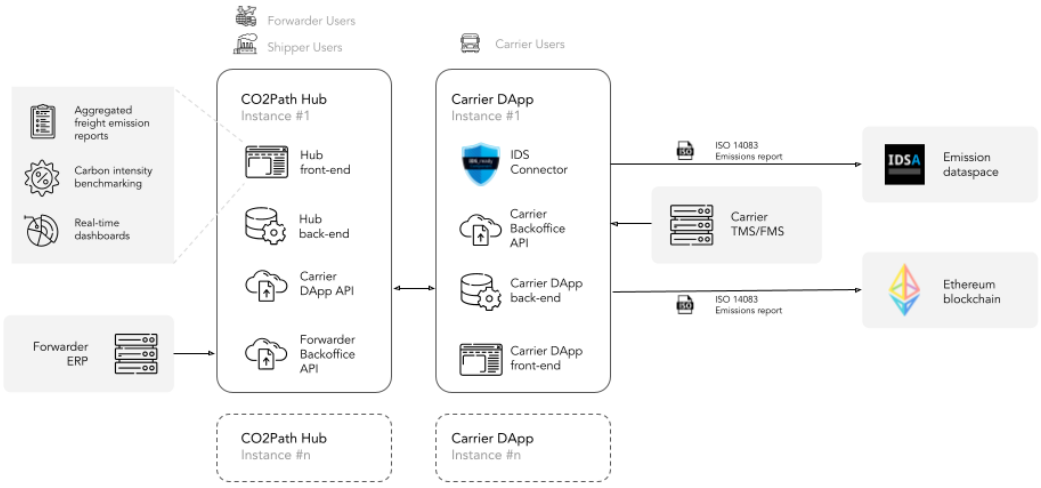
Technical Specification - CO2Path by Ideas Forward

1. **TECHNICAL SCOPE:** Summarize the mock-up devised during the EXPLORE phase: how have you addressed the challenge/Theme Challenges and tackled with its requirements and data. Include a diagram.

CO2Path (co2path.io) is a software platform developed by Ideas Forward to enable **dependable measurement and reporting of carbon emissions generated by logistics transport chains**. The architecture of CO2Path employs a decentralized data governance approach to provide a solution to a problem of growing importance for professionals in the logistics sector: The problem of obtaining accurate emission reports for freight transport, in compliance with the new **ISO 14083** international standard for the quantification and reporting of logistics emissions. The emissions quantified in these reports must be calculated based on real data that reflect the actual transport conditions, i.e. based on primary data which most transport operators consider sensitive and confidential. In addition to providing a viable solution to the problem of standardised logistics emissions quantification and reporting, the technology of CO2Path offers the following key benefits:

- **Preserving transport data sovereignty** – by allowing emissions to be calculated without the transport operators being forced to surrender their ownership or control of the primary transport activity data.
- **Facilitating emissions data sharing** – by allowing transport chain partners to form a dataspace in compliance with the IDSA standard and exchange data between them through an IDS Connector.
- **Enabling emissions data auditability** – by publishing the emission reports generated by the system to a public blockchain in appropriately pseudonymized form, thus creating an immutable audit trail for future certifiers of carbon emissions, but also a pool of valuable data accessible to researchers and policy makers



The architecture depicted above is tailored to the business model we envision: Transport service organizers (freight forwarders) obtain access to the CO2Path platform through a subscription service. Forwarders create an account for themselves in the CO2Path Hub and invite their shipper clients to create a free account through which they can access their emissions reports. Forwarders also invite their carrier partners to create a free account on the CO2Path Hub.

After creating their CO2Path user account each carrier receives detailed instructions on how to install the dockerized CO2Path DApp on their local or private cloud environment. The DApp produces accurate calculations of the CO2 emissions generated by each consignment based on the private data of carriers. Once a consignment has been completed, the CO2Path DApp receives the primary transport activity data from the carrier's ERP and calculates the respective emissions. Next, a pseudonymized version of the emissions report that is generated by the DApp is stored on the public blockchain, along with a hash of the primary data used to calculate the emissions. Lastly, the same emissions data is also stored in an IDS Connector which is included in the CO2Path Docker image.

The pseudonymized emissions data is now public to be viewed by any interested third party. The real identity of the business entities involved in each freight consignment is only known to the original creator and to CO2Path Hub. The latter is necessary so as to be able to generate aggregated emissions reports and facilitate future external audits.

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2. **ALGORITHMS, TOOLS AND CONCLUSIONS:** Detail the algorithms and tools identified to accomplish the challenge/Theme Challenges. Show clear understanding of the used REACH dataset/s and addressed challenge/Theme Challenges.

CO2Path is a challenge developed under Track 3. The full dataset made available by DS Freight Forwarding comprises 7000 actual road transport shipments across Europe from 2022 and 2023, primarily cold chain cargo such as fresh fruits & vegetables, dairy products and pharmaceuticals.

Technologies involved: ASP.NET Core, DevExpress ExpressApp, custom IDS Client for .NET, custom smart contract in the Ethereum blockchain using Solidity, Nethereum, Infura.io, MySQL (scalable in AWS) for Hub database, LiteDB.Net for DApp databases, MQTT with RabbitMQ. Main algorithm: Custom model-based CO2 emission calculation, based on segmented route/elevation/vehicle/cargo data.

The outcome is a fully working prototype which is demonstrated via integration to the Data Provider's ERP (myDS).

3. **SCALABILITY AND FLEXIBILITY OF THE SOLUTION:** Discuss whether the solution can truly cope with humongous and increasing datasets and how flexible it is to adapt to other related domains and integrate into Data Value Chains (DVC).

Solution scalability: CO2Path is designed as a scalable decentralized system where all of the data processing and storage that are resource-demanding take place in computing nodes which are maintained by different transport chain partners (carriers). The central CO2Path Hub only provides membership services and guarantees governance. The CO2Path Hub backend, frontend and APIs run in a horizontally scalable cloud infrastructure, behind a load balancer that automatically provisions new instances.

Solution adaptability: All architecture components presented earlier are fully working and support the quantification and reporting of GHG emissions from road freight transport based on the ISO 14083. The same system can easily be adapted to support multimodal transport (sea, rail, air, inland waterways). Further adaptation will be needed to fit exact customer needs in terms of reporting and integration with various logistics ERP systems.

4. **DATA GOVERNANCE AND LEGAL COMPLIANCE:** Describe the security level of the proposed solution, i.e. how authentication, authorization policies, encryption or other approaches are used to keep data secure. Explain how will be compliant with the current data legislations concerning security and privacy (e.g. GDPR).

Data security and confidentiality is at the core of the CO2Path architecture. APIs are secured using industry standard OAuth2 bearer authentication. All data is transferred via secured SSL channels and data at rest is stored in encrypted form. Frontend authentication is based on standard ASP.NET Core libraries.

GDPR compliance: Although not complete yet, all GDPR compliance requirements can be fulfilled by the architecture discussed earlier, including maintaining records of data processing flows and audit logs for detection and reporting of data breaches. Note that, by definition, the data stored at the CO2Path Hub does not include private information. The dataset provided to the CO2Path / Ideas Forward team by the Data Provider for the purposes of developing the REACH MVP included the business contact details of key staff working for transport chain organizations (contact persons) but this was appropriately removed before processing.

5. **QUALITY ASSURANCE AND RISK MANAGEMENT:** Describe the quality process planned for the final product. Technologically, which are the potential risks in all the phases of the project (design of the solution, development, testing, deployment…) and indicate mitigation plans to still fulfil the challenge/Theme Challenges and data provider requirements.

Risk description:

- Insufficient data: The available data, especially by carriers is of insufficient quality or quantity to demonstrate the use case [high]
- Time delays: Too much time is needed to reach the objective [low]

Mitigation strategy:

- Insufficient data: If trip or freight parameter data are not sufficient, fall back on validated industry averages and typical examples to develop a demonstration. If vehicle parameter data are not sufficient, estimate based on typical fleet characteristics (making carrier-specific assumptions).
- Time delays: Tackle a simplified form of the problem by estimating part of the transport activity data, by applying data augmentation, or by reaching an intermediate objective sufficient to support the demonstrator.

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