

Application of Web3 and Blockchain Technology in Physical Internet-Based Sychromodal Freight Transportation

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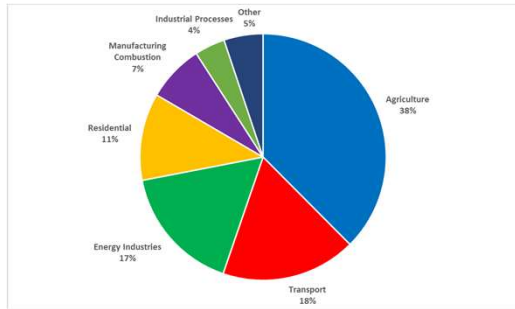
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Introduction

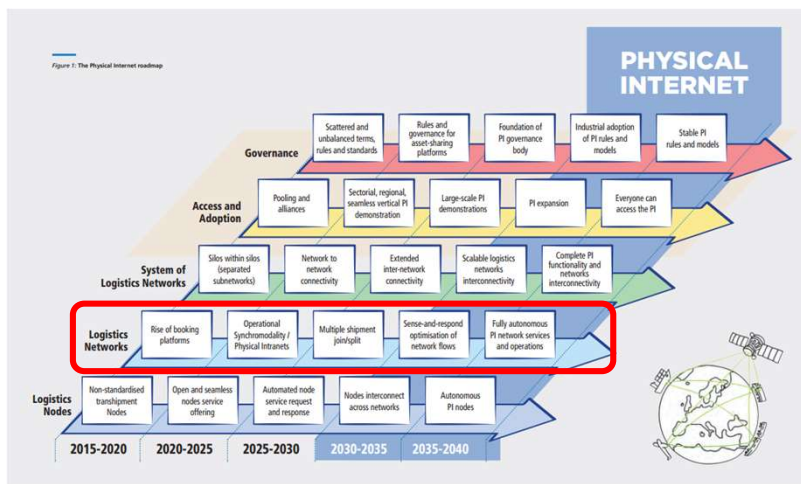
As the backbone of the global economy, the freight transportation industry has seen an increasing rise in the prevalence of sustainability, efficiency, and integration problems. Accordingly, today's industry practices of shipping, warehousing, production, distribution, consumption, and waste collection of goods are not sustainable from many aspects: operational, financial, environmental, and social.



Data Source: Environmental Protection Agency ([Link](#))

Synchromodal Transportation

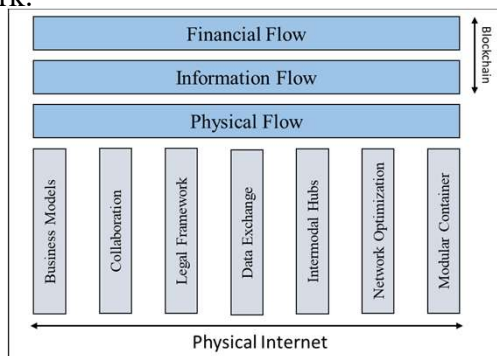
The Physical Internet (PI) concept has been introduced as a potential solution to overcome the above-noted problems. According to the PI roadmap by ALICE, we are currently experiencing the second generation of logistic networks that is about synchromodality.



Source: Roadmap to the Physical Internet, ALICE, 2020

Why Blockchain?

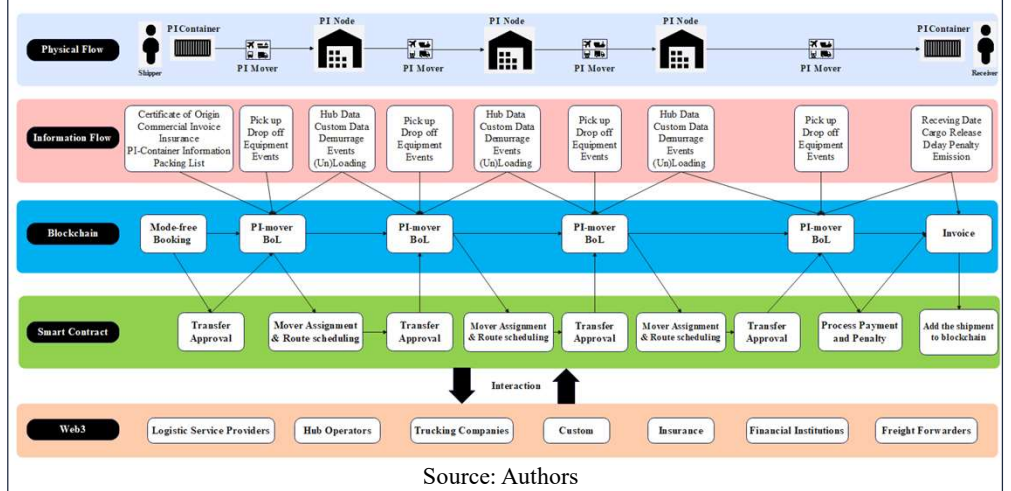
By considering the breadth of the coverage and depth of the interaction in the PI notion and the data as the currency in the synchromodal transportation, a centralized data warehouse and mutual-benefit-oriented solution provider are prone to malfunction, and it can easily become a single point of failure. Standard protocols for the stakeholders to trust the massive data inventory across the supply chain should be an inevitable feature of any synchromodal freight transportation system. Blockchain, as a distributed ledger idea, fundamentally seeks to handle the complex multi-stakeholder network.



Source: Authors

Blockchain-Enabled PI Framework

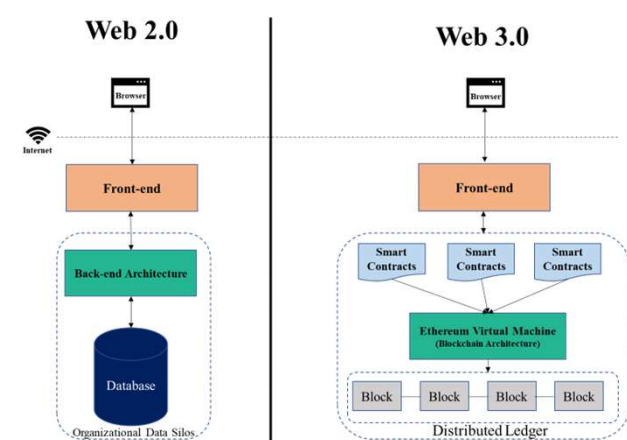
In addition to the problems of centralized planning systems, the PI idea entails too many physical movements. Accordingly, an even higher number of document and financial transactions should occur in parallel, which might become the bottleneck. The blockchain-based smart contracts could bring decentralized, secure, and on-demand executable and pre-defined agreements for financial and information flows. The overall architecture of the blockchain and smart contracts have been illustrated for Bill of Lading (BoL) as an example. The architecture is reproducible for other documents.



Source: Authors

Web 3.0 for Blockchain-Enabled PI

Instead of the Web 2.0 platform, where the entire functionality has been organized by a few matchmakers, the Web 3.0 argument has a decentralized network that allows all the participants to perform the transactions securely and trustfully based on the blockchain idea established above, embedded in the Ethereum Virtual Machine (EVM). Web 3.0 allows network users to interact directly with smart contracts without needing a central authority or intermediary.



Source: Authors

Future Works

In order to foster and promote the adoption of blockchain in the physical internet context, eclectic perspectives could be addressed. From the managerial point of view, blockchain technology adaptation is the most important hurdle that should be tackled. On the theoretical side, different avenues of research shall be addressed, such as finding the most robust and sustainable consensus mechanism, network tokenization, scalability, and embedding AI-based smart contracts into the network. From the technological perspective, further research and developments are needed to increase the interconnectivity of the three main flows and to develop Web 3.0 infrastructure and machine-to-machine communication.

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