

DECENTRALIZED DATA EXCHANGE PROTOCOL FOR THE MANUFACTURING INDUSTRY

Raymond Maiorescu¹ and Augustin Semenescu^{2,3}

¹ University Politehnica of Bucharest, 313 Splaiul Independentei, 060032, Bucharest, Romania
raymond.maiorescu@stud.fiir.upb.ro

² University Politehnica of Bucharest, 313 Splaiul Independentei, 060032, Bucharest, Romania
augustin.semenescu@upb.ro

³ Romanian Academy of Scientists, 3 Ilfov St., 050044, Bucharest, Romania

ABSTRACT: This article proposes a secure and transparent data exchange protocol that addresses the challenges of data privacy and security in the manufacturing industry. Sharing data among stakeholders is essential for optimizing production processes, enhancing product quality, and reducing costs. However, data privacy and security concerns hinder achieving these objectives, leading to missed opportunities and inefficiencies. This paper suggests utilizing blockchain technology, smart contracts, tokenization, and interoperability to develop a data exchange protocol that ensures security and privacy. The proposed protocol enables manufacturers to securely and transparently exchange collected and stored data while preserving privacy. The article includes a detailed technical description of the protocol and discusses its potential applications in manufacturing.

KEYWORDS: manufacturing, web3, blockchain, data, privacy, exchange, protocol

1. INTRODUCTION

The manufacturing industry generates vast amounts of data from sensors, machines, and other devices that hold enormous potential to optimize production processes, improve product quality, reduce costs, and enhance supply chain management. However, the use of this data is limited due to security, transparency, and privacy concerns. Traditional methods of data exchange, such as centralized databases and communication channels, are susceptible to attacks, manipulation, and unauthorized access, limiting data sharing among stakeholders.

Manufacturing industry participants are on the verge of a data-driven revolution. They work together in highly connected value networks that use a wide range of data and analytics applications. Data is the essential component that powers these applications, resulting in increased productivity, improved customer experiences, and positive impacts on society and the environment. However, most advanced applications require data sharing beyond company borders to train artificial intelligence algorithms and support collaboration in complex networks that demand greater transparency. Therefore, data sharing is critical in enabling numerous advanced data-driven manufacturing applications. [1]

As manufacturers shift away from relying solely on manual labor and deterministic operation models, they are now incorporating more complex data streams to integrate powerful AI models. However, existing solutions for data exchange in the

manufacturing industry have security, transparency, and privacy limitations. We propose an innovative protocol that utilizes blockchain technology, smart contracts, tokenization, and interoperability to address these limitations. The paper describes the technical details of the protocol and discusses its potential applications in the manufacturing industry, including improved performance, throughput, logistics, regulatory compliance, and safety. The proposed approach has the potential to revolutionize the way data is exchanged in the manufacturing industry, leading to significant improvements in efficiency, cost savings, and decision-making. [2]

2. BACKGROUND

The manufacturing industry can access abundant real-time data from various sources, such as sensors, machines, and other devices. By utilizing advanced analytics, manufacturing operations managers can thoroughly examine historical process data, identify patterns and relationships among discrete process steps and inputs, and optimize the factors that greatly affect yield. By aggregating and analyzing previously isolated data sets, manufacturers can uncover important insights and gain a competitive advantage in their industry. [3]

To harness the full potential of data, manufacturing managers need to follow a structured approach that includes selecting appropriate data sources, creating an orchestrated ecosystem of platforms to collect data from various sources, and cleaning, aggregating, and pre-processing the data to make it suitable for a specific business use case. Once the data is ready,

advanced techniques such as Data Science or Machine Learning/AI models can be applied to extract insights. Finally, visualizing these insights helps businesses understand complex data patterns and make informed decisions. [4]

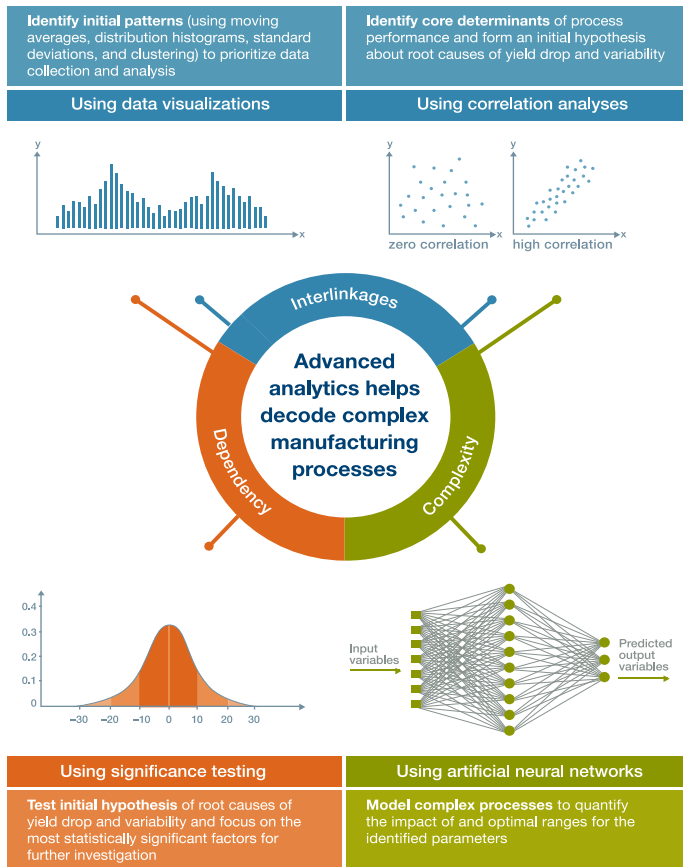


Figure 1. Advanced analytics (source: [McKinsey](#))

However, the increasing amount of data being generated and shared in the manufacturing industry has raised concerns about data privacy and security. To address these challenges, adopting a secure, transparent, and privacy-preserving data exchange protocol is essential. A secure data exchange protocol can help ensure that sensitive data is protected while being exchanged between different parties. Additionally, a transparent protocol can enable businesses to track the movement of data and ensure its accuracy, security, and integrity. By implementing such a protocol, businesses can foster trust among stakeholders and facilitate the seamless exchange of data, leading to more informed decision-making and improved operational efficiency.

3. KEY CONCEPTS

It is central to outline the concepts and technologies employed in the proposed protocol to understand how the solution tackles the issues faced by a manufacturing business looking to utilize operational data. While blockchain technology has emerged as a promising solution in recent times, other up-and-coming technologies and creative ideas are becoming

increasingly significant, complementing the use of blockchain.

Decentralization is the act of distributing power, authority, or control away from a central entity. In the realm of technology and computing, decentralization often involves the dispersion of data storage and processing across a network of nodes or computers, as opposed to relying on a central server or authority. This approach can provide advantages such as heightened security, since it is more challenging for a single entity to compromise the system, and increased resilience, as the system can continue operating even if certain nodes become inactive. Decentralization has gained interest in areas like blockchain and cryptocurrency in recent years, as it enables transactions to occur with trust and transparency, eliminating the need for a central intermediary or authority.

Web3 is composed of various nascent technologies that are utilized to construct decentralized platforms and applications, with the purpose of empowering users to exercise greater control over their online identity and data, as well as creating a more secure, private, and decentralized internet. Decentralized marketplaces, social networks, content platforms, and decentralized finance (DeFi) platforms that facilitate peer-to-peer financial transactions, obviating the need for conventional financial intermediaries, are some examples of Web3 applications. “The fundamental idea behind web3 is to create a decentralized version of the Internet.” [5]



Figure 2. The Web3 Stack (source: [Alchemy](#))

Compute-to-data is a privacy-preserving method for data analysis, where instead of moving the data to the computation environment, the computation is brought to the data. In this approach, the data remains at its original location, and the computation is executed on the data locally, or in a secure and controlled environment. This method provides several benefits, including reduced data movement, lower risk of data

exposure, and improved data privacy. Compute-to-data can be particularly useful for AI applications, where large amounts of data are needed for training and analysis. By bringing the computation to the data, compute-to-data can enable data scientists and researchers to analyze and train models on sensitive or confidential data without exposing it.

Smart contracts are self-executing contracts stored on a blockchain, allowing for automated transactions without the need for intermediaries. They are a core feature of blockchain technology and enable trustless, decentralized transactions. Smart contracts are programmed with specific conditions, rules, and actions that are automatically executed when those conditions are met. They are transparent, tamper-proof, and operate autonomously, enabling secure and efficient transactions that provide a higher level of security and transparency compared to traditional contracts.

Tokenization and token gating are two critical concepts that facilitate innovative asset ownership and access control in the world of blockchain and cryptocurrency. Tokenization involves conversion of a physical or digital asset into a digital token that can be traded on a blockchain. These tokens can represent various assets, including stocks, real estate, unique digital assets such as datasets and algorithms, and more. Token gating, on the other hand, is a mechanism that limits access to particular features or functions of a blockchain platform or application based on the possession or ownership of specific tokens.

Interoperability is the capacity of diverse systems or components to function together and exchange information seamlessly. It is an essential concept in technology and computing, allowing for different systems and technologies to communicate with each other and share data effectively. The importance of interoperability is particularly evident in blockchain and cryptocurrency, as these technologies involve multiple platforms, networks, and applications that must work together. Several approaches exist to achieve interoperability in the blockchain and cryptocurrency space, including the use of common standards and protocols like the ERC-20 standard for tokens on the Ethereum network.

4. DECENTRALIZED DATA EXCHANGES

Decentralized data marketplaces or data exchanges operate on secure, blockchain-based smart contract networks, which allow users to maintain control over their data and monetize its properties without relying on a centralized framework. The marketplace's smart contract system guarantees that data providers can

securely provide their data to buyers or users without compromising data privacy. Additionally, these marketplaces facilitate peer-to-peer data connections, allowing users to stream data with seamless payments. Data marketplaces can operate with increased security, transparency, and fairness. As a result, decentralized data marketplaces are becoming increasingly popular among users who prioritize privacy, security, and autonomy over their data. [6]



Figure 3. Decentralized marketplace flow (source: [Accubits](#))

In decentralized data exchange, data is shared directly among peers without the involvement of a central authority or intermediary, allowing for secure and transparent sharing between parties without the need for a trusted third party. Decentralized data exchange offers the benefit of giving greater control and ownership of generated data to individuals or organizations. It is instrumental in the manufacturing sector, where confidential data regarding production processes, supply chain management, and product quality needs to be shared between various stakeholders, including suppliers, manufacturers, and customers.

5. OCEAN PROTOCOL TECHNOLOGY

Ocean Protocol developed technology that allows for the creation of data marketplaces or exchange protocols that enables secure, privacy-preserving data sharing. It is designed to empower individuals and businesses to share data and AI models without giving up control or compromising privacy.

It employs blockchain technology, ensuring data is stored transparently and securely. Users can buy, sell, and share data on the platform without trusting a centralized authority. The protocol uses smart contracts to enable transactions and ensure data is used according to the parties' agreed-upon terms.

Ocean technology utilizes data NFTs and datatokens as an entrance and exit point for data assets in crypto ecosystems. It employs ERC721 [7] data NFTs that are unique and non-interchangeable, as well as ERC20 [8] fungible datatokens, to establish a link

between blockchain and DeFi tools with data assets. This approach enables the transformation of crypto wallets into data wallets, crypto exchanges into data marketplaces, and the formation of DAOs for data co-ops, among other possibilities enabled by DeFi composability.

5.1 Architecture

At the most fundamental level, platforms like Ocean Market enable users to introduce data, algorithms, and compute-to-data services into the realm of cryptocurrency. These platforms permit users to establish and distribute data NFTs and datatokens that represent both services and assets, which they can then store within data wallets. In addition, users can investigate the available assets, purchase or sell datatokens at either fixed or dynamically determined prices through data marketplaces, and utilize data services by expending datatokens.

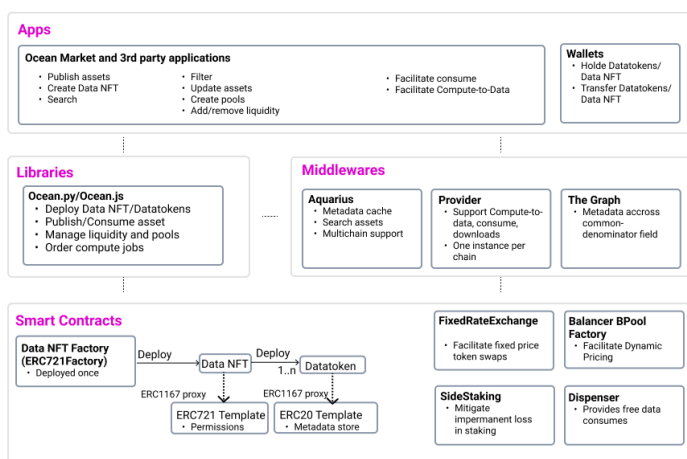


Figure 4. Architecture (source: [Ocean Protocol](https://oceanprotocol.com))

The Ocean ecosystem comprises libraries that enable the development of applications such as Ocean.js, a JavaScript library, and Ocean.py, a Python library. Additionally, middleware components, including Aquarius and Provider, are used to improve asset discovery and facilitate asset downloads, DDO encryption, and communication with operator services for Compute-to-Data jobs.

The Graph is also incorporated into the ecosystem as a third-party tool that allows developers to create customized applications and marketplaces using Ocean's libraries. [9]

At the lowest level of the Ocean ecosystem are the smart contracts deployed on the Ethereum mainnet and other compatible networks. These contracts are accessed through libraries that provide features such as publishing new assets, enabling consumption, managing pricing, and more. By encapsulating the calls to smart contracts, these libraries simplify the integration of Ocean's functionalities into applications built on top of the ecosystem.

5.2 Data NFTs and Datatokens

Data NFTs are created using the ERC721 standard, and publishers have the option to deploy new data NFT contracts through either Marketplace or client libraries. Publishers have the ability to designate other Ethereum addresses as managers, granting them the ability to deploy and mint new datatoken contracts. Every datatoken contract is linked to a specific data NFT contract.

When data assets are published through Ocean technology, data NFTs are generated automatically to provide the publisher with intellectual property (IP) rights. Additionally, datatokens are produced automatically to provide licenses for accessing the published assets. Through the use of predetermined smart contracts, publishers can establish specific access conditions for the data assets, including factors like price, types of accepted tokens, and the type of access granted.

Data NFTs represent ownership of a data asset's copyright or base IP. In contrast, ERC20 datatokens represent licenses to access the asset by downloading the content or running Compute-to-Data jobs. The Datatoken represents the asset that the publisher wishes to publish. It can be a dataset or algorithm stored in various locations such as Google Drive, Dropbox, AWS S3, on their phone, on their home server, etc. Publishers can use IPFS for a content-addressable URL or choose to run a compute-to-data service instead of a file. [10]

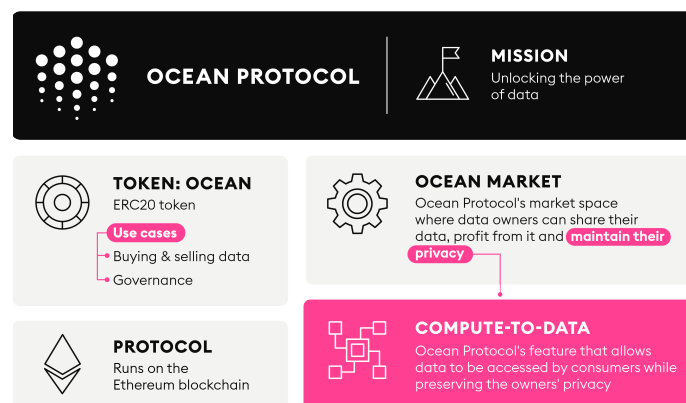


Figure 5. Ocean Protocol (source: cryptoarmy.io)

Datatokens limit access to specific resources or functionalities to users with a set amount of the platform's native token, such as OCEAN, ensuring that only authorized users with a sufficient amount of the ERC20 token can access specific data or perform certain actions.

5.3 Permissions and Data Access

The functions of the datatoken (ERC20) and data NFT (ERC721) smart contracts are restricted using permissions stored in the data NFT smart contract.

The data NFT contract serves as the base IP for the asset, to which all datatokens are linked. User roles can be assigned to introduce enterprise-level administration, with the NFT owner having the highest level of control and the ability to assign roles, including the manager role. Only the NFT owner can assign the crucial manager role, and when deploying or transferring the data NFT, the NFT owner is automatically added as a manager.

Access to data is considered a service that can be provided in various forms, including fixed datasets, dynamic datasets, and compute services. Different variants are available for static data storage, such as Web2 cloud storage (like AWS S3), Web3 non-permanent storage (like Filecoin), Web3 permanent storage at a small-scale (like Ethereum), Web3 permanent storage at a large-scale (like Arweave), or using IPFS with multiple "pinned" locations. For dynamic data, variants include Web2 streaming APIs (single-source), Web3 public data oracles (like Chainlink), and Web3 private data oracles (like DECO). Tokens can be used to control access to the data, with options for perpetual, time-bound, or one-time access. Tokens used for one-time access are burned after the initial access.

5.4 Metadata Tools

Marketplaces use metadata such as the name of the dataset and the date of creation to help discover data assets. Each data asset is given a decentralized identifier (DID) [11], which links to a JSON file called a DID document (DDO) containing relevant metadata. Ocean, an Ethereum-based system, uses the blockchain network to store the DID and DDO, ensuring that metadata remains available without further expenses or dev-ops work after the write fee is paid. While storage costs on blockchain networks are not insignificant, the benefits currently outweigh the tradeoff compared to alternatives, simplifying integration with the rest of the Ocean system. Due to the decentralized nature of data on the Ethereum mainnet and other EVM networks, any last-mile tool can access metadata, with Ocean Aquarius supporting different metadata fields for each marketplace.

To address GDPR right-to-be-forgotten regulations, metadata is stored, encrypted, and decrypted using a REST service provided by the publisher running a Provider. Typically, Ocean-powered markets retrieve decrypted metadata from various publishers and store it locally in Aquarius, with third-party tool TheGraph able to see metadata fields common across all marketplaces.

5.5 Data Custody & Data Wallets

Data NFTs and datatokens, being ERC721 and ERC20 compliant, respectively, can seamlessly integrate with various Ethereum tools and apps, such as MetaMask and Trezor as data wallets, and DEXs as data exchanges, among others, providing them with great composability potential.

Data custody involves data access, which can be obtained in Ocean by holding data NFTs or datatokens in wallets. Data sharing involves transferring data NFTs or datatokens to others.

As data NFTs and datatokens adhere to ERC721 and ERC20 standards, existing wallets for ERC721 and ERC20 can be utilized, including browser wallets like MetaMask, mobile wallets like Argent and Pillar, hardware wallets like Trezor and Ledger, multi-sig wallets like Gnosis Safe, institution-grade wallets like Riddle & Code, custodial wallets like Coinbase Custody, and more. Wallets may also be designed specifically for datatokens, offering features such as dataset visualization or facilitating the management of multiple datatoken assets.

Marketplace Architecture

Because each data service has its own ERC20 token, any ERC20 exchange has the potential to function as a data marketplace. These specialized marketplaces can assist users throughout the entire data flow process, including publishing, setting prices, curating, discovering, buying, and consuming data.

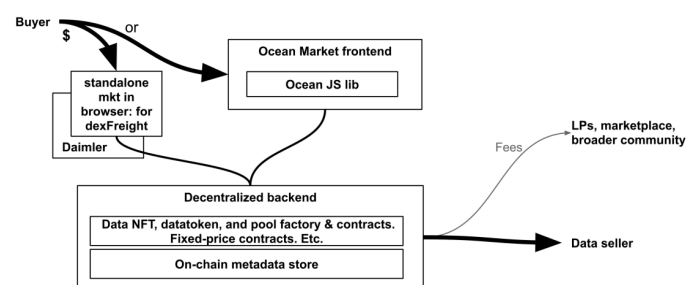


Figure 6. Marketplace architecture (source: Ocean Protocol)

There are numerous frontends for data marketplaces but share a common backend for a given network. Frontends include community markets like Ocean Market or independent third-party markets. These frontends are client-side applications that run in the browser and interface with the backend using the Ocean JS library. The Decentralized Backend is Solidity code that runs on the EVM chain and contains data NFT & datatoken contracts, pool contracts, and the on-chain metadata store.

5.6 Marketplace Actions

A marketplace's main objective is to connect asset publishers and consumers by facilitating buying and

selling and making assets easy to find. An Ocean-powered market offers various features to ensure a seamless experience for asset publishing and consumption.

When a user decides to publish a data asset, they are directed to a page where they can input metadata, such as the asset's title and description. Additionally, the publisher must provide a URL to access the data asset, which is encrypted and saved on the blockchain. The URL is decrypted when a consumer purchases a datatoken to access the data asset.

The publisher must also determine the asset's price, which can be free or sold at a predetermined cost. After providing all the necessary information, the publisher can click "Publish," and the marketplace will begin blockchain transactions to deploy a datatoken contract and publish metadata on the blockchain.

An Ocean-powered marketplace is expected to offer a vast collection of data assets. Ocean provides support for browsing, searching, and filtering these assets, making it easy for users to find what they need. For example, when a purchaser with OCEAN tokens visits an Ocean-powered market and clicks "Buy," Metamask prompts them to confirm the exchange of OCEAN tokens for 1.0 datatokens. Once confirmed, the swap occurs on the blockchain, and the purchaser receives 1.0 additional datatokens in their wallet.

In another scenario, a datatoken owner can visit an Ocean-powered market, connect their wallet, and click the "Use" button to access the dataset. They can then follow the instructions to download the dataset or receive the results of processing the data.

5.7 Developer Tools & Third Party Marketplaces

Ocean technology simplifies the process of creating personalized marketplaces for entities. Using Ocean JavaScript or Python libraries, various tasks such as creating a data asset, setting up a fixed-price market, purchasing datatokens, and submitting and consuming a datatoken can be accomplished with just a few lines of code. These libraries connect with Ocean smart contracts. Ocean Provider and Ocean Aquarius are available as supplementary tools for supporting data asset provisioning, on-chain data storage, and metadata retrieval (with the help of a local cache).

With these tools, developers can create an Ocean-based data marketplace in two main ways: (1) by forking Ocean Market that utilizes Ocean tools or (2) by directly utilizing Ocean tools, such as the JavaScript library, to build their marketplace.

5.8 Benefits of Ocean-powered Marketplaces

The Ocean marketplace offers tools that simplify creating and launching data marketplaces. These marketplaces, which utilize ERC20 tokens on the Ethereum mainnet and other EVM-compatible chains, have several defining features.

Firstly, users are not required to log in; instead, they simply connect their Web3 wallet (such as Metamask) and can quickly buy or sell datatokens. This approach offers a significant user experience improvement over traditional centralized exchanges (CEXs) and feels similar to decentralized exchanges (DEXs).

Criteria	Centralized Exchanges	Decentralized Exchanges
 Decentralization	Operated by centralized organizations.	Operated by users and liquidity providers.
 Custody of assets	The centralized exchange controls access to crypto assets.	Users have exclusive control over their assets.
 Impermanent loss	No concerns of impermanent loss due to high liquidity.	Impermanent loss is a highly possible risk in event of market fluctuations.
 Regulations	Highly regulated	No KYC and AML standards
 Liquidity	Institutional investors and a large user base ensure higher liquidity.	Lack of regulatory standards and competition from CEXs reduce liquidity.
 Trading Options	Multiple trading options, including spot trading, futures trading, and others.	Only limited to crypto lending and borrowing and speculative investments.
 Availability	Depends on the centralized company operating the exchange.	Always accessible to users.

Figure 7. CEX vs DEX (source: 101blockchain.com)

Additionally, these marketplaces are non-custodial, decentralized, and resistant to censorship, with fine-grained permissions available to meet data regulations or KYC requirements. Through Ocean Compute-to-Data, private data can be published and consumed while preserving privacy and maintaining the option to make data exclusive. Provenance is ensured through the auditability of purchase transactions using platforms such as Etherscan.

5.9 Ocean Compute-to-Data

Ocean Compute-to-Data provides a way for people and organizations to share or profit from their private data while still keeping it secure. Private data refers to sensitive or regulated information that individuals or organizations want to keep confidential.

To ensure privacy, tools are used to enable selective access to data so that only those who are authorized can view it. Private data is valuable because it can be difficult to obtain and can provide a competitive advantage in the market, as well as being critical to research that can lead to important breakthroughs in science and technology.

However, sharing or selling private data can be risky, as it can result in discrimination or persecution. As a result, large organizations with vast datasets often choose not to monetize their data due to the potential liability associated with data breaches.

Compute-to-Data solves this problem by allowing third parties to run specific compute jobs on the data without physically moving it from its original location.

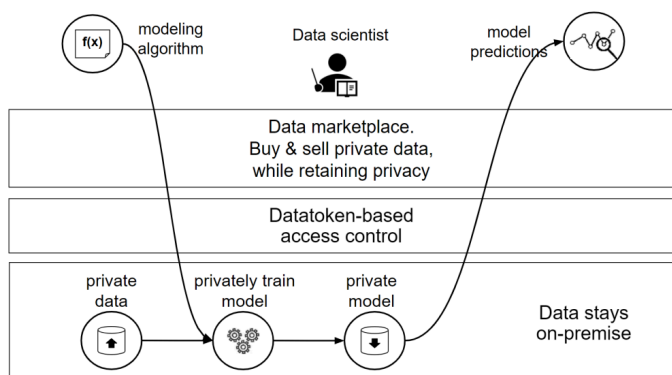


Figure 8. Compute-to-Data (source: Ocean Protocol)

The results of these compute jobs can be used in scientific, technological, or business contexts, while minimizing privacy risks through sufficient aggregation or anonymization techniques. This approach enables individuals and organizations to enjoy the benefits of private data while minimizing the associated risks.

5.10 Compute-to-Data Architecture

Ocean Protocol is a data exchange platform that connects Data Providers, Data Consumers, and Marketplaces. With the introduction of Compute-to-Data, the platform now includes Compute Providers as a new actor. Compute Providers offer compute services on data instead of selling the data itself.

The technology behind Ocean Protocol includes several components, such as the recently launched Operator Service and Operator Engine. These components are specifically designed for Compute-to-Data. The Operator Service manages the workflow and executes requests, communicating directly with the Provider's proxy server (i.e., the data provider) to perform computations on the data.

Meanwhile, the Operator Engine is a backend service responsible for orchestrating the compute infrastructure using Kubernetes. It retrieves workflows created by the Operator Service in Kubernetes and manages the necessary infrastructure to complete the execution of compute workflows. [12]

Regarding asset types, datasets were the only asset type in metadata (DDO) before. However, Compute-to-Data introduces a new asset type, an algorithm, a script that can be executed on datasets.

5.11 Benefits of Compute-to-Data

Compute-to-Data offers several advantages, one of which is privacy. This advantage ensures that personal or sensitive information is not leaked and data breaches are avoided.

With Compute-to-Data, data owners retain control over their data as it never leaves their premises. This technology also enables the sharing or selling large datasets without the need to move the data, which is particularly beneficial for slow or expensive-to-move datasets.

Compliance with data protection regulations such as GDPR [13] is facilitated by Compute-to-Data because there is only one copy of the data that does not move.

Furthermore, Compute-to-Data offers auditability, providing evidence that algorithms were executed correctly, and instilling confidence in AI practitioners regarding the accuracy of results.

5.12 Fine-Grained Permissions

Ocean's Fine-Grained Permissions feature allows publishers and data market owners to impose restrictions on publishing and consumption within an enterprise-focused data marketplace.

Ocean's two-level access control management system provides precise control over data access. Firstly, at the market level, access control is provided for activities such as browsing and publishing within the marketplace frontend. Secondly, fine-grained permissions at the asset level are required to manage access to the asset itself. This system is particularly useful for enterprises and other users who need to limit data access based on location, affiliation, and credentials. For example, in a manufacturing data use case, Ocean's Fine-Grained Permissions feature could restrict access to only appropriately credentialed EU analysts to browse and access the available supply chain-related datasets. This access control management ensures the security and privacy of sensitive data while enabling more efficient and effective data sharing and utilization.

Access control in Ocean's system is based on a role specified as a credential, such as *employee N*. For example, in a company, new hires can receive the credential when they join, giving them the necessary permission. [14] This approach is known as Role-Based Access Control (RBAC). To manage

permissions at the market level, Ocean uses an RBAC server that restricts access at the user level based on their credentials. The marketplace runs and controls the RBAC server, defining the permissions at this level.

To ensure the security and privacy of sensitive data at asset level, enterprises must restrict access to datasets based on user credentials. For instance, only appropriately credentialed analysts should be allowed to access the data in a manufacturing data use case. However, relying solely on datatokens is insufficient, as it would enable anyone with the required number of tokens to access the data.

Ocean has developed a model that combines datatokens with credentials to address this issue to provide more precise access control. Datatokens are used as the baseline access control and are fungible and independent of the user's identity, while credentials are based on the user's identity or roles in the enterprise.

Ocean uses the Role-Based Access Control (RBAC) approach to implement access control at the user level, where restrictions are based on the user's credentials. The RBAC server is run and controlled by the marketplace, which defines the permissions at the market level. With this approach, enterprises can ensure the security and privacy of sensitive data while facilitating more efficient and effective data sharing and utilization. [15]

Ocean's access control management includes a deny functionality that complements its allow list feature. Consumers who are on the deny list are prevented from accessing the resource. The access rules are determined by the combination of allowed and denied lists, where $\text{Access} = \text{allowed} - \text{denied}$. By default, everyone is allowed access, or a specific allow list can be used. Denied access is based on the entries in the deny list. Initially, the only supported credential is the Ethereum public address, used as a pointer to an individual rather than a true credential. However, the metadata schema in Ocean allows for the specification of other types of credentials, such as W3C Verifiable Credentials, for future extensibility.

When implemented, these additional credentials will enable proper RBAC for asset-level permissions. As the publisher controls the DDO, which contains the asset-level permissions, they also control the asset-level restrictions.

6. BUILDING A MARKETPLACE

Building a data marketplace using Ocean Protocol technology can have several advantages.

Decentralization: Ocean Protocol is a decentralized data exchange protocol that allows users to share and monetize data securely and transparently without relying on a central authority. It can help eliminate intermediaries and reduce transaction costs, making exchanging data easier and more affordable.

Security: Ocean Protocol uses blockchain technology to ensure the security and integrity of data exchange. It can help to prevent data breaches and protect sensitive information.

Privacy: Ocean Protocol allows users to maintain control over their data and decide who has access to it. It can help to protect user privacy and prevent unauthorized access to sensitive information.

Interoperability: Ocean Protocol is interoperable with other technologies and data sources by design. This aspect helps to facilitate data exchange and integration across different platforms and systems.

Overall, using Ocean Protocol technology to build a data marketplace can provide a secure, decentralized, and transparent way to share and monetize data while protecting user privacy and ensuring data integrity.

6.1 How to build a data marketplace

While building a data marketplace may be a challenging endeavor, there are general steps you can follow to simplify the process.

Understand Ocean Protocol: Start by familiarizing yourself with Ocean Protocol, its architecture, and its components. This will help you understand how the protocol works and what features you can leverage to build your data marketplace.

Identify your data sources: Determine the types of data you want to offer on your marketplace, and identify the sources of that data. You may need to establish partnerships or collaborations with organizations that can provide the data you need.

Design your marketplace: Decide on the design and functionality of your marketplace, including the types of data you will offer, how users will access and purchase the data, and how you will manage transactions and payments.

Set up your Ocean network: Install and configure the necessary software and tools to create your Ocean network, including the Ocean network stack, Ocean contracts, and OceanJS library. You will also need to set up a blockchain infrastructure and deploy smart contracts to enable data sharing and transactions.

Create and publish data assets: Use the Ocean Protocol to create data assets, including metadata that describes the data, pricing information, and usage

restrictions. You can then publish these assets on your marketplace, making them available for purchase.

Manage transactions and payments: Use the Ocean Protocol to manage transactions and payments on your marketplace, ensuring that data is exchanged securely and transparently. You will also need to develop a system for handling payments and distributing revenues to data providers.

Monitor and improve your marketplace: Continuously monitor and improve your marketplace to ensure that it is meeting the needs of your users. This may involve collecting feedback, analyzing data usage patterns, and making changes to your marketplace design and functionality.

Overall, building a data marketplace using Ocean technology requires a solid understanding of the protocol and its capabilities, as well as careful planning and execution to ensure a secure and effective marketplace.

6.2 Support

There are several ways you can seek support in building an Ocean Protocol-powered data marketplace:

Ocean Protocol Community: The Ocean Protocol community is a great resource for learning about the protocol, connecting with other developers and enthusiasts, and getting support. You can join the Ocean Protocol Discord channel, attend community events and workshops, and participate in hackathons to connect with others working on Ocean-based projects.

Ocean Protocol Documentation: The Ocean Protocol documentation provides detailed information on how to set up and use the protocol and sample code, and tutorials to help you get started. The documentation covers data asset creation, metadata, smart contracts, and more. [16]

Ocean Marketplace: The Ocean Marketplace is a live demonstration of the protocol, showcasing how data providers can publish and sell data assets and how data consumers can purchase and access those assets. Explore the marketplace to understand how the protocol works and see examples of data assets. [17]

Ocean Protocol Partners: Ocean Protocol has a network of partners who provide support and services related to the protocol. These partners include blockchain infrastructure providers, data providers, and consulting firms that can help you build your data marketplace.

Ocean Academy: Ocean Academy provides educational resources, such as tutorials and courses, to help you learn about Ocean Protocol and its capabilities. The academy covers data science, blockchain, and decentralized finance, providing a comprehensive understanding of how Ocean Protocol can be leveraged for your data marketplace. [18]

By leveraging these resources, you can gain the knowledge and support you need to successfully build an Ocean Protocol-powered data marketplace.

7. SHOWCASE

Mercedes-Benz's strategic initiative, Acentrik, has been launched on the Polygon Mainnet as a part of its enterprise release. Acentrik is a decentralized data marketplace that utilizes Blockchain Technology developed by Mercedes-Benz, leveraging the Ocean Protocol technology. [19]

It aims to facilitate data sharing and monetization across various domains for enterprises. By tokenizing data assets, secure access to data on the marketplace is made possible for multiple industries. Acentrik is designed to be a horizontal technology, providing added benefits to the data transformation process. The cornerstone of Acentrik is data sovereignty, ensuring that data is stored in the providers' chosen environment and that consumers can connect directly to the data source.

Furthermore, Acentrik plans to build a transparent Web3 ecosystem governed by Gaia-X community members. "Gaia-X represents this next generation of a data infrastructure ecosystem. The architecture of Gaia-X is based on the principle of decentralization. It creates an open, transparent, and secure federated digital ecosystem where data and services respond to common rules and can be freely and securely built, collated, and shared." [19]

Acentrik provides technical data sovereignty for enterprises through its Compute-to-Data feature, which leverages federation services built on the Ocean Protocol tech stack. This feature ensures data privacy and sovereignty for participants in the marketplace, promoting the adoption of the Gaia-X framework across various domains such as manufacturing, industry 4.0, mobility, and real estate.

According to Acentrik, the ability to perform computing jobs serves as the bridge between raw data and business analysis. Enterprises have a growing appetite for deeper analysis and insights from their data, and Compute-to-Data in Acentrik Data Marketplace provides the solution to this need. [20]

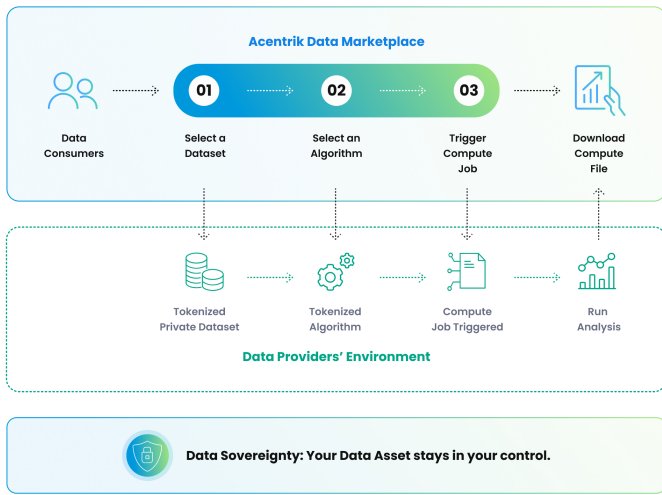


Figure 9. Acentrik Compute-to-Data (source: acentrik.io)

Compute-to-Data is a key concept that allows for the computation of anonymized data while preserving the security and privacy of data owners' raw data. This feature allows for the generation of analysis by granting access to algorithms for the raw data. The resulting output file is stored in decentralized storage solutions, which the Data Consumer can access. This feature benefits both Data Providers looking to monetize their data and Data Consumers seeking deeper insights into their businesses.

7.1 Latest Developments

Acentrik has had a significant year in 2022, marked by major milestones and the development of stronger relationships with corporations and Web3 leaders.

Since its enterprise release in July of 2022, Acentrik has continued to develop and scale its product, with Version 1.1.0 featuring additional enhancements. One such improvement is the introduction of a user-centric dashboard that tracks all sales transactions of a data provider's assets. This feature allows data providers to view the total number of sales transactions for their assets and provides a tabulated view of every company's purchase of their data products.

Another enhancement is the ability for data providers to transfer a specific asset's ownership and management rights to another wallet through the Acentrik Asset Management Token. Additionally, enterprises can now set access to their data asset directly during publishing, allowing data providers to restrict or allow access to their data assets based on specific criteria.

To improve user experience and avoid the need to re-publish the same tokens or metadata, Acentrik conducts periodic checks on transaction status. This ensures that users receive a more accurate response from the marketplace. At the same time, smart

contract transactions are executed during publishing and also supports users in speeding up transactions on their Metamask (Web3 Wallet Extension). [21]

8. CONCLUSION

In conclusion, the manufacturing industry generates vast amounts of data that can be utilized to optimize production processes, improve product quality, reduce costs, and enhance supply chain management. However, traditional methods of data exchange are limited due to security, transparency, and privacy concerns. Decentralized data exchanges, such as the data marketplace enabled by Ocean Protocol technology, provide a solution to these issues.

Ocean Protocol technology offers a secure, transparent, and privacy-preserving data-sharing solution that allows individuals and businesses to share data and AI models without giving up control. The decentralized nature of the protocol ensures that users can monetize their data while eliminating intermediaries and reducing transaction costs.

In addition, Ocean Protocol uses blockchain technology to ensure the security and integrity of data exchange, preventing data breaches and protecting sensitive information. The privacy-preserving aspect of the protocol allows users to maintain control over their data and decide who has access to it, protecting user privacy and preventing unauthorized access to sensitive information. Furthermore, the interoperability of Ocean Protocol with other technologies and data sources facilitates data exchange and integration across different platforms and systems.

The Acentrik initiative launched by Mercedes-Benz on the Polygon Mainnet is an excellent showcase of the potential of decentralized data marketplaces to unlock value for manufacturers. By leveraging Ocean Protocol technology, Acentrik provides a secure, transparent, and efficient data marketplace for the manufacturing industry, allowing manufacturers to monetize their data while maintaining control and protecting privacy.

With the increasing importance of data in manufacturing, businesses must explore and adopt new technologies to remain competitive in the industry. Decentralized data exchanges, such as the ones enabled by Ocean Protocol technology, offer a promising solution to the issues faced by manufacturers in utilizing their operational data. By embracing these new technologies, manufacturers can unlock the full potential of their data, optimize their processes, reduce costs, and improve their products' quality.

9. REFERENCES

1. "Unlocking Value in Manufacturing through Data Sharing," World Economic Forum. <https://www.weforum.org/projects/data-sharing-for-manufacturing/> (accessed Mar. 17, 2023).
2. "Top 10 Trends 2023." <https://view.ceros.com/applied-intelligence/top-10-trends-2023> (accessed Mar. 15, 2023).
3. "How big data can improve manufacturing | McKinsey." <https://www.mckinsey.com/capabilities/operations/our-insights/how-big-data-can-improve-manufacturing> (accessed Mar. 17, 2023).
4. "Big Data in manufacturing: Trends, tips, success stories," Software Development Company - N-iX. <https://www.n-ix.com/big-data-in-manufacturing/> (accessed Mar. 17, 2023).
5. "Web3 vs Web 3.0: The difference between the Decentralised Web and the Semantic Web," Business Anecdote, Jan. 02, 2023. <https://www.thebusinessanecdote.com/post/web3-vs-web-3-0-the-difference-between-the-decentralised-web-and-the-semantic-web> (accessed Mar. 17, 2023).
6. R. A. R, "The scope of Decentralizing Data Marketplaces using blockchain," Accubits Blog, May 11, 2021. <https://blog.accubits.com/the-scope-of-decentralizing-data-marketplaces-using-blockchain/> (accessed Mar. 18, 2023).
7. "ERC-721." <http://erc721.org/> (accessed Mar. 18, 2023).
8. "ERC-20 Token Standard," ethereum.org. <https://ethereum.org> (accessed Mar. 18, 2023).
9. "Data NFTs and Datatokens." <https://docs.oceanprotocol.com/core-concepts/architecture> (accessed Mar. 18, 2023).
10. "Data NFTs and Datatokens." <https://docs.oceanprotocol.com/core-concepts/datanft-and-datatoken> (accessed Mar. 18, 2023).
11. "Decentralized Identifiers (DIDs) v1.0." <https://w3c.github.io/did-core/> (accessed Mar. 18, 2023).
12. "Architecture." <https://docs.oceanprotocol.com/building-with-ocean/compute-to-data/compute-to-data-architecture> (accessed Mar. 18, 2023).
13. "General Data Protection Regulation," Wikipedia. Mar. 13, 2023. Accessed: Mar. 18, 2023. [Online]. Available: https://en.wikipedia.org/w/index.php?title=General_Data_Protection_Regulation&oldid=1144398012
14. "Role-based access control," Wikipedia. Feb. 13, 2023. Accessed: Mar. 18, 2023. [Online]. Available: https://en.wikipedia.org/w/index.php?title=Role-based_access_control&oldid=1139093053
15. Jamie, "Fine-Grained Permissions now supported in Ocean Protocol," Medium, Nov. 17, 2021. <https://blog.oceanprotocol.com/fine-grained-permissions-now-supported-in-ocean-protocol-4fe434af24b9> (accessed Mar. 18, 2023).
16. "Forking Ocean Market." <https://docs.oceanprotocol.com/building-with-ocean/build-a-marketplace/forking-ocean-market> (accessed Mar. 19, 2023).
17. "Ocean Market," Ocean Market. <https://market.oceanprotocol.com> (accessed Mar. 19, 2023).
18. "Learn Ocean Protocol | OceanAcademy." <https://www.oceanacademy.io/> (accessed Mar. 19, 2023).
19. "Acentrik, Decentralized Data Marketplace Now in Enterprise Release, Is On Polygon Mainnet." <https://polygon.technology/blog/acentrik-decentralized-data-marketplace-now-in-enterprise-release-is-on-polygon-mainnet> (accessed Mar. 19, 2023).
20. "Acentrik Knowledge Base - Compute-to-Data." <https://support.acentrik.io/help/en-us/28-key-features-of-acentrik-data-marketplace/61-compute-to-data> (accessed Mar. 19, 2023).
21. Acentrik, "Latest Release — Acentrik's Version 1.1.0," Medium, Dec. 21, 2022. <https://acentrik.medium.com/latest-release-acentriks-version-1-1-0-781108fd7c1c> (accessed Mar. 19, 2023).