Managing Workflow Actors: Contract Management[1]
Management of Actors participating in a supply chain workflow.

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This paper outlines how actors involved in an NFT Marketplace based supply chain are organised and managed under a strict provenance regime. In particular it talks of domain specific smart contracts, multi-sig and how relationships are tracked and recorded.

Supply Chain tracking

Supply chain tracking is important across many domains. These include materials procurement in the defence sector, distribution of public examinations, assembly and distribution of drugs from manifacture, to wholssale, hospitals and patients to name a few.

It is of primary importance to track relationships of organisations and the individuals that participate (the stakeholders) in order for the provenance record is complete. For example the individual batching drugs and the patient to whom the medicines are dispensed. Other examples include recording organisational and team structures for silicon chip design projects allowing design contributions to be tracked at the team and individual level.

Lockular's WAM system is a smart contract based app that is used to record organisational structures, team members and organisational relationships across the group of stakeholders which in all likelihood span organisations. WAM is foundational in establishing multi-sig across the group of stakeholders.

Workflow Actor Management System

Workflow Actor Management System (WAM) is a smart contract-based app used to facilitate multi-sig for organisational structures. The actual structures represented depend on the supply chain domain and are determined by the smart contract definitions. Often they involve globally labelled divisions divisions, teams, and members. Use of multi-sig across teams significantly enhances security, authorisation, and decision-making processes. WAM requires configuration for a specific domain. Configuration is made by a smart contract definition that addresses key considerations in respect of the domain:

- Representation of the stakeholder structure. In all likelihood this addresses inter-organisational hierarchical structures:

– Organisations are often divided by division which often have geographical connotation

– Stakeholders work in a division and are assigned one or many roles

– Role and division may have restricted approval and, or access

- Multi-Sig Rules Definition: Rules are defined for multi-sig within the organisational structures. This involves deciding how many signatures (approvals) are required for different types of transactions or decisions at each level of the those organisations involved (division, team, member). This requires making decisions around the following:

  – Global Rules: These apply to the entire organisation, for example financial thresholds above which multi-sig is required.

  – Divisional/Team Rules: Specific rules for divisions or teams, based on the sensitivity or importance of the decisions.

  – Role-Based Rules: Rules that apply based on the role of a member within the organization, such as managers having different thresholds or permissions.

- Adjustment of the smart contract to the Multi-Sig Mechanism: This involves creating a contract structure that:

  – Store Proposals: Create a structure to store proposals or transactions that require approval. Each proposal should include details like the type of decision, the required number of signatures, and the current number of approvals.

  – Manage Signatures: Develop functions that allow eligible members to sign or approve proposals. Ensure that each member can only sign a proposal once and that their signature is authenticated.

  – Execute Decisions: Once a proposal has received the required number of signatures, execute the decision. This could involve changing the state of the smart contract, transferring assets, or any other action that was proposed.

- Role-Based Access Control (RBAC) considerations. Integrate RBAC to manage who can create proposals and who can sign them. This involves:

  – Defining Roles: Define roles within your organization, such as admin, manager, team leader, etc.

  – Assigning Permissions: Assign permissions to these roles regarding who can initiate proposals and who is authorised to sign them.

- Role Assignment: Assign roles to individual members within your organisational structure.

- User Interface for Proposals and Signatures. Develop a user-friendly interface for the domain that allows members to:

  - Join the workflow at the appropriate points signing in via their wallets. Generically, the tasks they address are called proposals. Here stakeholders are able to view open proposals that they are eligible to sign.

  - Sign Proposals: A simple mechanism for stakeholders to sign or approve proposals they agree with.

  - Track Progress: Stakeholders are able to see the current number of signatures on a proposal and whether it has met the required threshold for approval.

  - Wallet Integration: For a stakeholder to participate in a multi-sig scheme within the Polkadot ecosystem, their Polkadot.js wallet is a key interface. The wallet stores the stakeholder's private keys securely and is used to sign transactions or approvals as part of the multi-sig process.

- Multi-Sig Wallet integration (polkadot.js)

  - Wallet Integration: For a stakeholder to participate in a multi-sig scheme within the Polkadot ecosystem, their Polkadot.js wallet is one of the key interfaces. This wallet stores their private keys securely and be used to sign transactions or approvals as part of the multi-sig process.

  - Signing Transactions: In a multi-sig setup, a transaction (such as approving a supply chain action or executing a contract function) requires signatures from multiple stakeholders before it can be executed on the blockchain. Stakeholders use their Polkadot.js wallets to review and sign these transactions, with the wallet ensuring the security of their private keys during the signing process.

  - Smart Contract Interaction: When interacting with a smart contract that requires multi-sig approvals, stakeholders would use their Polkadot.js wallets to initiate transactions or to sign off on proposals made by others. The smart contract would then verify that the required number of signatures has been collected before executing the agreed-upon action.

  - Configuration and Management: The initial setup of a multi-sig arrangement, including specifying which accounts are part of the multi-sig and defining the rules (e.g., how many signatures

are needed for different types of transactions), is managed through interactions initiated from Polkadot.js wallets. This setup should be encoded in the domain specific smart contract governing the multi-sig process.

– Security and Authentication: The Polkadot.js wallet plays a crucial role in the security and authentication process. It ensures that only authorised stakeholders, who hold the corresponding private keys, can sign off on multi-sig transactions. This adds an additional layer of security to the multi-sig process, as the wallet's security features protect against unauthorised access.

Benefits

Once Lockular WAM is configured for a given domain this operates as a multi-sig smart contract based system [within as Polkadot Parachain and Marketplace] and thereby manages supply chain activities across participating stakeholders, spanning multiple organisations, several key significant pieces of information can be discovered and tracked. Transparency and traceability are among the core benefits of using blockchain technology in supply chain management. In detail here's what can be discovered:

• Transaction History and Provenance

– Asset Origin: The origin of goods can be traced back to their source, including details about the manufacturer, the location, and the date of production. This is particularly valuable for verifying the authenticity of products and ensuring they meet regulatory standards.

– Ownership Transfers: Every transfer of goods between stakeholders in the supply chain is recorded on the blockchain, providing a clear history of ownership. This helps in verifying the chain of custody and ensuring that goods have not been tampered with or diverted.

• Compliance and Certification

– Regulatory Compliance: Information about compliance with relevant regulations and standards can be stored on the blockchain. This includes certifications, inspection reports, and compliance checks, which are crucial for industries with strict regulatory requirements, such as pharmaceuticals and food.

– Certification Verification: Certifications for organic, fair-trade, or sustainability credentials can be verified by accessing the blockchain. This supports claims about product quality and ethical standards, enhancing consumer trust.

- Operational Insights

  - Supply Chain Efficiency: By analysing transaction times and movement of goods, organisations can identify bottlenecks or inefficiencies in the supply chain. This data can inform operational improvements and optimizations.

  - Inventory Management: Real-time data on the movement of goods provides insights into inventory levels across the supply chain, helping in demand forecasting and reducing the risk of overstocking or stockouts.

- Security and Risk Management

  - Fraud Prevention: The immutable nature of blockchain records helps in preventing fraud, as any attempt to alter transaction history or forge documents would be evident.

  - Dispute Resolution: The clear and auditable trail of transactions and approvals facilitates faster resolution of disputes between stakeholders, as there is a reliable record of agreements and transactions.

- Stakeholder Collaboration and Trust

  - Transparent Operations: The visibility of supply chain activities to all authorised stakeholders fosters a culture of transparency, building trust among participants.

  - Collaboration Opportunities: Shared insights into the supply chain can reveal opportunities for collaboration, such as joint efforts to improve sustainability or efficiency.

- Consumer Insights

  - Product Journey: End consumers can access information about the journey of a product from production to retail, enhancing transparency and potentially influencing purchasing decisions.

  - Authenticity Verification: Consumers concerned about counterfeit products can verify the authenticity of their purchases through the blockchain, enhancing brand trust.

- Errata Management significantly improving the way errors, defects, or recalls are handled across the supply chain.

  - Real-Time Tracking: With every product and batch tracked on the blockchain, identifying where and when an issue arises becomes much more straightforward. This could include defects in manufacturing, issues during transportation, or any other problems that occur along the supply chain.

– Immutable Records: The blockchain's immutable record ensures
that once an issue is logged, it cannot be altered or deleted,
providing a transparent and accurate history of product quality
and handling.

– Smart Contract Triggers: Smart contracts can be programmed
to automatically notify relevant stakeholders when an issue is
detected. For example, if a product fails to meet certain quality
standards at a checkpoint, the smart contract could immediately
alert the manufacturer, distributor, and even end consumers if
necessary.

– Targeted Recalls: By having detailed records of the entire sup-
ply chain, recalls can be conducted more efficiently and pre-
cisely. Instead of recalling vast quantities of products, compa-
nies can target only those batches or items that are affected.

– Consumer Safety: For industries like pharmaceuticals and food,
rapid response to quality issues is critical for consumer safety.
Blockchain can facilitate this by quickly tracing and removing
compromised products from the supply chain.

Summary

The implementation of a multi-sig smart contract system for supply
chain management on the blockchain offers comprehensive visibility
into supply chain activities. It not only enhances operational effi-
ciency, compliance, and security but also builds a foundation of trust
among stakeholders and with end consumers. This level of trans-
parency and traceability is transformative, potentially reshaping how
supply chains are managed across industries.

References