Digital data sharing for greener transport in sustainable supply chains

- the benefits of establishing a Federated network of platforms

by **Mikael Lind**, Research Institutes of Sweden (RISE) and Chalmers University of Technology, **Jaime Luezas Alvarado**, Puertos del Estado, **Sandra Haraldson**, Research Institutes of Sweden (RISE), **Henk Mulder**, IATA, **Lasse Nykänen**, Vediafi, and **Guido Piccoli,** ALOT/Codognotto

The self-organised ecosystem of multi-modal transport leads to unnecessary GHG emissions

It has been assessed that the transport sector contributes over one sixth of greenhouse gas emissions (GHG) globally[1]. End-to-end supply chains usually involve multiple modes of transport and the cargoes carried are passing through different transport nodes. Transport is to a large extent operated within a self-organised ecosystem[2] (a network of innumerable operators that are impossible to hierarchically govern / steer) which requires coordination and synchronisation between actors and modes of transport to be efficient and sustainable. Historically, such coordination and synchronisation has been challenging due to each involved actor having limited knowledge on upstream progress and disruptions. This has caused the supply chain industry to follow sub-optimised solutions jeopardising overall energy efficiency and thus not deliver the potential of greener transport. Supply chain operators need to be able to expand their knowledge about the progress of shipments and possible disruptions to transport so that they can take timely actions as required. Decisions which tend to focus on optimising the capital productivity of single organisations in the supply chain result in less energy efficiency for the whole or parts of the supply chain.[3]



Figure 1: The self-organised transport ecosystem is composed by multiple transport modes and transport nodes operated by multiple parties across the globe

Federated agreements on data sharing are needed for greener transport

To achieve energy efficiency throughout the supply chain, it is essential that each involved actor is able to make informed decisions on the energy being used for acquiring, utilising, and operating the infrastructure in the co-delivery of transport services along the multi-modal chain.

Green transport in multi-modal chains requires that the involved actors synchronise their actions in relation to each other. While some digitalised transport operators may already part of a local information sharing community, that alone is not enough. Common situational awareness across different nodes and modes of transport is also required and will only succeed if digital data sharing

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[1] https://ourworldindata.org/emissions-by-sector

[2] Watson R. T., Lind M., Delmeire N., Liesa F. (2021), Shipping: A Self-Organising Ecosystem, in M. Lind, M. Michaelides, R. Ward, R. T. Watson (Ed.), Maritime informatics. Heidelberg: Springer.

[3] Lind M., Watson R., Chua C. P., Levy D., Theodossiou S., Primor O., Picco A. (2020) A Primer for a Profitable and Sustainable Maritime Business, Smart Maritime Network, 2020-09-09

allows for exchanging data between those environments.[4] For that purpose, agreements on which data, and when and how to share data between the data sharing environments that the actors are part of becomes a necessity. Due to the self-organised characteristics of the supply chain industry, such decisions need to be made in a federated governance structure. In this way connectivity between involved actors would then be no further away than the click of button.

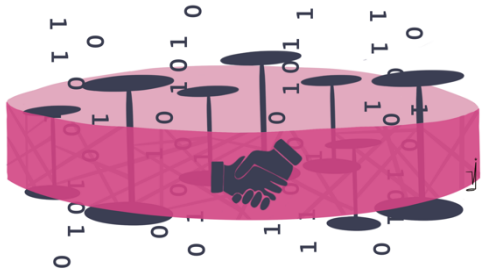


Figure 2: Digital data sharing agreements for platform inter-operability by federated governance

Digital data sharing for green conversion – some areas of application

A reduction of the carbon footprint in the transport sector will be enabled by the optimal use of physical infrastructure, wise use of sustainable energy sources, and synchronisation of activities between the different actors. Some examples of areas of application where a difference can be made are covered below. At the core for such efforts is digital data sharing and digital collaboration that enables enhanced quality in decision-making, making it possible to conduct transport operations as green as possible. This is important both within a particular mode of transport as well as between different modes of transport, thus enabling seamless transport end-to-end with high and efficient utilisation of the infrastructure that is co-utilised by many.

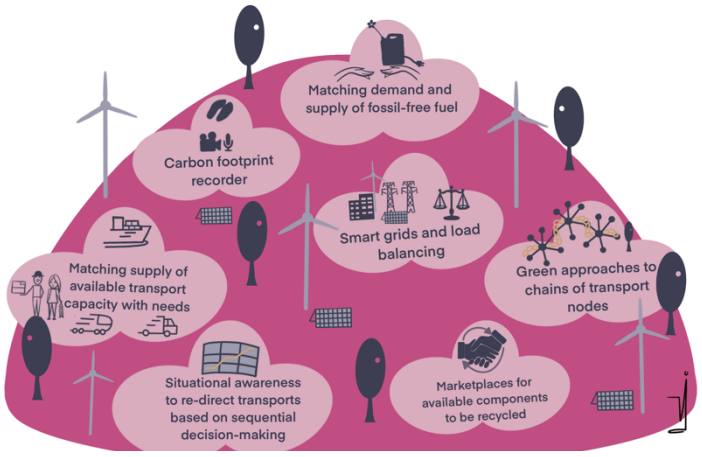


Figure 3: Green digital services utilizing the federation of inter-operable platforms

Associated with enhanced connectivity among the ecosystem participants, there is also a need for digital services that allow people and organisations to achieve a green multi-modal transport system. The FEDeRATED approach aims to assist all participants in the transport sector to strengthen their operational brainpower also in relation to their capacity to contribute to the EU Green Deal. The following are examples of how such digital services would contribute to the greening of the transport ecosystem.

<u>The use of fossil-free energy (alternative fuels) in movements and operations.</u> To enable the green conversion of the transport ecosystem, carriers are already moving to green electricity or other fossil-free energy. In some cases, this is already a mandatory requirement in local areas to protect the environment. The use of green energy sources brings with it the need to provide appropriate fuelling stations for carriers. Initiatives are underway to establish such capabilities at transport nodes by

[4] Lind M., Renz M. (2020) Do maritime authorities have a role in digitalization of shipping? – the "Digital (port)Approach" in a sea transport context, The Maritime Executive, 2/7-2020 (https://www.maritime-executive.com/editorials/do-maritime-authorities-have-a-role-in-digitalization-of-shipping)

making them "pit stops" for refuelling carriers[5]. But this requires that information on the supply and demand requirements for the energy is shared, since green energy sources are most-often derived locally and often require lead-times to ensure adequate supplies are available, such as organising smart grids and load balancing. Digital data sharing and digital collaboration are the essential enablers.

More efficient and less wasteful shipment. Carriers transporting part loads leads to the need for more carrying platforms - which generates an increased carbon footprint, both in terms of the fuel used and the resources needed to build and operate a larger pool of trucks, ships or rail wagons. More efficient loading and scheduling of existing carrier platforms and the recycling and re-use of obsolete vehicles and their materials when building new ones as part of the so-called circular economy both require dependable and near-universal digital data sharing to succeed.[6] The circular economy can benefit from the possibility of digital marketplaces for available components to be recycled from scrapped transport infrastructure. Establishing a common and shared situational awareness and improved synchronisation could enable sequential decision-making[7] and the efficient matching of available transport capacity with needs.

Enhanced coordination and synchronisation throughout the supply chain. To allow for distributed coordination and synchronisation within the self-organised ecosystem of transport, with its sub-systems, requires that information about plans, progress, and disruptions are shared among the involved parties. This is key to a seamless flow across the different modes of transport being used and for operations at transport nodes. Direct flight approaches would not be possible if airports were not prepared in all respects for a plane to land and discharge its passengers and cargo at a particular time, port call synchronisation is not possible if the actors in the port serving its visiting ships are not coordinated, and visits to transport nodes by trains and trucks result in long waiting times causing congestion if information is not shared along the transport chain. Under a comprehensive digital data sharing environment, it is possible to enable "just-in-time" approaches to chains of transport nodes as well as the synchronised coordination of multiple carriers visiting transport nodes. The former service is carrier-centric, and the latter is transport-node centric, putting the efficient utilisation of infrastructure at the core but from different perspectives - the transport infrastructure for moving goods and the transport infrastructure for facilitating episodic visits and managing the cargoes. [8]

Carbon footprint tracking throughout the supply chain. For all cargo being moved across different modes and nodes of transport in the end-to-end supply chain, a carbon footprint is generated. Historically, emphasis has been placed on individual carriers and improvements in their own technology and operations. Tracking of CO_2 emissions over the total end-to-end transport chain is a powerful addition to any carrier specific initiatives, that would be empowered by a federated approach to data sharing, to respond to the increasing pressure from shippers and from consignees to provide such information, to support sustainability objectives. Data being generated and accessed at different information islands can serve as the foundation for a digital *carbon footprint recorder* service at the

[5] Lind M., Pettersson S., Karlsson J., Steijaert B., Hermansson P., Haraldson S., Axell M., Zerem A. (2020) Sustainable Ports as Energy Hubs, The Maritime Executive, 27/11-2020 (https://www.maritime-executive.com/editorials/sustainable-ports-as-energy-hubs)

[6] Hvid Jensen H., Munch Andersen M., Dao A., Lind M., Pandey V., Bapuji G., Petersen M., Hobson B., Lehmacher W., Turos A. (2021) Digitalisation in a Maritime Circular Economy, in M. Lind, M. Michaelides, R. Ward, R. T. Watson (Ed.), Maritime Informatics: Additional Perspectives and Applications. Heidelberg: Springer.

[7] https://castlelab.princeton.edu/RLSO/

[8] Lind M., Becha H., Simha A., Larsen S. E., Ben-Amram E., Gnass M. (2021) Port call optimization: Two sides of the same coin, Smart Maritime Network, 25/2-2021

individual consignment level. This would provide awareness of the carbon footprint generated for the consignment across a full multi-modal journey.

A federated approach for data sharing to "green" the supply chain

The GHG footprint of the supply chain must be reduced. This will require us to overcome the sub-optimal planning and operations that prevail at present. We also have a very limited measure of the emissions generated by multimodal supply chains. This limitation is mainly due to the market (supply chain) fragmentation, lack of collaboration, and the use of data that is often difficult to share because of the lack of interoperable data formats and standards. The data sharing in operation today relates more to micro than macro; the focus has been on single transport modes and a non-integrated information and communications technology model among the different players along the supply chain rather than across all the modes of transport used in an end-to-end supply chain.

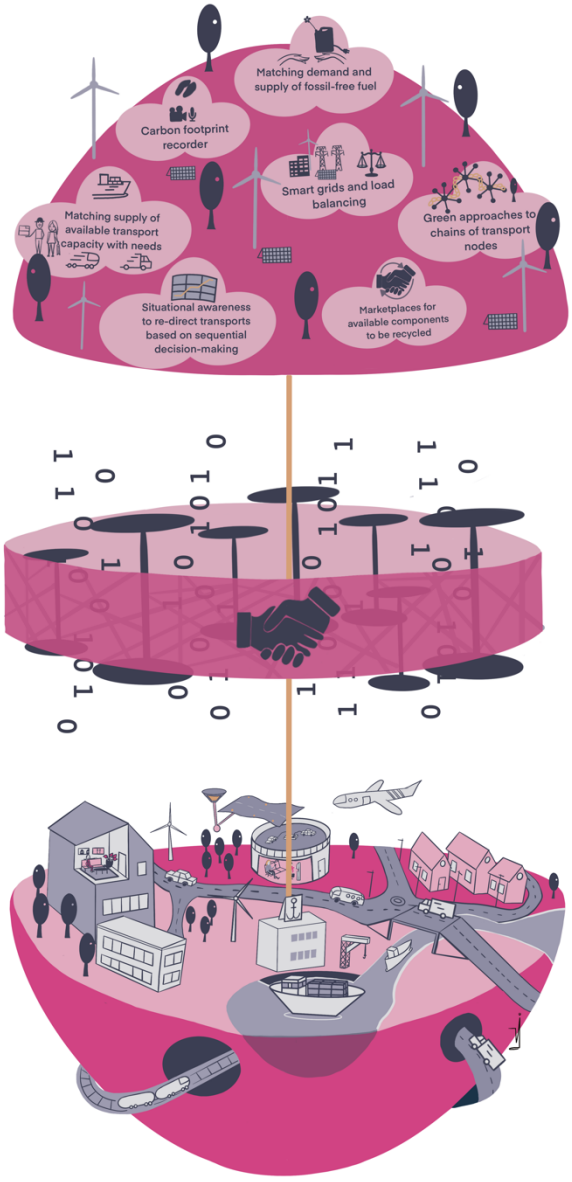


Figure 4: A layered approach for greening the multimodal transport ecosystem; connecting the physical world with green services through federated agreements on data sharing

The greening of transport agenda challenges the transport sector to take a leap towards a more integrated approach than today. Reduction of the environmental footprint of freight transport puts the effective utilisation of transport assets and infrastructure at focus. This includes moving the goods by and between different carriers and modes of transport as well as providing value-adding services to the goods being transported. In this paper we have identified several services that will support the greening of the multi-modal transport chain. However, in order to make such services available the sourcing of data needs to be facilitated, enabling involved actors from local to geographically delimited areas to be included. This requires a federated network of platforms in which data may be shared seamlessly between data sharing environments.

Multimodal data sharing is at the core for enabling energy efficient transport. As there is no over-arching body to take control, we need to rely on individual participants to contribute towards the common good, which is the reduction of the carbon footprint. This will be enabled by digital data sharing and digital collaboration. This is something all involved parties need to put on their agenda, including authorities and policy makers, who can and who should push for sustainable development.

Digital data sharing will allow new green digital services to emerge, focused on connecting actors through matchmaking and marketplace services, carbon footprint visibility services generated along the supply chain, synchronisation and coordination services for seamless integration, sequential analytics, and monitoring services for the optimal use of energy and the transport infrastructure. All this requires digital connectivity and digital collaboration between the many actors and is aimed at reducing the environmental footprint.

As is being explored by the principles of FEDeRATED, allowing for the exchange of data between different data sharing environments means the transport industry can take responsibility for the more efficient use of resources in the movement of people and goods. To empower this situation existing platforms need to exchange data. However, today's platforms are all targeted at different customer groups and applications in the supply chain. These platform and standards "battlefields" result in different specifications, a lack of harmonisation at all levels, a variety of closed solutions, and lead to incompatibility.

Greening the transport ecosystem must be a collaborative effort that requires standardised ways of connecting, providing and consuming data, thereby providing the basis for services for greening the transport ecosystem. The FEDeRATED approach, through its leading principles that put platform interoperability at the core, allows the information provider and information consumer to connect once with technology independent services, and provides the foundations for success. Such development is also key to allowing the different involved actors to coordinate prior to physical movements and operations taking place. This is paramount for the green operation of the transport infrastructure and the multi-modal transport chain.

Concluding remarks

Today, the developments in the field of information and communication technologies make it possible to access data in a decentralised way directly from the source. There is also increasing reliability and the quality of data; this is enabling further innovation.

Within the perspective of data sharing there are three governance approaches: a centralised control over an integrated infrastructure, a private decentralised model, and a community-led network. FEDeRATED considers that the latter, due to the large number of participants and systems operating in the self-organised ecosystem of multi-modal transport, is the most suitable option to choose to achieve green multi-modal transport.

Green transport involves the many actors that co-produce value throughout the transport chain. They jointly need to take responsibility for the common good achievement - which is the sustainability of our planet. While capital productivity is a concern of the single actor, overall energy efficiency and sustainability in the multi-modal chain is an increasing community concern that will only be addressed by collective and collaborative responsibility. The collaborative, data sharing, coordinated approach set out under the FEDeRATED principles can provide a win-win for both concerns.

About the authors

Mikael Lind is the world's first Professor of Maritime Informatics and is engaged at Chalmers, Sweden, and is also Senior Strategic Research Advisor at Research Institutes of Sweden (RISE). He serves as an

expert for **World Economic Forum**, Europe's Digital Transport Logistic Forum (**DTLF**), and **UN/CEFACT.** He is the co-editor of the first book of maritime informatics recently published by Springer.

Jaime Luezas Alvarado is the Service to Port Community Head of Unit in Puertos del Estado, and is also the national Coordinator of the Spanish Maritime Single Window and leads the design, development and deployment of a federative platform for logistic data sharing and digital collaboration (SIMPLE project) in Spain. He serves as an expert for DTLF, UN/CEFACT and IMO.

Sandra Haraldson is Senior Researcher at Research Institutes of Sweden (RISE) and has driven several initiatives on digital collaboration, multi-business innovation, and sustainable transport hubs, such as the concept of Collaborative Decision Making (e.g. PortCDM, StationCDM, YardCDM) enabling parties in transport ecosystems to become coordinated and synchronised by digital data sharing.

Henk Mulder is Head, Digital Cargo at the International Air Transport Association. He is the initiator and driving force behind the development of the IATA ONE Record data sharing standard and has recently launched the development of an Interactive Cargo standard for the use of IoT in air transport.

Lasse Nykänen is the Project Director of Finnish Vediafi SME company. Nykänen has his background in transport research where he has been working with transport services, ecosystems, automation, ITS and sustainable road freight. Nykänen was one of the inventors of CaaS (Corridor as a Service) concept. https://www.vedia.fi/

Guido Piccoli, Transport Economist and senior EU project expert, is CEO of ALOT, consulting company dealing with Public Administrations in planning transport infrastructure and alternative fuels initiatives, supporting private operators in the development of intermodal services. He is consultant of Codognotto one of the most relevant intermodal logistic provider in Italy.

FEDeRATED (www.federatedplatforms.eu) is a both-feet-on-the-ground EU funded CEF data sharing project. The aim is to demonstrate how a federated network of platforms as proposed by the EU Digital Transport and Logistics Forum (www.dtlf.eu) can work. can actually work. The goal is seamless data flow management in logistics and smart mobility services in multimodal transport. The project runs from 2019-2023, has 15 partners located in 6 EU Member and connects many stakeholders through various cross bordering 21 Living Labs.