PROJECT

SciQuipShar - Scientific Equipament Sharing

MEMBERS

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Problem

- Researchers lack a unified, transparent way to discover, book and manage shared scientific equipment across institutions.
- Equipment owners and institutions can't securely register assets, enforce access controls or maintain tamper-proof maintenance and usage logs.
- Fragmented payment and reputation tracking creates low trust, manual reconciliations and suboptimal resource utilization.

Solution

A hybrid blockchain platform combining Hyperledger Fabric (private) and Ethereum (public) to facilitate secure, transparent, reputation-based, and cost-effective sharing of scientific equipment. Fabric ensures trusted equipment registration and sensitive data management, while Ethereum handles public discovery, payments, and tokenization (e.g., fractional ownership via NFTs). An off-chain web application manages user interfaces, bookings, and integrations with payment and logistics systems.

Entities

- **Quantity:** Thousands of researchers, hundreds of institutions, dozens of logistics providers globally.
- **Diversity:** Researchers or research groups (end users), research institutions, technicians, logistics providers (optional). Entities span academia, industry, and developing regions, with varying technical expertise and trust levels.

Divergence

Low trust among entities due to unfamiliarity, concerns of equipment damage, misuse, or intellectual property theft. Current platforms depend on institutional policies or commercial intermediaries, leading to disputes over access, liability, and maintenance. Blockchain's transparency and immutability can be leveraged to reduce reliance on trusted third parties.

Motivation

For **researchers/research groups:**

- As **providers**: Earn financial compensation (crypto/fiat) for equipment use or internal platform tokens for free sharing, which can be used to book other equipment. Tokens incentivize reducing underutilization and foster reciprocity.
- As **users**: Access advanced equipment affordably, enabling novel research. Reputation badges (NFTs) enhance credibility.

For **institutions**: Streamlined management, verifiable maintenance logs.
Discouraging malicious behavior: Escrow holds funds/tokens until usage is confirmed. Reputation scores and badges penalize misuse by restricting access to high-value equipment.

Network Peers

- **Researchers/Research Groups**: Book equipment, provide equipment (for fees or free with tokens), update equipment details, approve bookings, provide ratings, manage profiles.
- **Institution Administrators**: Verify members, set sharing policies.
- **Technicians**: Log maintenance/calibration events.
- **Logistics Providers**: Manage transport (optional, via API).

Rights: Role-based access control via Fabric's smart contracts. Only verified entities (via Fabric MSP) can register/provide equipment or approve bookings. Ethereum enables public discovery and transactions.

Transactions

- **Fabric (Private)**: Equipment registration, booking records, maintenance/calibration logs, access control updates, institution registration, token issuance for free sharing.
- **Ethereum (Public)**: Payment processing (crypto/stablecoins), reputation badge issuance, internal token transactions, public equipment catalog updates and (possibly) fractional ownership (NFTs) in the future.
- **Off-Chain**: User profile management (private data), interface for booking requests, fiat payments and (possibly) logistics coordination.

Data

- **Fabric**: Equipment details (specs, status, location), booking ledgers, maintenance logs, institutional policies, token issuance records.
  - **Volume**: Medium. **Criticality**: High.
- **Ethereum**: Public equipment metadata, payment records, reputation tokens, internal token transactions.
  - **Volume**: High (less frequent). **Criticality**: Medium (non-sensitive, public data).
- **Off-Chain**: User profiles, notifications, logistics tracking.
  - **Volume**: High. **Criticality**: Low.

Type of Processing

- **Distributed Storage (Logs)**: Fabric stores immutable records of equipment status, bookings, maintenance, and token issuance. Ethereum logs payments and token transactions.
- **Distributed Calculation (Smart Contracts)**: Fabric chaincode manages asset registration, access control, booking, and token logic. Ethereum smart contracts handle payments, escrow, tokenization, and internal token exchanges.
- **Oracles**: Off-chain oracles verify real-world events (e.g., equipment delivery, usage completion) to trigger Ethereum escrow releases or Fabric status/token updates.

Value

- The system uses a multi-value approach:
- **Cryptocurrency/Stablecoins**: Ethereum PaymentProcessor handles paid transactions, enabling intermediary-free global payments.
- **Internal Platform Tokens**: Awarded for free equipment sharing, redeemable for booking other equipment, incentivizing collaboration and reducing underutilization.
- **Tokenization**: NFTs/ERC-20 tokens represent fractional ownership or reputation badges, linking blockchain to real-world assets. Escrow ensures trust in transactions.

Network Dynamics

The platform ensures secure, consistent transaction processing across its hybrid blockchain. On **Fabric**, transactions like equipment registration or bookings require digital signatures from authorized peers (e.g., researchers, research groups). Institutional nodes execute these transactions via chaincode, confirming compliance with rules (e.g., equipment availability or possibly technician signatures for maintenance). For example, a booking transaction is only committed if multiple endorsing peers approve, preventing unauthorized access.

On **Ethereum**, public transactions like payments or token transfers use cryptographic signatures, with smart contracts enforcing conditions (e.g., sufficient token balance, escrow terms). Validators, operating under Proof of Stake (PoS), confirm these transactions by staking ETH, achieving global consensus for transparency in non-sensitive actions (e.g., public catalog updates). Gas fees prioritize urgent transactions, like booking confirmations. Off-chain **oracles** (e.g., trusted APIs) feed real-world data (e.g., equipment delivery) to trigger actions, such as releasing escrow funds or updating token balances.

A typical flow starts with an off-chain booking request, triggering a Fabric transaction (e.g., booking record), validated by institutional nodes. Paid bookings initiate Ethereum payment transactions, while free sharing awards Fabric-issued tokens, both finalized by oracle-confirmed events (e.g., usage completion). This ensures secure, transparent, and consistent operations across private and public layers.

Points to verify (off-chain)

- User adoption: Will researchers embrace blockchain and token systems due to their learning curve? Surveys needed to assess willingness and training needs.
- Token system viability: Will internal tokens effectively incentivize free sharing? Economic modeling required to ensure token stability.
- Regulatory compliance: GDPR and cross-border data/token regulations need clarification for global operations.
- Insurance handling: One of the suggestions for revenue streams is selling insurance for the operations within the plataform. How could this be aranged? Will the insurance be outsourced to insurance companies? How can make use of Ethereum tokens as collateral?
- Equipment integration: Feasibility of standardizing diverse equipment interfaces for blockchain interaction (e.g., IoT compatibility).