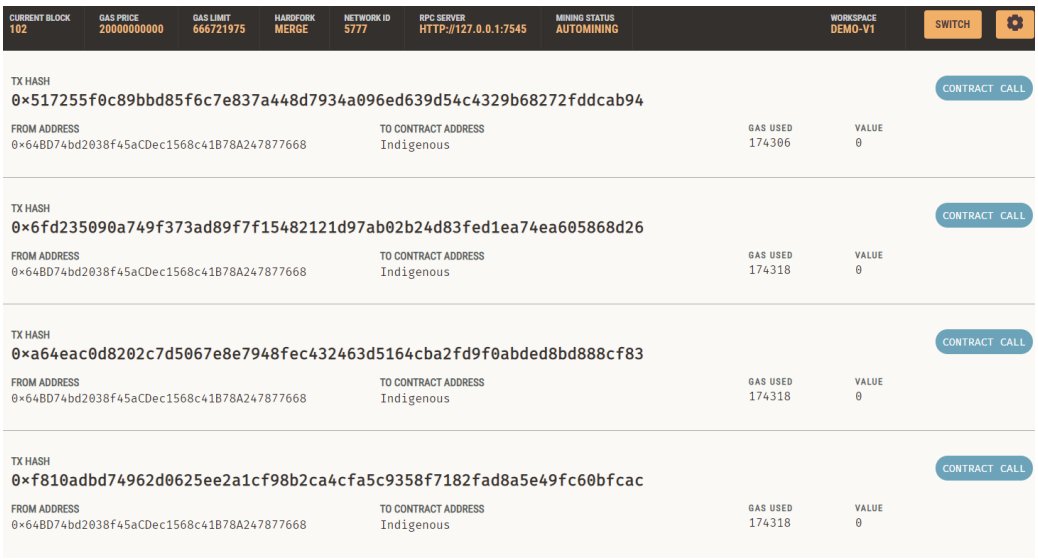


Figure 2.4. Transactions of trip data logged on the blockchain

Smart contracts are self-executing programs stored on a blockchain. The blockchain automatically runs actions when predefined conditions are met – without the need for intermediaries like administrators, brokers or auditors. In the INITS system, smart contracts automate the provision of reward to essential parties (business operators like food suppliers, and the Indigenous Nations), based on the contribution of each Nation in terms of time and resources supplied. Figure 2.5 shows an example on the Truffle[3] framework to create and deploy the smart contract.

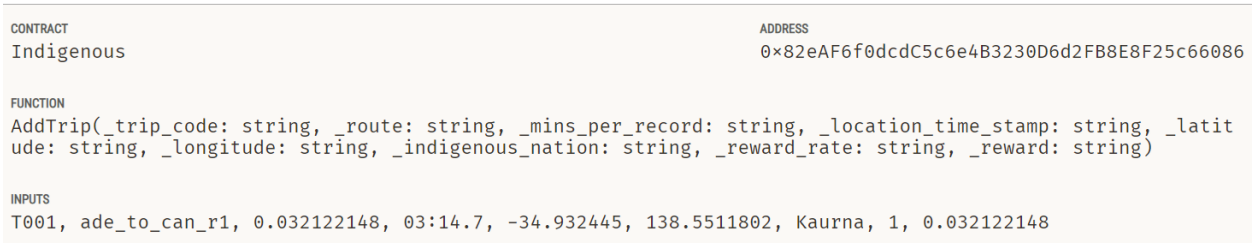


Figure 2.25. Trip details on blockchain through a smart contract transaction

Generative UI

The generative UI is the primary channel through which stakeholders interact with system components and communicate with INITS. As shown in the architecture design (Figure 2.2), data contributed by each industry and by Indigenous Nations – including the temporal and GPS coordinates – is committed to the blockchain. The reward-provisioning records held in the smart contracts are surfaced through the same interface, which is rendered dynamically and tailored to the needs of each stakeholder group and audience.

For example, when food consumers request access, their queries are relayed to INITS, which searches the database and returns the relevant information to the user's mobile device through a UI generated specifically for that consumer's needs. When Indigenous users upload data, or food suppliers add or edit information through their own custom-generated UI, that data is initially visible only to them while it is held temporarily in the database. Once submitted, both data types

[3] https://archive.trufflesuite.com/

are routed to the data verifier for validation. Depending on the verification outcome, the system either adds a new entry, corrects existing data or deletes erroneous information. Where database maintenance is required, alerts are dispatched to administrators for corrective action, and administrators also carry out routine system updates and maintenance.

In summary, the generative UI dynamically customises the INITS interface to the needs of each stakeholder. Building on this overview, the next section turns from the conceptual role of the interface to its concrete design – first detailing the stakeholder-specific UIs across the traceability system and then returning to the generative UI to show how AI-driven, adaptive interfaces personalise these interactions in practice.

3 UI design and generative UI

This section outlines the UI design and interaction flow across all stakeholders in the traceability system. Based on the stakeholder requirements outlined in Section 2.1, the following sections present the corresponding UI design to cover different stakeholder roles. Section 3.5 then introduces generative UI, showing how adaptive, AI-driven interfaces can personalise interactions and further integrate transparency, traceability and social impact.

3.1 Stakeholder: Farmer

For farmers, based on the needs analysis previously outlined, the platform is designed to provide several key functions. First, when planting crops, farmers can use the platform to upload information about their produce. A start time stamp is generated at this stage. This time stamp is crucial because, according to the initial design, rewards will later be distributed based on the proportion of time a crop occupies a given region within the overall growth cycle, as well as their market share compared with other regions.

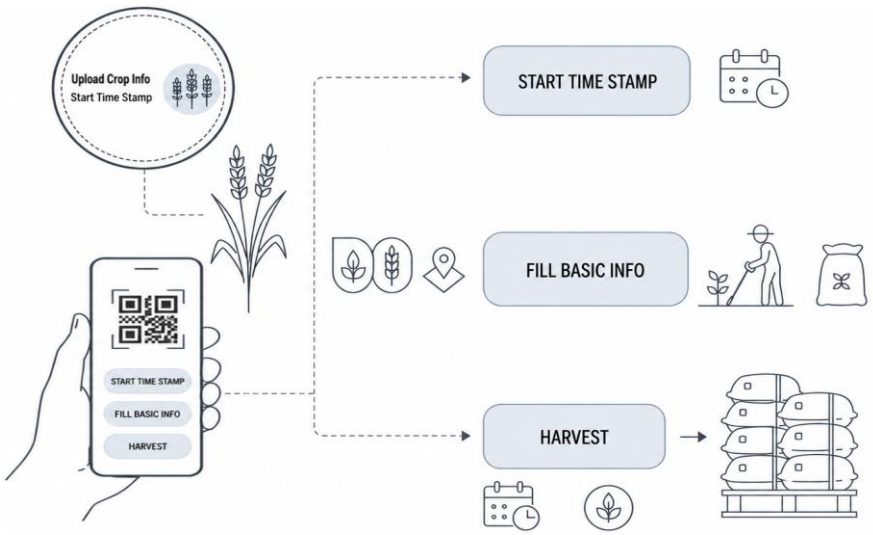


Figure 3.1. Farmer UI design needs

To support this process, each crop can be given a physical QR code label. By scanning the QR code with a mobile device, the farmer is directed to the platform, where the growth time stamp is opened and initial data can be entered (Figure 3.1). This includes basic information such as the geographical location of the farmland, the crop category and other relevant details. At the stage of harvesting, additional details can be captured. Farmers can record the exact time of harvest, the quantity collected, and quality assessments such as how much of the harvest was classified as high quality versus lower quality. These records not only support transparency but also contribute to future reward distribution and analysis.

Equally important, the platform provides a form of recognition and encouragement for farmers. Their hard work and dedication are acknowledged directly within the system, creating a sense of achievement and validation. For instance, when farmers log their activities, they may receive messages such as 'Thank you for taking care of our Nations' or other appreciative notes. In addition, the platform is designed to provide farmers with a clear understanding of the broader benefits they can gain through their participation. These acknowledgement mechanisms are intended to make Indigenous contributions and stewardship activities more visible within the supply chain.

3.2 Stakeholder: Consumer

From the perspective of customers – those purchasing products such as popcorn – the platform provides a transparent and engaging way for them to interact with the system. The first step begins with QR codes printed on food packaging. By scanning the QR code with a mobile device, customers are directed to the platform where they can access detailed information about the journey of the product they purchased.



Figure 3.2. Consumer UI design needs

Once on the platform, customers are able to view the entire trajectory of the product on the Indigenous Nations' map of Australia (Figure 3.2). For example, they can see where the product was originally cultivated, which locations it was transported through, and where it was stored along the supply chain. This information is visualised as a traceable path, with 'pins' displayed on the map to mark each significant location. Importantly, the map highlights the specific Indigenous Nations connected to those locations, identifying their names and providing background information.

For customers, this creates a meaningful connection between their everyday purchase and broader social impact. By buying a product such as popcorn, they can clearly see how many Indigenous Nations and communities benefit from their choice, as well as the scale of the contribution. To reinforce this connection, the platform also communicates messages of gratitude – for instance, thanking customers for their role in supporting Indigenous Nations and acknowledging the positive economic impact generated through their purchase.

In this way, customers are not just passive buyers of a product; they become active participants in a cycle of recognition, transparency and shared benefit. Their purchase decisions are transformed into opportunities to support Indigenous communities, while at the same time fostering trust and accountability within the supply chain.

3.3 Stakeholder: Transport and distribution providers

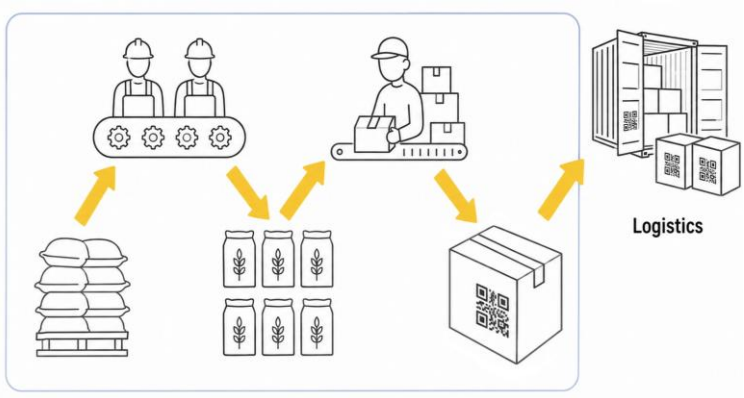


Figure 3.3. Logistics provider UI design needs

Logistics plays a central role in the overall supply chain, ensuring that products move seamlessly from raw materials to the final point of sale. As shown in Figure 3.3, the process begins at the production stage, where raw materials enter the factory already labelled with QR codes. Each bag of raw material carries a unique code, enabling precise monitoring from the very beginning of the product's journey.

Once inside the factory, the materials are processed and converted into consumer-ready products, such as popcorn bags. At this stage, new packages are created and assigned their own unique QR codes, ensuring that every item can be individually tracked.

The next step is packaging and distribution. Packaged items are grouped into boxes, and each box is labelled with a QR code. These boxes are then placed into larger containers, which are also given QR codes. By maintaining this layered coding system, the platform ensures that every level of the supply chain – whether single units, bulk packages or shipping containers – can be traced accurately. This enables precise monitoring of transportation, storage and delivery.

In addition to operational efficiency, the QR-based system lays the foundation for broader social and environmental benefits. By linking transport routes with Indigenous Nations' territories, for example, it becomes possible to align logistics with the reward mechanism, ensuring that communities along the pathway are recognised and compensated. In this way, transport and distribution is not just a matter of moving goods, it becomes a channel for traceability, fairness and community engagement.

During road transportation, vehicles often travel along routes that pass through the territories of different Indigenous Nations. A single journey may begin in the area of Indigenous Nation A, continue into Indigenous Nation B and later cross into Indigenous Nation C. To ensure fair recognition and benefit sharing, it is important to identify which road segments belong to each Nation. Using real-time GPS tracking, the platform can monitor how long a vehicle spends on each

segment and record the precise duration within each Nation's boundary. This information becomes the foundation for calculating rewards, ensuring that each Indigenous community is acknowledged according to the actual time goods spend within their land. By combining route identification with GPS-based tracking, the system guarantees a transparent and accurate link between logistics activities and Indigenous territories.

34In essence, the platform moves beyond traditional tracking by combining accuracy, accountability and ethical responsibility. It transforms logistics from a simple delivery update system into a transparent and socially responsible tool that not only informs customers but also supports Indigenous communities in meaningful ways.

3.4 Stakeholder: Retailer

For retailers, the platform goes beyond the basic functions of product scanning for GS1 recording, sales registration and real-time inventory updates. It creates both a compliance mechanism and a transparent incentive structure that highlights the broader social value of participation.



Figure 3.54. Retailer UI design needs

In practice, retailers interact with the system through three scanning stages (Figure 3.4). The pre-scan ensures that products are registered correctly before being placed on shelves. The scan-record step captures ongoing updates and provides a consistent log of product flow within the store. Finally, the scan-selling process records the actual point of sale, linking customer purchases directly to the database and enabling real-time reflection of stock levels.

By combining these layers of functionality, the platform transforms the retail process into more than just a commercial exchange. It provides retailers with accurate data management tools, strengthens compliance with GS1 and enhances the visibility of social impact – ultimately creating a system where retailing, accountability and community contribution are interconnected.

3.5 Generative UI

A showcase demonstration of the proposed generative UI concept illustrates how the key outcomes of an organisation's sustainability report can be dynamically represented on an Indigenous Nations map of Australia. Rather than implementing the complete multi-stakeholder

interaction workflow described in the system overview, the current prototype focuses on a representative application scenario of the generative UI framework. Specifically, it demonstrates how sustainability outcomes, geographical context, and Indigenous-related information can be dynamically organised and presented through a customised interface, while the broader stakeholder-specific interaction and verification workflows remain part of future platform development.

Normally, the sustainability report itself provides a comprehensive overview of the organisation's achievements, presented in the form of text, charts, data tables and images. While these materials are detailed and informative, they remain somewhat abstract and difficult to situate geographically. Readers cannot easily see where in Australia the outcomes occurred, nor can they connect these results with the specific Indigenous Nations whose lands and communities are relevant. In other words, the current format makes it challenging to link scientific outcomes with the Indigenous contexts in which they may have significance.

To address this gap, several achievements from CSIRO's sustainability report were selected as examples. Each of these outcomes is typically represented with images and short descriptions. When combined, these fragments of information provide a basic overview, but they still lack a spatial dimension. They do not show *where* the outcomes took place, nor do they explicitly connect them with Indigenous communities.

Through the platform, these research achievements can be visualised on an interactive Indigenous Nations map (Figure 3.5). Each outcome is associated with its geographical location and displayed with detailed supporting information. For example, markers or icons on the map indicate the research results, and by clicking on them, users can access specific details, images and data. In this way, users can clearly see not only what CSIRO has achieved, but also where these achievements are situated, and to which Indigenous Nations and communities they are connected.

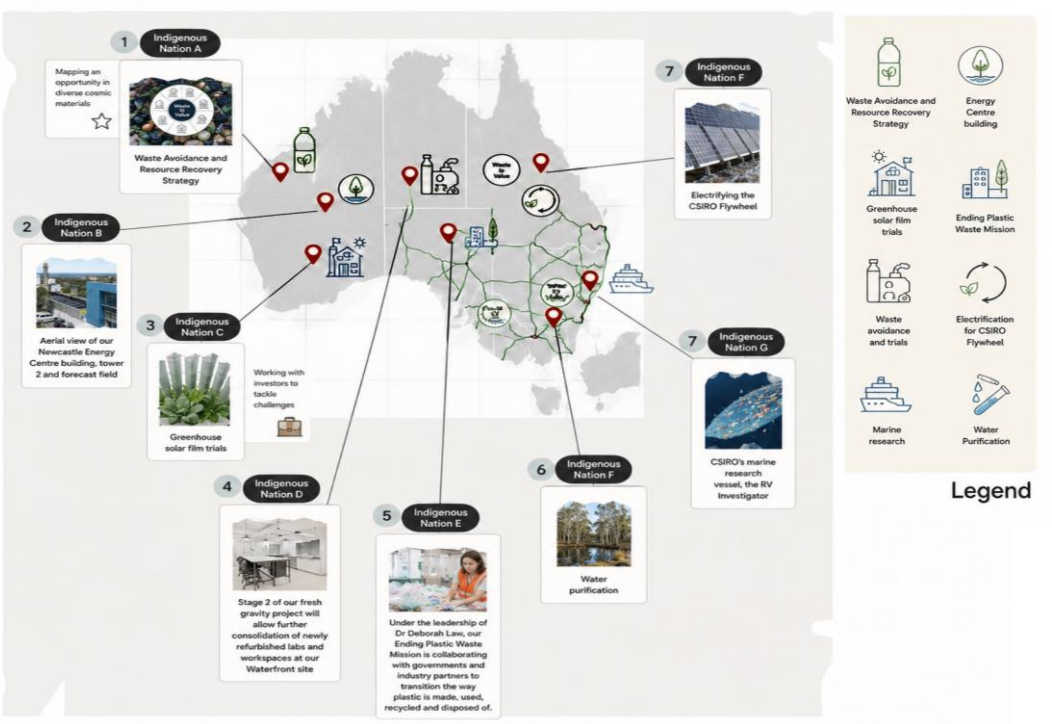


Figure 3.65. Sustainability outcomes represented on an Indigenous map

This approach transforms fragmented report content into an integrated, spatially anchored view. By connecting sustainability outcomes with the Indigenous Nations map, the platform enhances transparency, accessibility and relevance. It allows the broader community – including policymakers, researchers and Indigenous stakeholders – to engage more directly with the outcomes and better understand how sustainability research is distributed across Australia and its Indigenous landscapes.

Different stakeholders require different views of the same underlying information. For example, consumers may seek product provenance and Indigenous Nation-linked narratives, while businesses may focus on operational traceability, sustainability outcomes or contribution reporting. Generative UI provides a mechanism for dynamically adapting interface content and presentation to stakeholder needs while remaining consistent with governance and access-control requirements.

UI preferences and influences

UI design is not one-size-fits-all. Users bring diverse backgrounds, beliefs, habits and expectations into their interactions with digital systems, which leads to noticeable variations in their UI preferences. This section explores key dimensions along which UI preferences diverge, as well as the factors that influence them.

- **Simplicity versus complexity:** Users differ in their preference for minimalistic versus complex UI designs. While some users value clean, flat and easy-to-navigate interfaces, others appreciate more elaborate layouts with personalised themes, such as those evoking fantasy or heroism. These preferences are often shaped by subconscious biases, thinking habits, education levels and technical expertise.

- **Operational preferences:** Operationally, users vary in how they prefer to interact with content and features. Some want all functions visible and accessible from a single screen to maximise efficiency, while others opt for simpler layouts that require more navigation but reduce on-screen clutter. Influencing factors are similar to above: cognitive habits, educational background and technical proficiency.
- **Materialism versus idealism:** Personal belief systems play a role in how content is received. Materialistic users may prefer realistic, goal-oriented displays linked to finance or performance, whereas idealists may prefer abstract or purpose-driven presentations that avoid overt material references. Cultural background and individual values heavily influence these preferences.
- **Gender-specific preferences:** Gender can also affect UI choices. Research suggests men gravitate toward practical, function-driven designs, while women show a preference for aesthetically pleasing and emotionally engaging layouts. These trends, however, are also shaped by prevailing cultural norms and should not be treated as strict binaries.
- **Influence of other factors:** A variety of contextual factors further shape UI expectations. These include religious practices, symbolic meanings of colours, clothing norms and even the linguistic structure of different languages (such as text direction or translation length). Together, these can significantly impact how users perceive and interact with interfaces across cultures.

4 Blockchain-based token architecture for ESG contribution incentivisation in INITS

This section extends the INITS architecture from food supply chain traceability to ESG contribution tracking. The key idea is that once activities can be linked to Indigenous Nations, places and time, the same infrastructure can also support contribution measurement, auditability and recognition. Blockchain and token mechanisms are therefore used as enabling technologies for place-aware ESG attribution, rather than as standalone financial instruments.

The comprehensive, technically detailed blockchain-based token architecture is designed to track companies' ESG contributions, and based on their location on Indigenous Nations, provide tokens as incentives. The proposed system leverages the inherent transparency, immutability and verifiability of blockchain technology to address critical challenges in traditional ESG reporting, such as data opacity, fragmentation and susceptibility to manipulation. By directly linking measurable ESG performance to tangible token rewards, this framework aims to foster genuine corporate sustainability, aligning economic incentives with environmental stewardship and social responsibility. The architecture integrates robust off-chain data management with on-chain verification and employs geospatial linking for localised auditing, ensuring accountability and trustworthiness across the entire ESG value chain.

4.1 ESG background

ESG frameworks are increasingly used by organisations to measure and report their environmental performance, social responsibility and governance practices. Examples include renewable energy generation, waste reduction, workforce diversity initiatives and governance compliance activities.

While ESG reporting has become widespread, existing approaches often focus on aggregated organisational metrics and provide limited visibility into where activities occur and which communities are affected. As a result, the environmental and social impacts experienced by specific locations, regions or Indigenous Nations may not be adequately represented or verified. The INITS infrastructure provides an opportunity to extend conventional ESG reporting through place-aware tracing. By linking activities to Indigenous Nations, geographical locations and temporal information, ESG contributions can be recorded, attributed and audited with greater transparency. This enables organisations, Indigenous communities, auditors and regulators to better understand how ESG activities are distributed across locations and how benefits and impacts relate to specific Indigenous Nations.

4.2 Overall architecture design

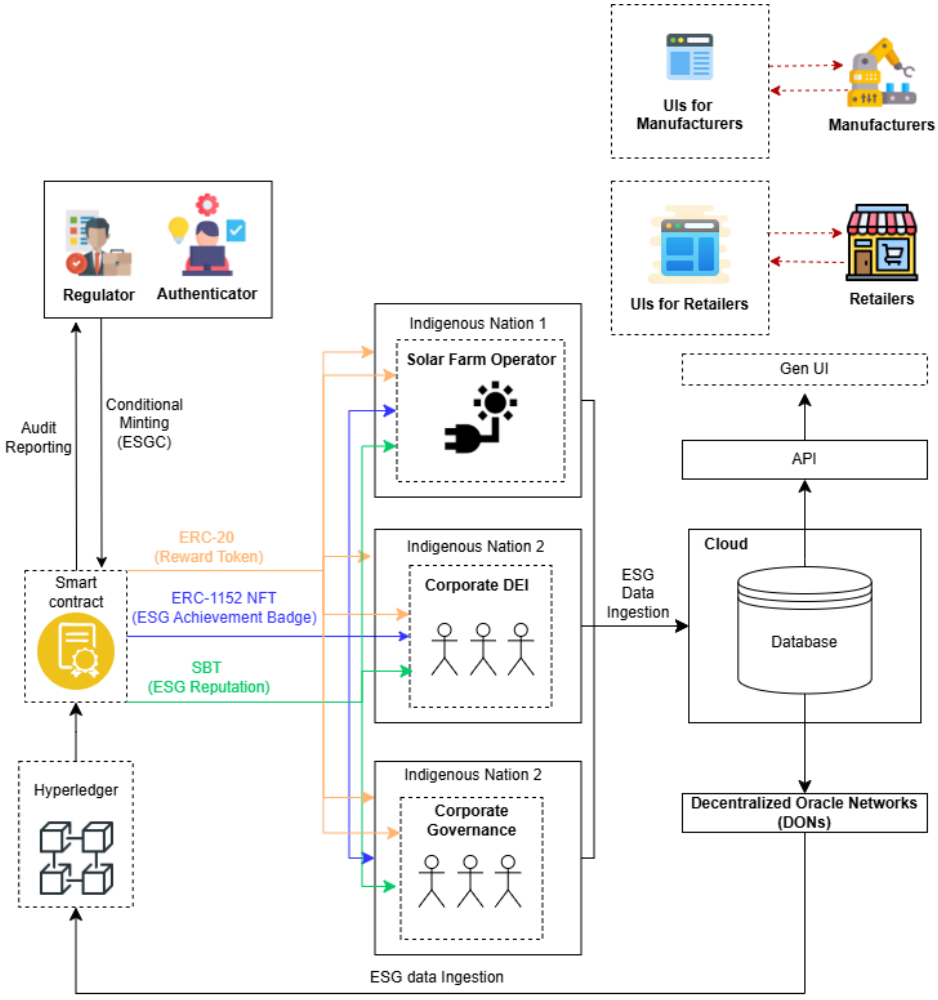


Figure 4.1. Architecture overview

Figure 4.1 illustrates how the INITS infrastructure can be extended to support ESG contribution tracking. Building on the place-aware tracing capabilities introduced in earlier sections of the report, ESG activities are linked to Indigenous Nations, locations and time. This enables environmental, social and governance contributions to be recorded, attributed and audited in a transparent manner while maintaining visibility of their impacts on Indigenous Nations and local communities.

The three ESG activities noted in Figure 4.1 include:

- solar farm operation
- corporate diversity, equity and inclusion (DEI) evaluation
- corporate governance metrics evaluation.

All these ESG data are logged in a database located on a cloud infrastructure, where the data are being hashed and stored on the Hyperledger blockchain.[4] At the same time, the database serves the generative UI frontend.

[4] https://hyperledger.github.io/

The smart contracts issue the respective reward tokens (ERC-20), ESG achievement badge (ERC-1155 NFT) and ESG reputation token (SBT) to the Indigenous Nations and the corporates that conducted the activities. Simultaneously, the data that are anchored on the blockchain are available for ESG audit and conditional minting by auditors and regulators. Finally, through the generative UI, all stakeholders are able to view the activities, the reward, and the impact of each activity on the respective Indigenous Nations.

The integrity and effectiveness of a blockchain-based ESG token system hinge on a meticulously designed process flow that ensures data accuracy, privacy and verifiability from its point of origin to its final audit. This process integrates real-world data with blockchain's immutable ledger, specifically tying ESG contributions to their geographical locations. This end-to-end process flow ensures that ESG contributions are not only incentivised through tokens but are also rigorously measured, transparently recorded and robustly auditable, fostering genuine corporate sustainability and accountability.

4.3 The data model

The system features a layered architecture, with each layer performing a distinct function. The data model reflects the core design principle of the INITS platform: activities, contributions and digital records should ultimately be traceable to physical locations and Indigenous Nations. Rather than treating geographical information as supplementary metadata, the architecture places location and Nation at the foundation of the information hierarchy, enabling subsequent traceability, governance, auditability and contribution attribution mechanisms.

- **Layer 1 – Foundational layer (GPS and physical data)**: This is the base layer, representing the physical, verifiable reality of the land. It consists of geospatial data (GPS coordinates, geographic information system (GIS) mapping) that defines the boundaries, features and specific locations within the Indigenous Nations' territories. This data acts as the immutable digital anchor for all subsequent activities. For example, a specific GPS coordinate can be linked to a particular agricultural plot, a forest resource or a section of a transport route.
- **Layer 2 – Core infrastructure (blockchain and smart contracts)**: Blockchain provides an immutable, time stamped and transparent record of all activities. Each new activity is added as a new 'block' of data, creating an unchangeable history. This is critical for building trust, as it prevents data manipulation. Smart contracts are self-executing agreements whose rules are encoded on the blockchain. They are triggered by predefined conditions, automating processes without the need for intermediaries.
- **Layer 3 – Application layer (activities and data)**: This layer sits on top of the blockchain, using its secure foundation to manage various activities. The data from this layer is what gets written to the blockchain. Below are the examples of the applications:
  - **Agricultural**: Data points like crop type, planting and harvesting dates, and agricultural input usage (fertilisers, pesticides) are recorded. Smart contracts can manage fair trade agreements or supply chain payments.
  - **ESG**: This includes data on carbon emissions from farming, water usage, labour practices and cultural preservation efforts. Smart contracts can enforce ESG standards and trigger a record of compliance.

  - **Transports and logistics**: This involves tracking the movement of goods from a starting point (such as a farm) to a destination. Data includes shipment details, transport logs and delivery confirmations. Smart contracts can handle the payment and transfer of ownership upon delivery.
- **Layer 4 – Presentation layer (user interface)**: This is the front-end that allows different users to interact with the system without needing to understand the underlying blockchain technology. There are three main stakeholders that interact with this layer:
  - **Indigenous Nations**: The dashboard provides a holistic view of all activities, from agricultural yields to ESG compliance.
  - **Farmers/producers**: UIs allow them to input data, view their records and receive payments.
  - **Auditors/partners**: A dashboard provides a secure way for external stakeholders to verify data and compliance records. For instance, a coffee roaster could verify that the coffee they are buying comes from a specific Indigenous farm and that it meets certain sustainability standards.

The layered data hierarchy provides several advantages for Indigenous Nations information tracing and ESG contribution management. By placing geographical location and Indigenous Nation information at the foundation of the architecture, activities across different domains can be consistently linked to place and community. This supports traceability, governance and auditability while enabling multiple applications, such as agriculture, logistics and ESG reporting to operate on a common information foundation. The hierarchy also separates physical data, infrastructure services, application logic and stakeholder-facing interfaces, allowing each layer to evolve independently while maintaining a clear chain of provenance from recorded activities back to their associated locations and Indigenous Nations. Together, these capabilities provide a scalable and transparent framework for recording, attributing and visualising contributions across diverse operational contexts.

4.4 ESG token system

After understanding the blockchain and smart contract-based data hierarchy, architecture, and its benefits, the application of these technologies can support the token system for ESG tracking. The aim is to support the growing importance of ESG and blockchain's role in transparency.

Blockchain technology offers a transformative solution to these challenges due to its foundational characteristics: decentralisation, tamper-proof records and an immutable ledger. By providing immutable audit trails, enabling verified data sharing across complex supply chains, facilitating real-time tracking of sustainability metrics and automating compliance through smart contracts, blockchain can significantly enhance the credibility and efficiency of ESG reporting.

System vision: How the token system incentivises and verifies ESG contributions

The core vision for this token system is to promote and reward sustainable and responsible business practices by establishing a transparent and tamper-proof record of a company's ESG activities, in conjunction with the ESG impact on the Indigenous Nations where the company or the activities take place. Drawing inspiration from academic credit systems for their inherent

scalability and flexibility, the system utilises smart contracts and crypto tokens to assess corporate sustainability performance.

The fundamental mechanism involves directly rewarding companies with tokens based on their verifiable ESG contributions. This creates a tangible financial incentive for achieving positive environmental and social impact, moving beyond mere regulatory compliance or public relations exercises. Additionally, the tokens are provided to Indigenous Nations to support their development. The system is designed to identify and recognise 'ESG elites' within various industries, fostering equitable value creation and distribution throughout the decentralised ecosystem. This approach aims to integrate ESG performance into the core business strategy, making sustainability a direct driver of economic benefit and competitive advantage.

A significant advantage of this blockchain-based approach is its potential to counteract greenwashing. Environmental claims often lack rigorous, independent verification, leading to instances where companies may exaggerate their sustainable practices without substantive backing. More importantly, the ESG impact on Indigenous Nations where those activities physically occurred is not verified or recorded. Once ESG data is recorded on-chain, it becomes an unalterable and publicly verifiable record. This makes it substantially more difficult for companies to engage in deceptive practices or selectively report favourable data. The token system, by being built upon this foundation of verifiable data, inherently cultivates greater trust and accountability within the entire ESG ecosystem, thereby enhancing the credibility of corporate sustainability claims for investors, consumers and regulatory bodies.

The implementation of a token system can fundamentally alter a company's motivation for engaging in ESG initiatives. Traditional ESG reporting often stems from a need to comply with regulations or to satisfy stakeholder demands. However, by providing tangible rewards and public recognition through token holdings and verifiable credentials, the system encourages a deeper, more authentic commitment to ESG. When companies are genuinely incentivised to improve their ESG performance due to direct, measurable benefits (for example, token rewards, enhanced reputation, access to capital), their sustainability efforts become more integrated into their core business strategy. This aligns with the intention to promote financial asset allocation towards responsible entities and foster an ecosystem where value is created and distributed equitably based on verifiable impact.

4.5 Token architecture design

The proposed architecture uses two complementary token types:

- ESG reward tokens for quantifiable ESG contributions
- ESG recognition badges for verified achievements or certifications.

Together, these records can support stakeholder-facing reputation views through the generative UI, without requiring a separate reputation token. The token architecture operates on top of the place-aware tracing infrastructure described in earlier sections. ESG activities are first linked to Indigenous Nations, locations and time through verifiable records. Contribution metrics are then derived from these records and used to support recognition and token issuance mechanisms. As a result, tokens represent verified contributions rather than self-reported claims.

- **ESG reward tokens (ERC-20):** A fungible token, provisionally named 'ESG credit token' (ESGC), will be issued using the ERC-20 standard. This choice is predicated on ERC-20's inherent suitability for redeemable points and reward mechanisms. ESGC will function as a quantifiable, divisible and transferable reward, allowing companies and Indigenous Nations to exchange or utilise them within the broader ESG ecosystem.
- **ESG recognition badges/certificates (ERC-1155 NFTs):** ERC-1155 NFTs are used for non-transferable recognition of significant ESG milestones or certifications (for example, achieving a certain carbon reduction target, reaching a diversity benchmark or receiving a waste management award). It provides the critical flexibility to issue various types of NFTs (such as a Carbon Neutrality Badge, Diversity Champion Certificate or Zero Waste Facility Award) from a single contract. This approach optimises gas costs and streamlines management, as each badge will possess a unique token ID within the overarching ERC-1155 contract.

The distinct token types are designed with specific utilities and provision mechanisms to create a robust incentive and verification framework.

- **ESG credit token (ESGC – ERC-20):**
  - **Provision:** ESGC tokens will be minted and distributed to the Indigenous Nations where the companies or organisations are located physically, based on a calculated, weighted ESG performance score. This score will be derived from their verified contributions across various environmental and social metrics. The quantity of ESGC minted will be directly proportional to the positive ESG impact achieved, ensuring that greater sustainability efforts yield greater rewards.
  - **Utility:**
    - **Direct incentivisation:** ESGC provides a tangible, liquid financial reward that Nations can utilise or exchange, directly incentivising and driving the positive changes of the Nations, and promoting the achievement of ESG targets.
    - **Governance participation:** ESGC tokens can grant voting rights within a decentralised autonomous organisation (DAO) established to govern the ESG token ecosystem. This allows token holders (Indigenous Nations) to directly influence future system parameters, reporting standards or reward mechanisms.
    - **Ecosystem benefits:** ESGC could be redeemable for discounts on certified green technologies, sustainability consulting services, or preferential rates from partner organisations that are also committed to the ecosystem's sustainability goals.
    - **Staking rewards:** Companies or organisations can stake their ESGC tokens to unlock higher tiers of benefits, gain access to exclusive sustainability initiatives or earn additional ESGC for demonstrating long-term commitment to the platform.
- **ESG achievement badges (ERC-1155 NFTs):**
  - **Provision:** These NFTs will be issued automatically via smart contracts when predefined, verifiable achievement criteria are met. Examples include achieving a specific percentage reduction in Scope 1 emissions, reaching a predetermined diversity index score or diverting a significant threshold amount of waste from landfill.

– **Utility:**

  - **Enhanced reputation:** Each badge serves as public, immutable proof of specific, verifiable ESG achievements. This significantly enhances a company's brand image, attracting ESG-conscious investors, customers and top talent.
  - **Exclusive access:** Holding certain achievement badges could grant access to restricted industry forums, sustainability leadership conferences or preferred supplier networks within the broader ESG ecosystem.
  - **Partnership validation:** These NFTs can function as verifiable credentials for business-to-business partnerships focused on sustainability, streamlining due diligence processes and building trust.

The interplay between fungible and non-fungible incentives within this architecture is a critical design choice. ERC-20 tokens (ESGC) provide immediate, liquid and quantifiable financial rewards. This can drive short-term behavioural changes and offer direct economic benefits to companies. In contrast, the non-transferable nature of ERC-1155 NFTs builds long-term, non-monetary value in the form of reputation, verifiable credentials and exclusive access. This dual incentive structure addresses both immediate performance motivation and sustained commitment to ESG principles, fostering a more holistic and robust engagement model. This aligns with the 'tokenomics' principle of incentive alignment, ensuring that both short-term operational improvements and long-term strategic ESG goals are supported (Table 4.1).

Table 4.1. Token type utility matrix

Token standard	Token name	Fungibility	Transferability	Primary utility/purpose	Provision mechanism
ERC-20	ESG credit token (ESGC)	Fungible	Transferable	Direct financial incentive, DAO governance, ecosystem benefits, staking rewards	Minted and distributed based on weighted, verified ESG performance score
ERC-1155	ESG achievement badge	Non-fungible	Transferable (optional, typically non-transferable for credentials)	Verifiable proof of specific ESG milestones, enhanced reputation and exclusive access	Issued automatically via smart contract when predefined achievement criteria are met

4.6 ESG metrics and measurement

The proposed architecture is designed to support a wide range of ESG metrics while maintaining a consistent approach to attribution, auditability and reporting. Rather than focusing on a single ESG standard or industry sector, the system provides a common framework for linking ESG activities to Indigenous Nations, geographical locations and time.

Environmental metrics

Environmental metrics capture the ecological impacts of organisational activities. Examples include greenhouse gas emissions, renewable energy generation, waste management, biodiversity initiatives and resource consumption. Through the INITS architecture, these activities can be linked to specific locations and Indigenous Nations where they occur. This enables environmental contributions and impacts to be recorded and traced in a transparent and auditable manner.

Social metrics

Social metrics represent activities that affect people, communities and social wellbeing. Examples include workforce diversity initiatives, Indigenous employment and procurement programs, community engagement activities, cultural preservation efforts, and training or educational programs. By associating these activities with Indigenous Nations and locations, the system provides greater visibility into how social contributions are distributed across communities and regions.

Governance metrics

Governance metrics relate to organisational accountability, transparency and compliance practices. Examples include audit outcomes, policy compliance activities, ethical sourcing programs, regulatory reporting and risk management initiatives. Recording governance activities through the same traceability infrastructure provides an auditable history of organisational practices and supports transparent reporting to stakeholders.

4.7 Geospatial integration for auditability

Integrating geospatial data into the blockchain-based ESG system is crucial for enabling location-specific auditability and ensuring accountability to local legislative bodies. This adds a critical layer of verifiability and compliance.

Linking ESG data to coordinate locations

Geographical coordinates (latitude and longitude) will be systematically embedded or cryptographically linked to relevant ESG data records. This ensures that every reported ESG contribution can be precisely tied to its physical location.

- **Georeferencing mechanism:** Location metadata can be included directly within the data payload submitted to the blockchain via oracles. This could involve adding latitude and longitude as structured fields within the data hash that is stored on-chain, or as separate, verifiable fields in the smart contract's data structure. For instance, carbon emission data from a specific facility, solar energy generation from a particular plant, or waste diversion data from a designated site will include its precise geocoordinates.
- **Data structure:** Geospatial data representing physical assets or activities (for example, factory locations, solar farm boundaries, waste collection points) will be structured using recognised technical standards. Formats like GeoJSON[5] are suitable for representing

[5] https://geojson.io/https://geojson.io/

geographical features with accompanying non-spatial attributes as a pointer stored on the blockchain.

- **Crypto-spatial coordination:** The system will leverage the concept of a crypto-spatial coordinate system. This involves combining geocoded descriptions of physical assets or activities with georeferenced maps, and then cryptographically securing this combined geographical data within a distributed ledger. This creates an immutable, decentralised record of location-based environmental and social impacts, enhancing trust and transparency in land management and environmental monitoring.

Enabling local legislative audit and authority

The integration of geospatial data directly facilitates auditing by local legislative bodies, enabling them to exercise their authority within their specific jurisdictions.

- **Permissioned access**: To ensure controlled and compliant access to sensitive ESG data, local legislative bodies and designated auditors will be granted specific, permissioned access rights to relevant on-chain data and associated off-chain proofs tied to their jurisdiction. This aligns with the operational model of permissioned blockchain networks (for example, Hyperledger Fabric), which are designed for enterprise solutions requiring controlled data storage and access within defined boundaries.
- **Verifiable credentials (VCs) for auditors**: Auditors could be issued VCs that are cryptographically linked to their Decentralised Identifiers (DIDs). These VCs would serve as tamper-evident attestations of their authority, jurisdiction and auditing scope. Smart contracts within the ESG system would be programmed to recognise and verify these VCs, granting auditors specific read-only access to relevant ESG data, transaction logs and geospatial records pertinent to their geographical area of oversight. This streamlines the audit process and ensures that only authorised entities can access sensitive information.
- **Smart contract logic for audit trails**: The smart contracts will incorporate functions specifically designed to facilitate auditing. These functions will allow authorised auditors to query specific ESG data points (for example, carbon emissions for a facility at a given location over a defined period), verify cryptographic hashes against off-chain records, and review the immutable transaction history related to ESG contributions within their designated geographical area. This capability significantly enhances the ‘immutable audit trails’ and supports ‘automated compliance’ features of the blockchain system.
- **Regulatory alignment**: The system’s design must inherently consider existing and evolving ESG disclosure regulations in various jurisdictions, such as the EU’s Corporate Sustainability Reporting Directive (CSRD) and California’s Senate Bills 253 and 261. While the system does not provide legal advice, its technical architecture is engineered to facilitate compliance by providing verifiable, granular and location-specific data that can be mapped to these reporting standards.

The integration of geospatial data, combined with permissioned access, addresses the critical need to balance transparency with privacy for audits. Companies are often hesitant to disclose all their operational data, even for ESG purposes, due to competitive concerns. This can be achieved by enabling auditors to verify compliance (for example, that an ESG score meets a certain threshold)

without requiring full disclosure of proprietary operational details. This approach is essential for fostering broader corporate adoption and ensuring the system's practical viability.

The system's technical framework must also be designed with a keen awareness of the evolving legal framework and regulatory compliance landscape. ESG reporting regulations, such as the EU's CSRD and various US state-level initiatives, are rapidly developing and becoming more stringent. While blockchain technology inherently facilitates compliance by providing verifiable and immutable data, the legal status of blockchain-based records and digital assets is still maturing in many jurisdictions. Therefore, the system's architecture should prioritise adaptability, potentially through upgradeable smart contracts and flexible data schemas, to accommodate new requirements and ensure ongoing regulatory alignment.

The interoperability of geospatial standards is crucial for effective location-based auditing. Environmental and social data often spans multiple geographical areas and involves diverse data collection systems. By adhering to recognised GIS data standards (for example, ISO 19115 for metadata, GeoJSON for spatial data representation), the system ensures compatibility and seamless data exchange for auditing purposes across different systems and jurisdictions. This standardisation is vital for aggregating and analysing location-specific ESG impacts efficiently and reliably.

5 Potential social and economic impacts

The INITS prototype demonstrates a possible approach to improving the visibility of Indigenous Nations within information systems, supply chains and digital services. While the long-term impacts of such systems would depend on adoption, governance arrangements and community participation, the concepts explored in this report suggest several potential social and economic benefits.

By linking activities, products and services to Indigenous Nations and geographical locations, the platform may help improve transparency, traceability and recognition of Indigenous contributions. The architecture also provides a foundation for recording, visualising and communicating relationships between organisations, communities and places in ways that are difficult to achieve using conventional provenance systems.

5.1 Social impact of INITS on Indigenous communities

A key contribution of the proposed architecture is the ability to make Indigenous Nations more visible within digital records, supply chains and reporting processes. By linking activities and products to place, the system may help organisations, consumers and communities better understand the relationships between economic activities and Indigenous Nations.

Improved visibility may also support greater recognition of Indigenous contributions across agriculture, environmental management, cultural activities and other sectors. Rather than treating Indigenous Nations as peripheral stakeholders, the architecture provides mechanisms for representing Nations, places and associated activities as first-class entities within digital systems.

The traceability and auditability capabilities of the platform may also support more transparent approaches to contribution recognition and benefit-sharing. While the specific governance and allocation mechanisms would need to be determined through community consultation and policy processes, the architecture provides a technical foundation for linking contributions to verifiable records and locations.

For consumers and businesses, access to place-aware provenance information may encourage greater awareness of Indigenous Nations and their relationships to products, services and landscapes. Such visibility has the potential to support more informed decision-making and strengthen connections between economic activities and Indigenous communities.

More broadly, the concepts explored in this report demonstrate how digital technologies can be designed to better represent Indigenous Nations, places and knowledge systems within contemporary information infrastructures.

5.2 Social impact of generative UI on Indigenous communities

The generative UI capabilities explored in this project provide a mechanism for presenting the same underlying information in ways that are appropriate for different stakeholders. Consumers,

businesses, Indigenous communities, auditors and government agencies often require different views of data, and generative UI offers opportunities to adapt information presentation to these differing needs.

Within the INITS context, generative UI may improve accessibility and understanding of Indigenous Nation-linked information by presenting provenance, location and contribution data through interactive maps, narratives, visual summaries and stakeholder-specific interfaces. This can help reduce the complexity of underlying technical systems while maintaining transparency and traceability.

Generative UI may also support governance objectives by enabling controlled disclosure of information according to stakeholder roles, permissions and community preferences. Different users can therefore access information that is relevant to their responsibilities while respecting agreed governance arrangements.

More generally, the combination of Indigenous Nation-linked tracing and adaptive UIs demonstrates how emerging AI technologies may support more inclusive, understandable and context-aware interactions with complex information systems.

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