ROAD FREIGHT **LAB**

Demonstrating the GHG reduction potential of

- asset sharing
- route optimization
- and other measures

A Low Carbon Freight report under WBCSD's Low Carbon Technology Partnerships initiative (LCTPi)

Report 2: Business models and demonstration project design

About the World Business Council for Sustainable Development (WBCSD)

WBCSD is a global, CEO-led organization of over 200 leading businesses working together to accelerate the transition to a sustainable world. We help make our member companies more successful and sustainable by focusing on the maximum positive impact for shareholders, the environment and societies.

Our member companies come from all business sectors and all major economies, representing a combined revenue of more than $8.5 trillion and 19 million employees. Our global network of almost 70 national business councils gives our members unparalleled reach across the globe. WBCSD is uniquely positioned to work with member companies along and across value chains to deliver impactful business solutions to the most challenging sustainability issues.

Together, we are the leading voice of business for sustainability: united by our vision of a world where more than 9 billion people are all living well and within the boundaries of our planet, by 2050.

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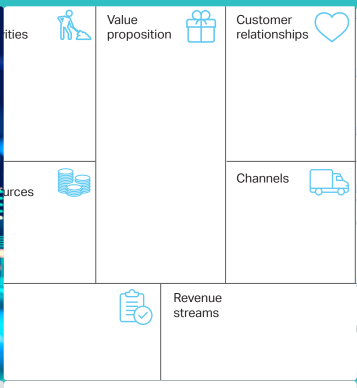
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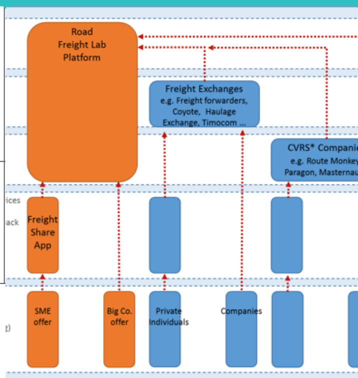
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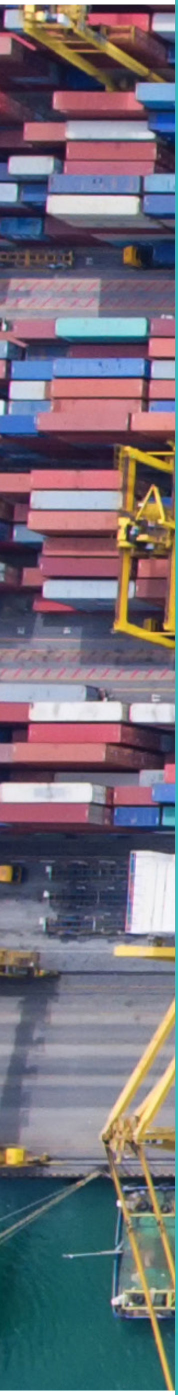
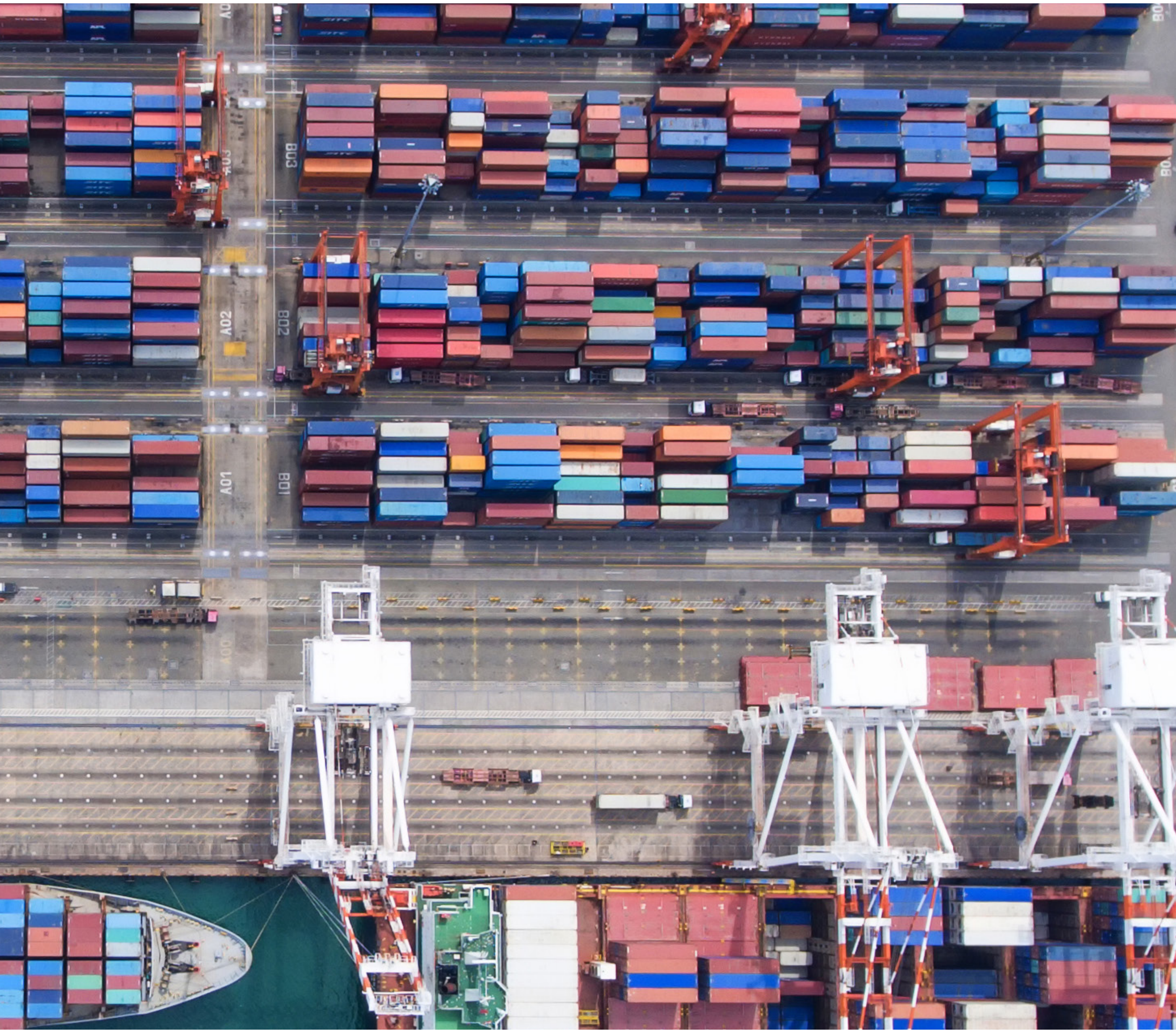


Transport accounts for 20% of global final energy consumption, and road-freight is a rapidly growing component of that, especially in developing countries. WBCSD's Road Freight Lab initiative aims to investigate and select measures that companies can adopt to reduce GHG emissions from road freight transport. This report represents a mature stage in that process, discussing six high potential measures and attempting to quantify their benefits via data collection, modeling, and other evidence. The key outcomes are:

- Use of top-tier asset optimization tools could reduce energy use and emissions by on average 12.5%, and are still to be taken up by approximately 85% of fleet operators;
- The increasing prevalence of tight delivery windows, especially in the "last mile" context, is set to increase transport energy use and emissions if left unchecked; but relaxing delivery windows from 1hr to 5hrs could lead to savings of 25%;
- Modest asset sharing models that can save 15% are only being used by 20% of operators, while highly integrated vehicle and depot sharing can lead to a 20% savings and is yet to be taken up in the case of at least 85% of commercial vehicle miles;
- Accelerated adoption of immediately available alternative fuels such as biogas and electric vehicles would lead to an 83% reduction in GHG emissions;
- Widespread adoption of vehicle-centric efficiency measures would lead to a 32% reduction in fuel consumption;
- Eco-driver training has been widely adopted in many markets and can save on average 7% GHG emissions by better fuel efficiency.

These findings show that fleet operators have significant opportunities to reduce emissions from freight transport. The solutions relating to alternative fuels and drivetrains, vehicle efficiency and driver training are well known and many local initiatives are in place to help deploy these across fleets. On the other hand, solutions relating to optimization, relaxing delivery time windows and asset sharing are either not known or the market does not yet offer many ready commercial solutions to fleets. Another feature of these latter three solution areas is that companies will be required to collaborate in order to reap the GHG reduction benefits that are possible.

WBCSD is facilitating collaboration between member companies and partners to better understand how these solutions can be developed into viable business models and deployed at scale across road freight transport providers. Given the scale of the necessary challenge to decarbonize transport, WBCSD and its members recognize the need to develop all solutions. Those described within this report will all be key elements in the fight against climate change in the road freight sector.



INTRODUCTION

Transportation alone accounts for 20% of final global energy consumption [IEA Energy Technology Perspectives, 2015]. In the EU, transport produces a quarter of the greenhouse gas emissions, of which road transport, passenger and freight contribute to over 70% (vsEuropean Commission White Paper, 2011), consequently, accounting for 15%-20% of emissions.

The freight transport sector will significantly evolve by 2050. The global demand for road freight, measured in ton-kilometers (Tkms), will almost triple between 2015 and 2050 (ITF, 2017), with the growth concentrating in developing economies. In 2050, non-OECD countries will represent more than 80% of the demand for road freight transport, up from 60% in 2015. Demand will grow particularly strongly in countries where rail infrastructure is not well developed, such as African or South-East Asian countries. It is also expected that road will remain the primary mode of transport for short distances (EC White Paper, 2011).

Given the potential to create a meaningful impact, WBCSD is exploring several practical measures that could be promoted for global carbon footprint reduction in the freight sector.

The practical measures suggested can be achieved by the majority of operators at low or reasonable cost. Operators fall into two groups: (i) those relating to logistical arrangements, both in the contexts of individual operators, and the sharing of data and other assets between pairs or groups of operators; (ii) those relating to materials and human factors, such as fuels, vehicle modification and driver training.

For the first group, the focus is given to the potential benefits that would arise as a result of the following three measures:

- Use of top-tier tools for optimizing routing and resource-allocation;
- Changing the business context to avoid narrow delivery windows;
- Promoting the sharing of assets (vehicles and/or depots) between suitable groups of operators.

Regarding materials and human factors the report considers the following measures:

- "Eco"-oriented driver training;
- Alternative fuels;
- Vehicle-centric efficiencies, via modifications to onboard components or systems.

Given the results in the Road Freight Lab report 1, which showed a large potential for the various operators to decrease the carbon footprint of freight transport through collaboration, the development of a cloud-based platform focusing on the first group of measures was chosen for further development.


EXPRESS
CHARGING STATION

1. OUTCOMES FROM **THE FIRST REPORT**

High-quality routing and resource/allocation

Road transport routing and scheduling involves meeting conflicting objectives such as minimizing vehicle driver's time, maximizing the vehicles' carrying capacity (weight and/or volume), minimizing the distance traveled, minimizing the fleet size, while satisfying cost and service parameters. The granular capability for organizations to be able to select their priorities will ensure efficient utilization of available transport capacity. Computerized Vehicle Routing and Scheduling (CVRS) allows this optimization of objectives, with typical cost savings of between 5%-30% in comparison to manual processes (Hosny, 2014).

After analysis of the data from 35 fleets, provided by Route Monkey, WBCSD showed that fleet size did not influence the mileage savings percentage. Results also showed that the largest benefits in terms of time, cost and emissions savings came from more complex route plans (involving large volumes of data) under short time restrictions. The broad average of 12.5% emerged as the cost saved by applying routing and resource allocation optimization. If all commercial vehicles across the UK used such CVRS systems, 6.4 billion vehicle miles could be avoided annually.

The research thus far implies a typical transport cost saving of 10-20%, supporting the business case for this complex integration of software in operations. At the same time, WBCSD can tentatively conclude that 85% of the transport market has yet to transition to high-quality route optimization use.

Widened delivery windows

The consideration of time windows in this report stems from two facts. First, scenarios of the "hard/narrow" type are becoming increasingly prevalent, fueled by growth and competition in e-commerce and associated shifts in customer expectations. Second, the "hard/narrow" scenario has significant negative implications for mileage and GHG emissions. The results provide potential evidence for legislative action or other mechanisms to dissuade operators and clients from the "hard/narrow" scenario.

Data was captured from 20 fleets, where 100 separate route optimizations were performed. After modeling, WBCSD discovered relaxing the delivery window from one hour to half a working day saves up to 25% of the mileage that would have been covered. Comparisons of findings to literature can be seen in Table 1.

For all references in this section please refer to the first report available on the wbcsd website: www.wbcsd.org/Clusters/Climate-Energy/Road-Freight-Lab

Table 1: Summary of percentage impact of mileage traveled when relaxing time windows for commercial transport

Time window relaxation	% mileage saved	Source
2-3 hours	7	(Boyer, 2009)
3-9 hours	15	(Boyer, 2009)
1-2 hours	35	(Punakivi, 2001)
1-2 hours	6	WBCSD
1-5 hours	25	WBCSD

Boyer (2009) found that there could be up to 10% variance in mileage/ cost savings when dealing with a dense urban area or sparse setting. The 35% savings stated by Punakivi (2001) seems extreme, however, their simulation settings were consistent with high-density urban customers.

The customer behavior of expecting narrow delivery windows challenges logistics operators who wish to avoid the need to offer "narrow/hard" delivery windows. Logistics operators require legislative frameworks or other mechanisms to help change the direction of this trend. However, the 2015 Accenture report suggests that absent customers are an even bigger issue than cost management. Thus, minimizing this factor through narrow delivery windows may equally be advantageous. Overall narrow delivery windows have a significant effect on mileage for freight and goods operators.

Asset sharing

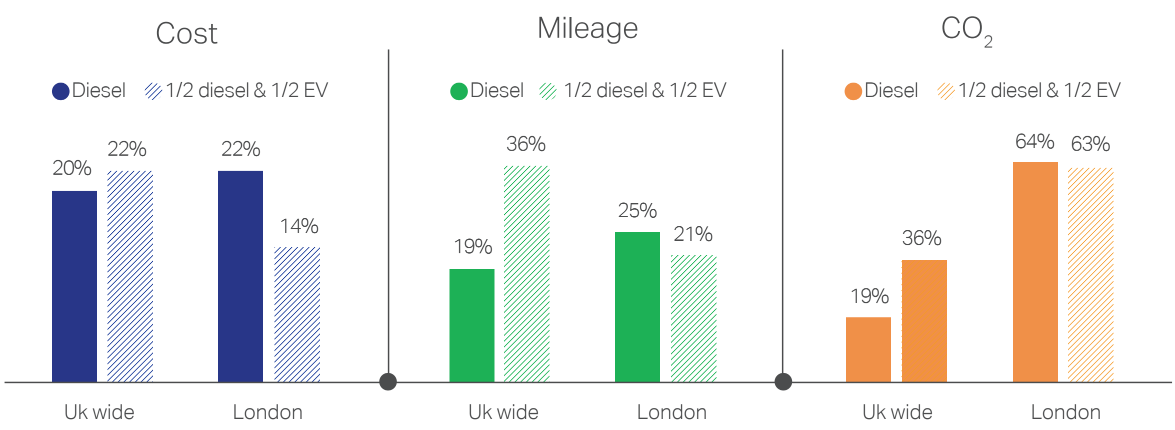
While CVRS can lead to improved operational efficiency, there are limitations to what can be achieved for a single organization. In 2003, around 130,000 lorries traveled empty between Scotland and England, as 31% more freight (tons) was moved in the opposite direction (McKinnon and Edwards in Green Logistics 2010). Higher levels of vehicle load utilization have been found to be possible through collaboration across separate companies (McKinnon in Global Logistics 2010).

There are several asset sharing approaches. However, we focus on the sharing of a several companies' jointly optimized resources to meet their current delivery tasks. Based on this focus area, four scenarios of modeling experiments were performed and the results can be seen in Figure 1.

Each scenario involved either being set UK wide or London-based and either used a diesel or a hybrid diesel/EV truck.

As seen in Figure 1, there is a significant cost benefit (20% or higher) when fleets operate collaboratively and an additional benefit with regards CO_2 emissions if hybrid trucks are used.

Figure 1: Highlights the percentage potential benefits with regards to cost, mileage and CO_2 emissions when collaborating (both diesel and hybrid trucks)



In the second set of asset sharing experiments, a set of five simulated long-haul continent-wide fleets were optimized to identify the benefits of multi-national co-operation, and the full range of potential combinations was tested, ranging from all pairwise combinations, through to the combination of all five fleets. Acknowledging model limitations, two key findings emerged: firstly, the range of benefits, though always significant, is highly sensitive to geographic context; and secondly, independent of geographical context, rapidly diminishing returns are seen when collaboration goes beyond two fleets.

Asset sharing will result in saving 7-70% of GHG emissions depending on the degree to which operations (seen in approaches above) are jointly optimized, the number of independent operators involved in the alliance, and the geographic context. Backhaul-centered asset sharing can lead to emission benefits around 8%, while more extensive sharing of assets between two operators can lead to 15—30% emission and mileage saving, with higher benefits achievable in some cases. Based on the modeling, WBCSD would propose a tentative average of 20%, varying significantly with details, recognizing that pairwise collaborations are likely to be more numerous and achievable in the short to medium term. Meanwhile, a cautious extrapolation suggests that 85% of current commercial vehicle miles are yet to benefit from such measures. Given the potential for positive impact and current low uptake, we recommend national regulators facilitate collaborative solutions reaching the market.

Alternative fuels

While technology and policy may well advance in the future to boost the economic viability of hydrogen fuel cells or biofuels, short and medium-term pragmatics seem to favor the recommendation of R-CNG / R-LNG and electric vehicles (EVs) for businesses seeking to meaningfully reduce their carbon footprint quickly at feasible levels of investment. Over the longer term, a mix of advanced biofuels, EVs and FCEVs (both with decarbonized production pathways) will achieve the best GHG emissions reduction results, but these pathways require time for the technologies to reach scale and become more economically viable. The conversion and infrastructure costs of R-CNG and EV are favorable compared to those for hydrogen, while their emissions benefits profile and fuel costs are favorable in comparison to biofuels; however, it must always be recognized that this is assessed against a constantly changing landscape.

Using lifecycle average estimates for R-C/LNG and EVs, we estimate that full take up across commercial vehicles would lead to an 83% reduction in well-to-wheel GHG emissions in comparison with diesel (LCFS, 2009).

Vehicle efficiencies

The efficiency measures in this theme broadly fall into five categories. The first, "intelligent vehicle," refers to the exploitation of telematics, GPS, vehicle state and environmental information via sensors and software. The second measure, "aerodynamics" refers to modifications that can be installed to reduce air-resistance. The third, "rolling resistance," relates to improved tires (in terms of weight reduction and/or tread), along with specifics of their arrangement in multi-axle vehicles, and the maintenance of tire pressure. Fourthly, "weight reduction," refers to the replacement of components with lower-mass alternatives (e.g. replacing standard panels with aluminum composite versions). The final measure in this theme is, "auxiliary loads," which concerns minimizing the power demands for systems other than driving the wheels, such as power steering, braking, alternators and fans.

Vehicle-centric efficiency measures tend to be additive and widely applicable, and could lead to an indicative fuel consumption savings of 32% on average if multiple such measures are used and the vehicle is updated regularly. Considering average fleet age, it seems that these measures could be applicable to at least 80% of commercial vehicles.

Driver training

Finally, eco-driver training is widely acknowledged to be one of the most cost-effective means of reducing fuel consumption and GHG emissions in the road freight sector. Greening (2015) cites average improvements that vary from 9% on long-haul journeys to 5% on urban journeys, consistent with this 7% fuel efficiency improvement average found by our previous analysis.

The UK Center for Sustainable Road Freight concludes that sustained take-up of driver training programs will account for 2.5 Mt CO_2 reduction in the UK by 2035, placing it on a par with a range of "logistics measures" such as a backhaul, urban consolidation and acceptance of night-time deliveries, and telematics (Greening, 2015). However, they did not include route optimization among these measures.

2. FOCUSING **OUR EFFORTS**

Focusing on demonstration of optimization and asset sharing potential

During the course of 2016 and preparation of the first report, it became clear to the group that WBCSD could best add value to existing efforts by focusing on the first group of measures, namely those relating to logistical arrangements, both in the contexts of individual operators, and the sharing of data and other assets between pairs or groups of operators (see introduction). The literature review and discussion with road freight operators showed that this group of measures is not well known outside subject matter expert groups and that few commercial solutions exist to enable the potential GHG savings.

Although there is a potentially large opportunity to reduce GHG emissions by relaxing delivery time windows, the group decided not to pursue this option immediately for two reasons. Firstly, there is a need to reduce the scope of work for designing and implementing a demonstration project. Setting up an optimization and asset sharing platform will present sufficient challenges for a single demonstration.

Secondly, it is still unclear how customers can adapt and will react to amending delivery windows. Although concepts building on either smart pricing structures or transparent GHG information were explored, the group found that more customer research was needed to define a promising concept for trialling.

While our research found that large sophisticated fleets do employ CVRS software and in some cases, companies have shared assets for specific goods and routes, there is plenty of potential to expand the use of these measures across the sector. Given that the majority of road freight is moved by small and medium sized companies, it is critically important to be able to provide low cost access to cutting edge CVRS systems.

Another important innovation being pursued by the companies at WBCSD is the optimization of shared assets across companies. In effect, applying sophisticated CVRS to multiple companies' assets as if they were a single fleet. This concept is illustrated by the figures below:

Figure 2: Single fleet: One vehicle, one company's delivery. This is the status of most fleet operations and only optimizes the route taken by a single fleet.

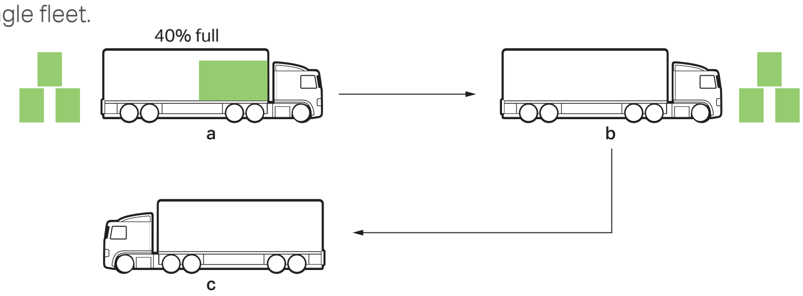


Figure 3: Freight exchange: One vehicle, two companies' deliveries. This is the service provided by several more recent companies. These existing offerings find sharing opportunities between two fleets on the basis of "pre-optimized" (or simply pre-planned) routes.

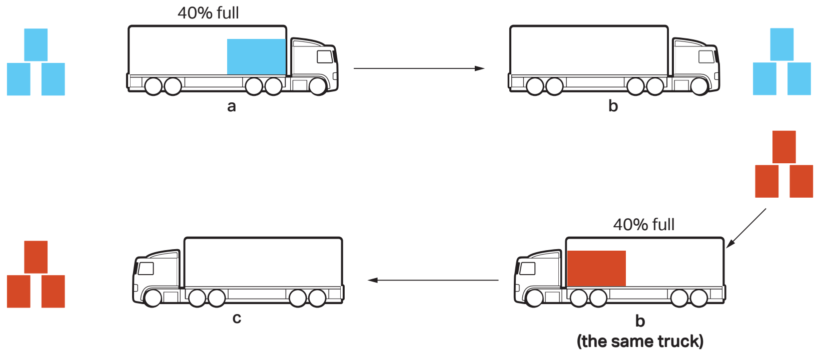
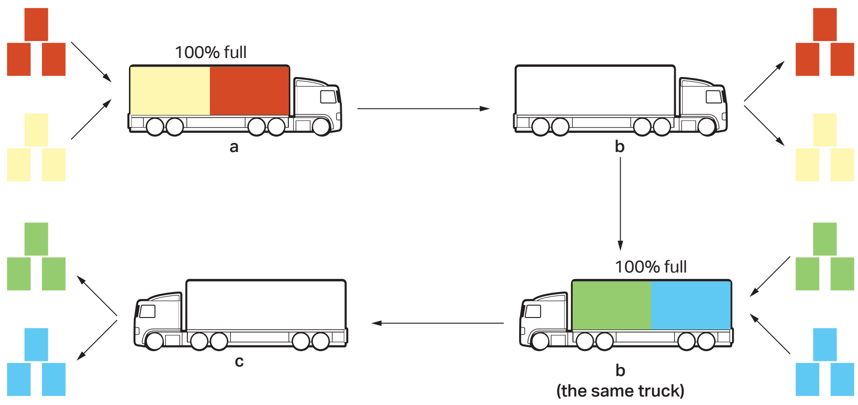


Figure 4: Road Freight Lab platform: One vehicle several companies' deliveries. This is being developed at WBCSD.



The asset sharing benefits from the Road Freight Lab platform are entirely about a different process that combines the two preceding examples. We will optimize routes for several fleets together, including sharing opportunities as part of the optimization process. The four main steps of the process are to the right.

- Fleets provide their data to the platform
- Platform knows each fleets' sharing rules and arrangements
- Platform jointly optimizes the fleets, optimizing route and sharing opportunities together
- Platform provides the results: a route for each fleet, indicating sharing opportunities used

The idea: learning from the power sector

The freight sharing and optimisation platform concept draws heavily from the design and operation of demand response (DR) systems within the power sector. The most successful DR systems aggregate a wide variety of assets across customers with an objective of creating a level available capacity curve over time. This enables the DR operators to respond when called. Similarly, the Road Freight Lab platform will need to reach critical mass of compatible fleets and customers to create value across the system.

Another important similarity worth mentioning is how successful DR operators have created "opt-out" rather than "opt-in" systems. At first, customers opt-in few assets, but as they see no negative impact on their operations, more assets (or time) are opted in. The management of participation within the DR system with several assets is simplified by using rules rather than reviewing every event.

Over time, the number of assets active within the DR platform is increased and the rules determined by the customer allow more frequent use of their assets by the DR operator.

These two design principles, along with several other lessons from the power sector have informed the design of the Road Freight Lab platform.

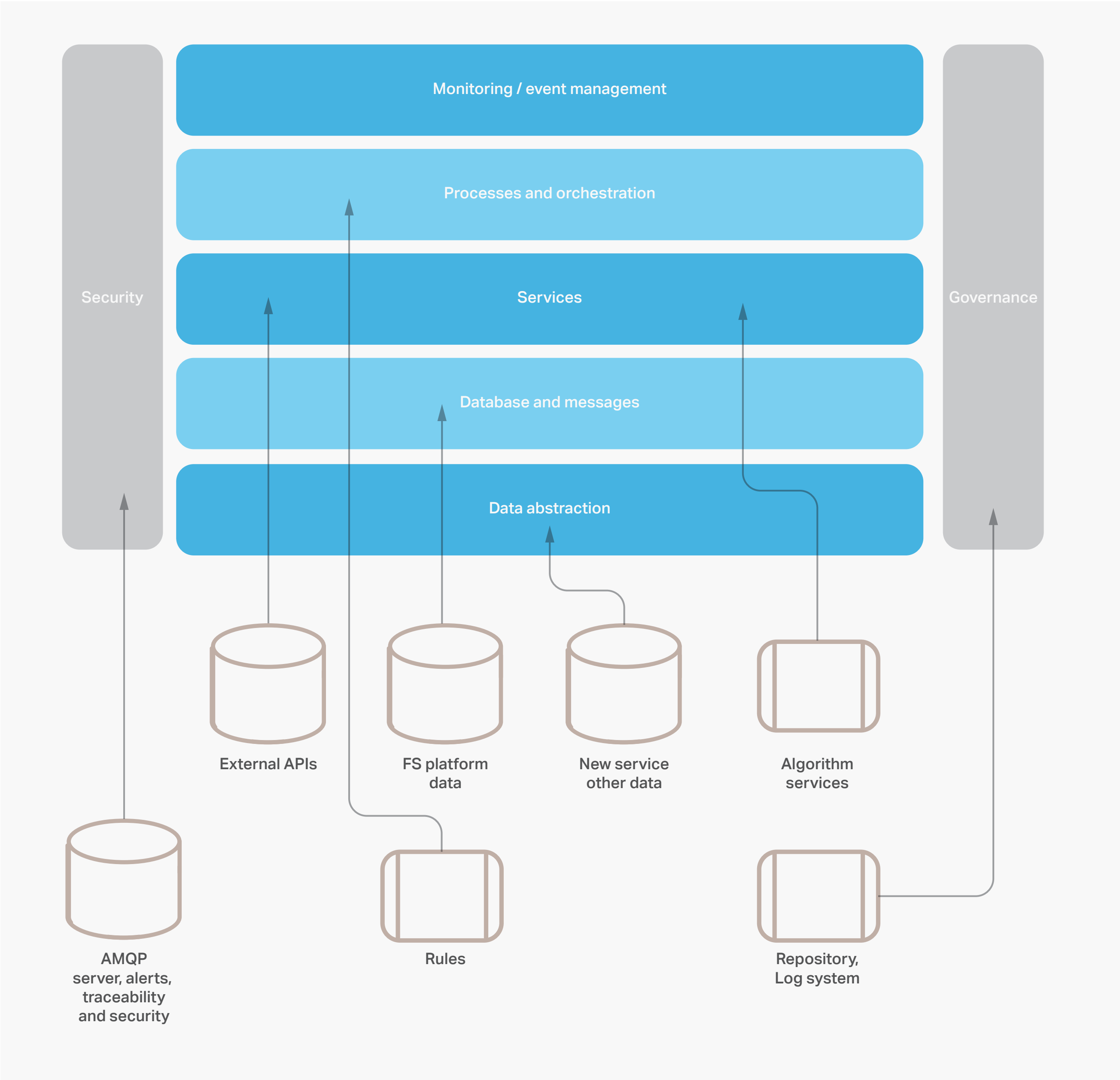
An advantage of the power system, however, is the movement of a very homogenous commodity, namely electricity. This contrasts sharply with the freight sector that must deal with goods ranging from perishable food to heavy machinery. Indeed, it is expected that the main challenges of designing and demonstrating a successful Road Freight Lab platform will be operational. The question of how to set the rules for compatibility of goods on the same vehicle must be determined. Similarly, access to 3rd party distribution centres or loading bays must be secured. The solutions to these and many other operational challenges will be explored during the course of a demonstration project in 2017.

3. **PLATFORM OPERATION** AND ACHITECHTURE

The FreightShare Lab platform will be built based on Service Oriented Architecture (SOA) and an open standard approach to interfaces and communication protocols to ensure that the system layers are independent and server applications with new and updated services can be seamlessly deployed.

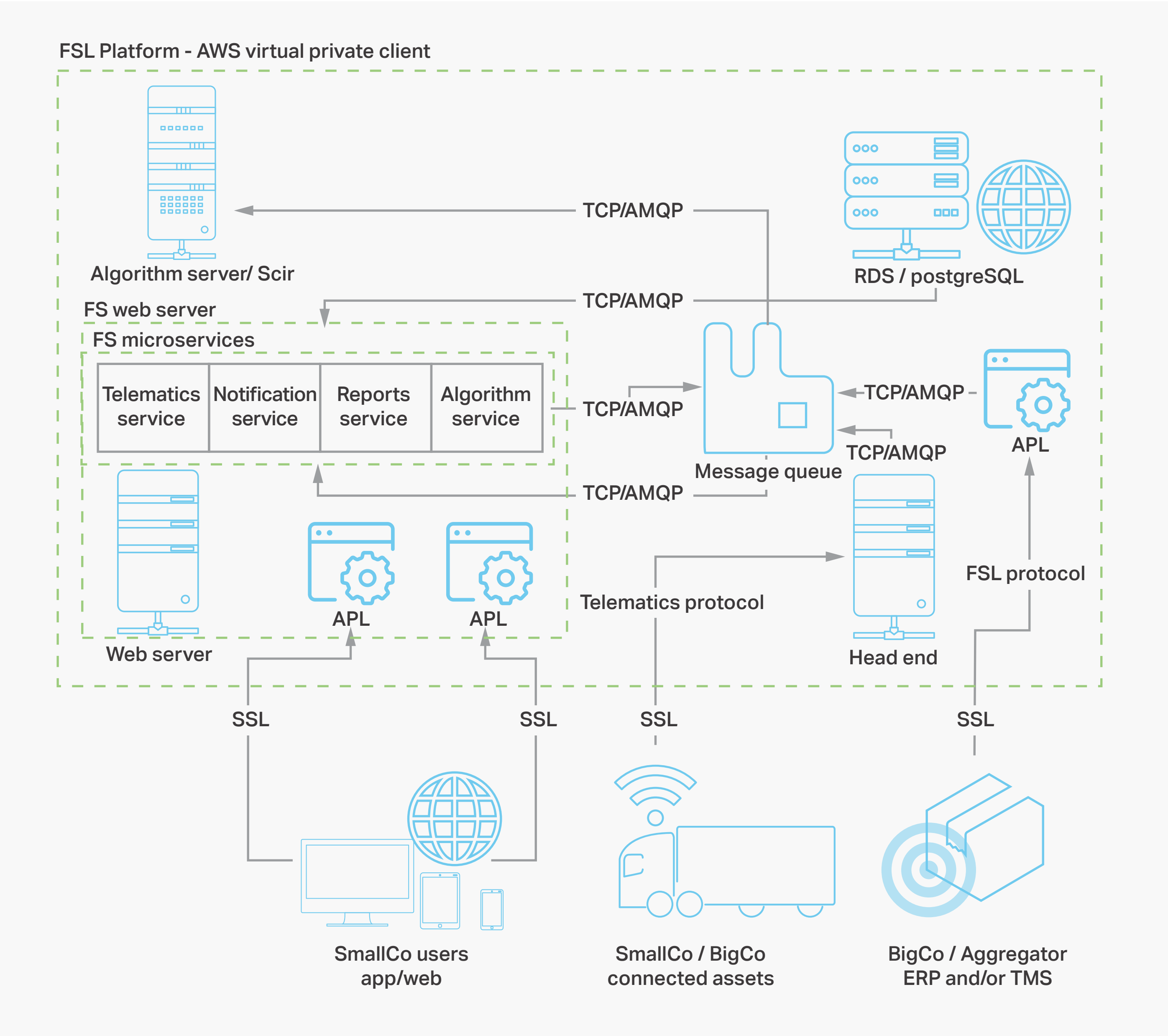
Generic SOA platform diagram of FreightShare lab and architectural principles are shown in the figure below:

Figure 5: FreightShare Lab Architectural high-level Principles (Service Oriented Architecture)



The architecture of the Freight Share Lab platform and its system context diagram is depicted in figure 6 below and further described in chapter 4.

Figure 6: FreightShare Lab System Context Diagram and Architecture



Integration

This section describes the integration approach to both internal and external interfaces.

External interfaces

This platform includes three basic types of third party system integration:

a. **Big Co or Aggregator of freight** – this interface ensures that a system which connects to a Freight Share (FS) platform and already contains an algorithm to identify which routes and assets have freight sharing potential, searches the FS lab database of uploaded schedules and identifies the match (this can be done by the FS lab or the Integrating 3rd party, depending on the design decisions).

b. **ERP system or TMS system of a Big Co** – this interface serves as an automated feeder of selected information to the FS platform. ERP data will be updated periodically, will be event based (integrating party will have settings available on the frequency and type of update) and will include mainly the following information:

   i. Asset information
   ii. Schedules
   iii. Business rules
   iv. Pairing rules and constraints

c. **Third party optimization engine** – third parties will be able to connect their optimization engines as server applications that can be accessed by users via a web service (or another means). These applications will have access to the schedules and asset information uploaded by fleets. They may require their own additional information and may connect or provide a separate user interface, where the fleets that select their services can choose their preferences and how their load should to be optimized. These applications will be connected to the service layer of the FS platform and all executed transactions will be subject to monitoring and reporting on the platform level.
   All data inputs will be provided in the same unified way due to the data abstraction layer. These applications can use FS lab user interfaces or provide their native ones. In case of separate user interfaces being used, the data from these will be subject to data abstraction layer adjustment to allow transparency for monitoring and reporting.

Internal interfaces

The FSL platform will have the following internal interfaces:

a. **Web portal** – web server hosting the FSL portal will integrate with the FSL platform, this will be the primary user interface of the platform.

b. **Mobile application** – mobile application will be connected to the web server, so that all rules and processes, including the connection to the database and the algorithm are implemented only on the web server and the app makes use of the information.

c. **Algorithm** – algorithm will be hosted on a separate environment and integrated with the FSL platform. The optimization inputs will be sent to the algorithm in form of files. The rules and periodicity of the interactions between the algorithm and FSL platform, as well as the event management (triggers of the algorithm), will be adjustable through the web portal.

d. **User database** – for security reasons, the user information database will be hosted separately and accessed by the web portal and matched with other events and real-time information.

e. **Message queue** – all information and message flows among system components will be realized through a message queue, to ensure traceability and accountability of all transactions.

All internal interfaces to these components are depicted in figure 6 above, the platform architecture and system component diagram.

Robustness of the environment and security

The platform will be deployed on Amazon EC2 elastic cloud servers (AWS) with scaling, load balancing and queuing technology to ensure performance and user experience is optimal and no degradation of service is possible. From the security standpoint, the platform will be accessible from its frontends over secure connection with SSL certificates.

Connectivity of the FSL platform with devices in the field (telematics/ on-board units)

The cloud based integration layer of the platform (data services and messages layer in the architecture) will enable a multitude of connection points from hundreds of backend systems over publicly exposed APIs. The data exchange formats will be published and available to business users. Based on experience, we will build the platform such that the complexity of the data exchange formats is minimal.

Overview of the development approach

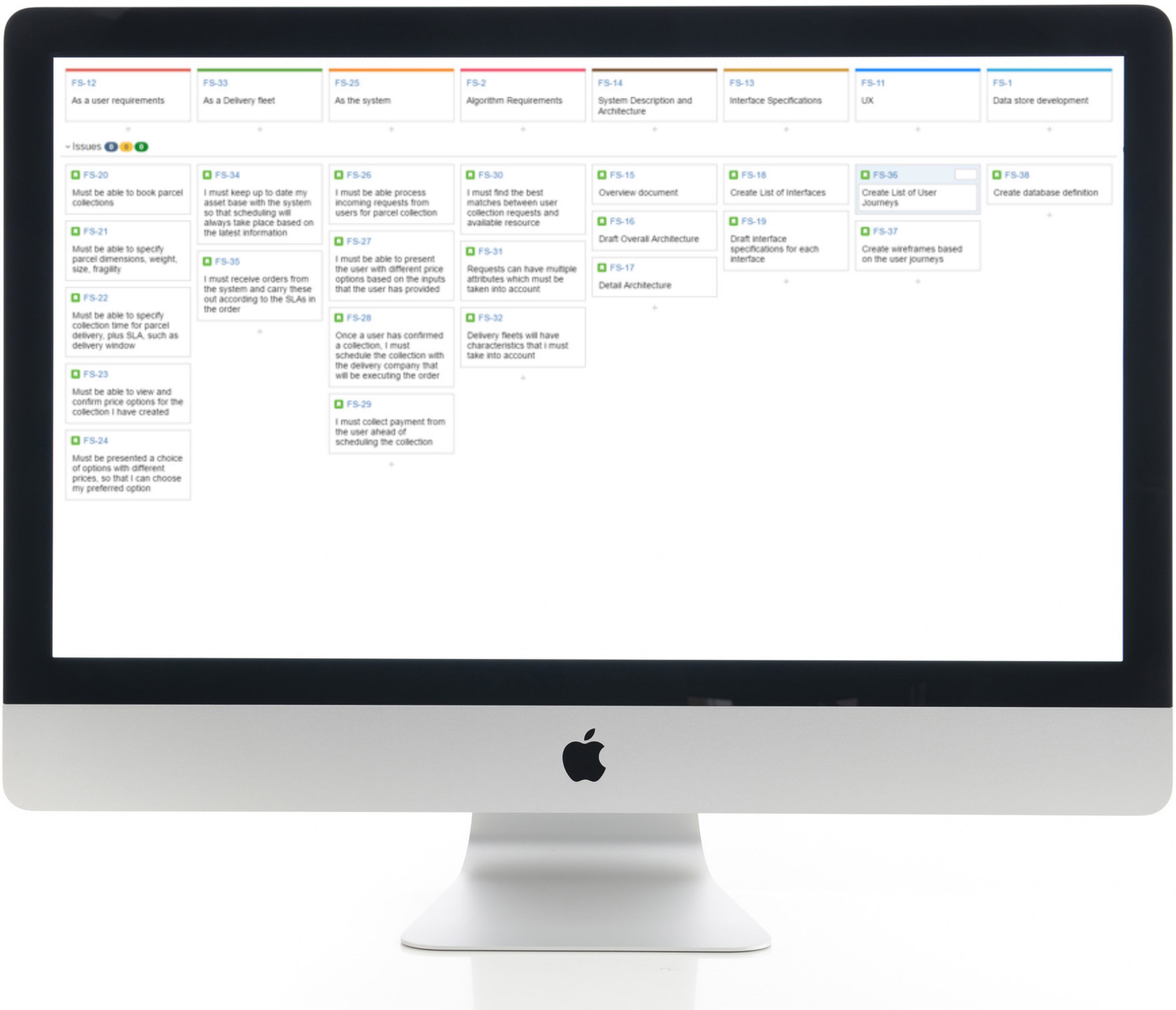
Agile development to the requirements

We envisage an agile development approach to enable rapid development of a minimum viable product (MVP) system that can be extended as the project progresses. Screenshot in figure 7 shows an initial task list for this system (Day 1 approach) – initial set of requirements for the platform.

Approach to integration and design of interfaces

We are looking to take an agile approach to interface design as well, agreeing APIs in an ongoing fashion and based on the current level of requirement, with some forward planning to ensure that additional features can be accommodated where it is clear that these will be needed in the near future.

Figure 7: List of the initial requirements for the FSL platform (how does the team start on day 1



Users and registrations

This is a business-to-business platform where users or actors can be divided into two groups based on their type of interaction

a. **Big Co / aggregator** – large companies, or freight aggregators, which can integrate their own systems with the FSL platform

b. **Small Co** – smaller companies or launching users looking to trial the platform, which would make use of the native user interface (app and web portal) to communicate its availability or demand

Registration of the users will undergo a process that needs to be defined to enable the Fleet Marriage algorithm to identify likely matches of participating users. This will then be used to provide the automated demand / supply matches or suggestions for matches (based on settings).

Supply demand matching process

Shipping demand

Companies with shipping needs can sign up to the FreightShare Lab platform and upload their shipping requirements in two ways:

1. **Individually** – this can be done for individual ad hoc jobs on the day

   i. Manually through FSL web portal or app

   ii. Automated via the standardized interface or

2. **Bulk** – this is expected to be done mainly by integrated ERP and TMS systems in the form of upload and maintained during the day automatically. For fixed schedules, this could be done manually as well, but needs to follow rules (posted demand needs to be accurate during the day, otherwise the shipper will lose credibility)

The platform then performs an algorithmic matching of available supply of spare logistics capacity and returns a number of options to the operator of the platform. The algorithm then either selects an option or pre-selects near optimal options based on pre-configured rules and confidence levels that need to be set up. Once confirmed, the shipment is scheduled and the chosen logistics operator informed.

Vehicle supply

Logistics companies typically schedule a day's work the day before, assigning shipments to trucks and vans, with the aim to utilize the vehicle, keep to agreed delivery SLAs, as well as weight and size restrictions and run duration.

1. **Shipper's pull** - where free capacity, as well as time, is known, this information can be made available by the carrier's system to the freight share platform (either automatically, or manually). The resulting "snippets" of vehicle availability are then accumulated in the platform across all member logistics suppliers and can be:

   a. Identified by the algorithm to suggest a match, or

   b. Picked up from by the shipper's operator directly

2. **Carrier's push** - in a second mode of operation, a market mode posts the shipment request onto a market of logistics operators with relevant parameters, such as weight, delivery time requirement and cost willing to accept. Any shipper operators taking part in the market are then able to claim the shipment request

   a. Directly (buy now option), or

   b. Via a bidding system (this would be an optional enhancement to the platform)

Fulfilment

Shipments agreed through the platform are confirmed to both shipper and operator for fulfilment.

4. BUSINESS MODEL

Customer segments

RFL has three main customer segments: small fleets, large fleets and aggregators. Each has dissimilar problems and face different barriers to become more sustainable and save cost. For example, cost presents a large barrier to SMEs with regards to the use of advanced optimization software. Generally, the licencing fees for use of advanced ICT tools are high and thus many SMEs cannot afford to use them. Large companies are being put under immense pressure to decrease their emissions. However, data privacy and fear of the competition are restricting them from moving towards a big data system and from further optimizing their fleets. Thirdly, a lack of scale prevents current freight aggregator companies from achieving economies of scale.

Channels to market

RFL will have several channels in place to manage the three different customer relationships and scale the platform. A digital cloud-based platform will act as the primary channel for SMEs. Large companies and aggregators will have the option of using the digital channel, however, most can be expected to opt for backend integration with their existing ERP system. This integration will be provided at a fee.

In addition, key partnerships and WBCSD's network of companies will be a valuable resource to ensure the growth of RFL.

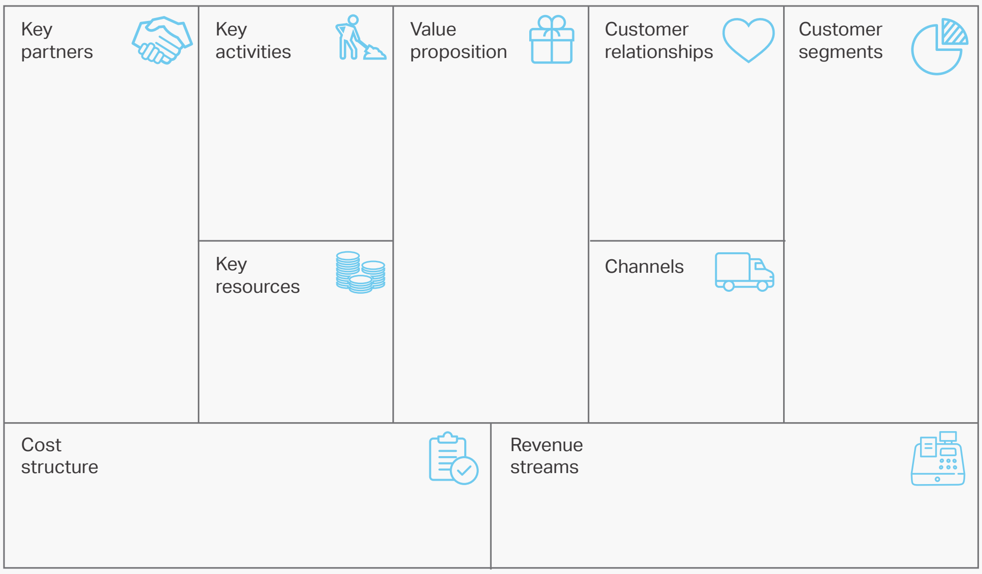
Customer relationships

The success and penetration of RFL into the freight industry will rely on creating, capturing and maintaining good relationships with customers. For casual users, RFL eliminates the cost burden of advanced ICT tools and gives them the opportunity to use the platform ad hoc. It is key to foster relationships with high-volume users of RFL and ensure there are clear channels of communication. The high-volume users will form the backbone of the RFL user base. Larger fleets or aggregators that need to build an API with their ERP systems will require a fast and efficient transition from their current operations to using the RFL platform. To ensure a smooth transition, RFL needs to have sufficient staff (or contracts in place) to offer this service. RFL is constantly engaging with current aggregators to ensure that their needs are addressed in the development process. Group meetings and open discussions during development and build will be important in fostering and growing these relationships.

Value proposition and benefits to customers

RFL provides a tailored value proposition to our three categories of customers. All customers benefit from having a platform that can provide centralized logistics helping simplify operations.

Platform features, which aim to improve customer



The business model canvas is a strategic management template which can be used for developing new or documenting existing business models. The elements, contained in the business model canvas, such as value proposition, infrastructure, customers and finance have been used to structure the business model for Road Freight Lab (RFL). Using this structure ensures that all important factors which will impact the success of RFL are considered.

efficiency, include direct online platform payments as well as tracking of shipments, compliance, driver training with feedback and easy reporting.

Reducing transport and distribution emissions is becoming increasingly important due to the stricter regulations on air quality combined with access to urban centres, Scope 3 GHG emissions reporting and the Science Based Target of reducing transport-related CO_2 emissions by 48% by 2050.

Small operators have the most to gain from using RFL. They will have access to more jobs, their margins will improve with increased utilization rates and RFL gives SMEs the opportunity for new business development and marketing. Similarly, large fleets gain access to further jobs, however, the true added value is the ability to reduce their costs (reducing fuel and trip times) and CO_2 emissions by an average of 20%. To add value to all stakeholders along the distribution supply chain, the business model sought to include current freight and logistics aggregators. Value delivered to aggregators are in faster delivery, broader geographic coverage, and economies of scale.

Key activities

Following on from the platform operations explained in Section 4, the key activities are primarily focused on actions carried out by the RFL and the outreach required to commercialize and scale the operations. To scale, importance will be placed on the channel and partner management as well as investing into creating robust technology.

Moreover, the platform will rely on the key activities of acquiring and processing a company's static and dynamic data. Freight matching and optimization will also be a key activity as well as managing the transactions taking place on the platform.

Key resources

Key technical talent provided by the participating companies, IP, project management staff and coordination staff will make up the key resources for RFL. Server space will be key in realizing the cloud-based platform. In addition, the use of participating companies' fleets in the demo of the platform will play a central role in the success and scale up of the RFL project. WBCSD and partners will provide critical stakeholder network access and dissemination to potential clients.

Key partners

RFL's credibility and the ability to realize its ambitious objectives stems from the diversity of partners assisting in the scoping, design and implementation phases of the project. RLF has worked with the following core partners in designing a UK-based trial:

- *Heriot-Watt University, Road Transport Media, Smart Freight Centre, Transport Systems Catapult, WBCSD*

RFL has been working with the following companies who act as developers and customers in designing a UK-based trial:

- *BT, Ecodesk, Michelin, Nestle, Route Monkey, Travis Perkins, UPS*

The dissemination and network required to ensure RFL is successful relies on organizations such as RTM, SFC, WBCSD. Platform development will rely heavily on organizations such as Route Monkey and Transport Systems Catapult. Aggregators such as Loadfox, Quicargo, Xchange, and shippers will also play an important role in helping design the platform for value-added use by aggregators as well as bringing potential transaction volumes to the platform.

Costs and revenue streams

Two revenue models were explored, the transaction and subscription fee models. Each present different pros and cons. A transaction based model has a lower barrier to entry and can thus help build scale quickly. On the other hand, a subscription based model allows more sophisticated offers that package different value adding products and services while bringing incentives for high transaction volume clients. A simplified image outlining the potential revenue streams can be seen in figure 8.

The present revenue streams shown in figure 8 are based on a transaction fee model.

In the future, data gathered on the platform can be leveraged to generate further revenue streams. For example, the data insights on the vehicle and driver performance can be monetized with fleet operators or insurance companies. When a substantial part of the freight and distribution industry use the platform, it could be leveraged to assist in traffic flow management. This could potentially be a large revenue stream due to traffic congestion on average costing countries 2% of annual GDP. A further revenue channel is targeted marketing campaigns.

Figure 8: Potential present and future revenue streams from Big and Small Co.

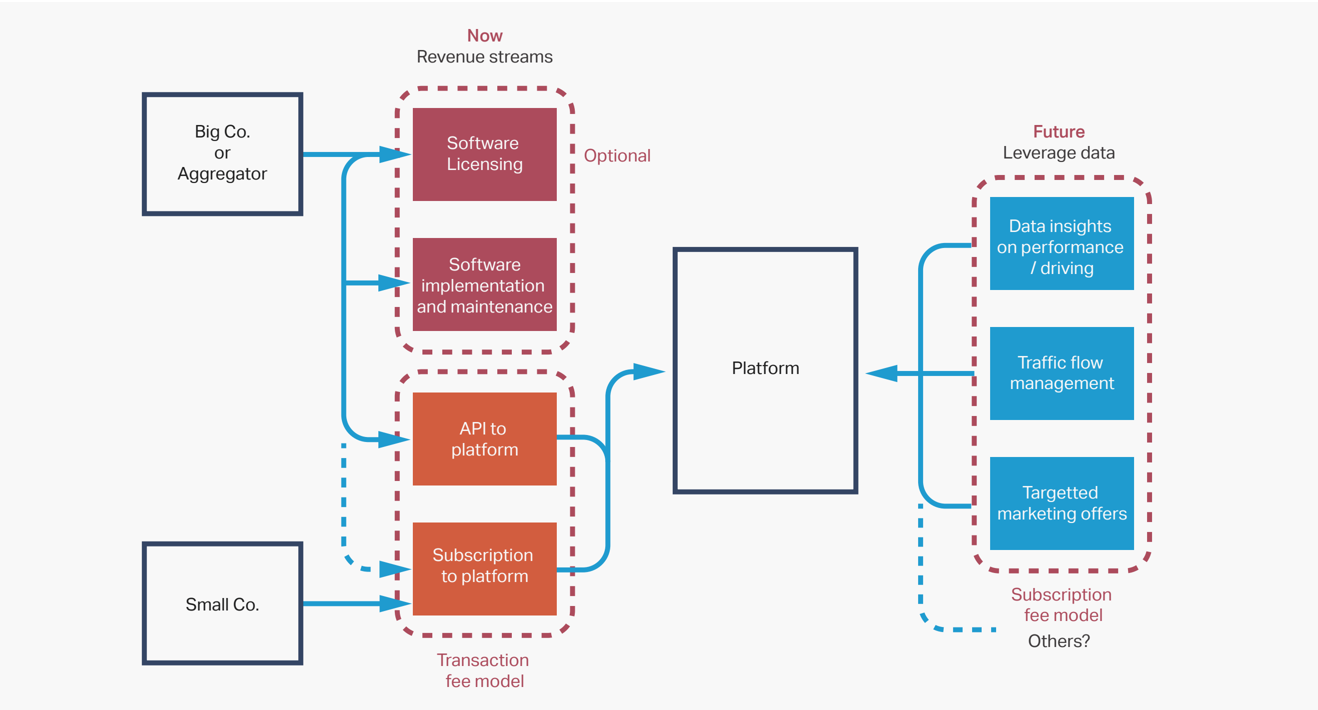


Table 2: Estimated costs in year 1

ACTIVITY	COST
Labor/overheads	635,637
IT Software	15,000
Hardware	25,000
Research	7,500
Communications	18,300
Travel & subsistence	17,850
Total project cost	**£719,287**

Table 3: Estimated costs in year 2 (ongoing running costs)

ACTIVITY	COST
Management (1 FTE)	120,000
Operators (2 FTE)	15,000
Marketing Comms/PR	50,000
Administration/overheads	100,000
Server/hosting	20,000
Licences	100,000
Data/Algorithm refinement	50,000
Total ongoing costs	**£540,000**

The estimated revenue calculations have been based on assumptions for large fleets and the average fuel savings potential results from the first RFL report.

Per trip	Fuel price (GBP/L)	1.169
	Average trip (km)	85
	Average fuel consumption (L/km)	0.22
	Road Freight Lab fuel saving	20%
	Cost saving (GBP)	£4.37
Per truck	Number of trips per year	571
	Cost saving (GBP)	£2,496
Per fleet	Average fleet size	58
	Cost saving (GBP)	**£144,794**

The revenue generated is based on scenarios for various margins retained from the cost saving made possible to each fleet.

Table 4: Estimated revenue generated under different scenarios

MARGIN RETAINED	PER FLEET (£)	PER TRIP (£)
3%	4,344	0.13
5%	7,240	0.22
10%	14,479	0.44
20%	**28,959**	**0.87**

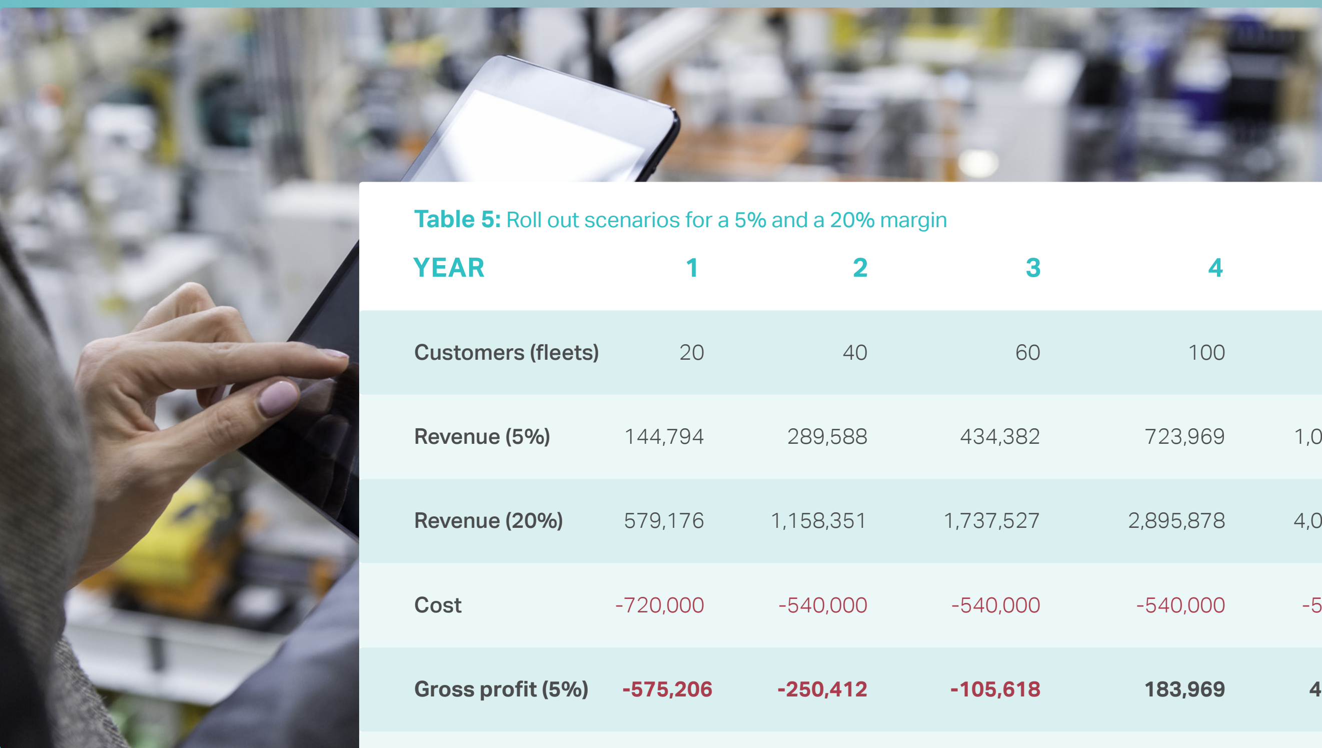


Table 5: Roll out scenarios for a 5% and a 20% margin

YEAR	1	2	3	4	5
Customers (fleets)	20	40	60	100	140
Revenue (5%)	144,794	289,588	434,382	723,969	1,013,557
Revenue (20%)	579,176	1,158,351	1,737,527	2,895,878	4,054,229
Cost	-720,000	-540,000	-540,000	-540,000	-540,000
Gross profit (5%)	**-575,206**	**-250,412**	**-105,618**	**183,969**	**473,557**
Gross profit (20%)	**-140,824**	**618,351**	**1,197,527**	**2,355,878**	**3,514,229**

Although the above figures look very promising, it's important to remember that this is assuming a full 20% cost saving per fleet by using the platform. This assumption is based on a high number of optimisation and asset sharing opportunities. Given the operational constraints mentioned in Section 3.2, it may be some time before the platform nears the theoretical capacity to optimize and share assets.

5. MARKETPLACE AND COMPETITOR ANALYSIS

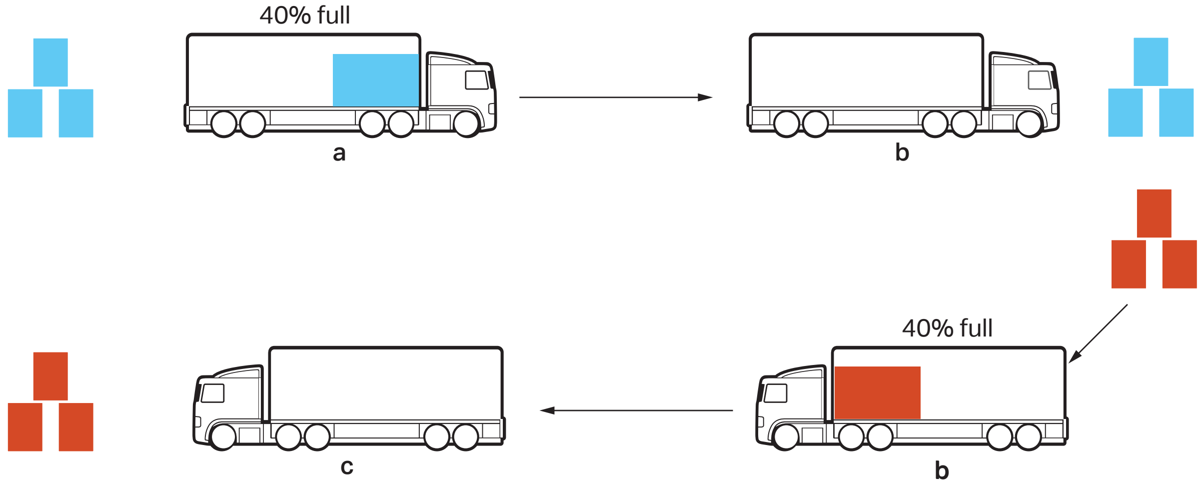
How our idea is different from the competition

Companies who focus on optimizing freight transport primarily fall into three categories, connecting shippers and carriers, providing a matching service and route planning and optimization. There are a few exceptions and in this case, we have categorized them as other. A sample of potential competitors and the region in which they operate can be seen in table 6.

Table 6: Potential competition and the regions in which they operate

GROUPING	COMPANY	PRIME REGION
Connect shippers and carriers	Transporeon	Global
	Transfix	USA
	Cargomatic	USA
	Timocom	UK
Matching service	Tgmatrix	UK
	Coyote Logistics	USA
	Keychain Logistics	USA
	Quicargo	NL, Israel
	Plantools	USA
	Uber freight	USA
Route planning and optimization	Paragon Routing	UK/USA
	Eye Freight	Europe
	Routific	USA
	Descartes Route Planner	Global
Other	UberRush	USA
	Aeris	Global
	3T Group	UK

Figure 9: Current solution matching freight with empty backhaul journeys, one vehicle services two company's deliveries in two journeys.

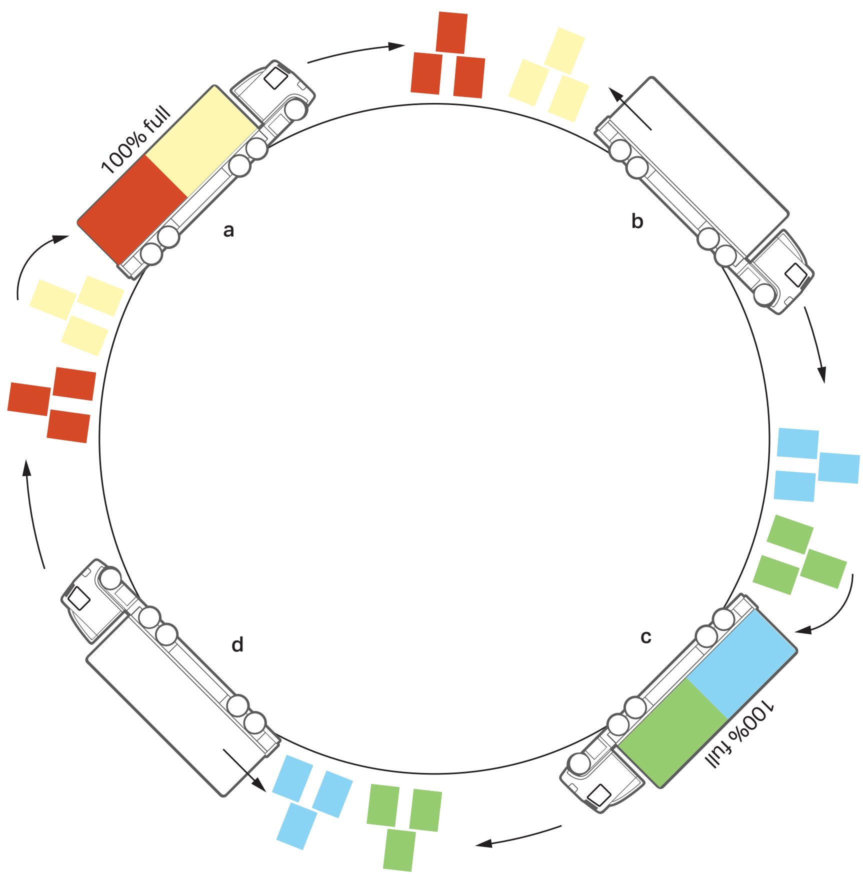


Road Freight Lab has simply created a platform where companies can share trucks and loads thus optimizing every truck journey as seen in figure 10. The RFL brings multiple companies and freight exchanges together and optimizes all of them as if they were one fleet. As mentioned in Section 2 of this report, this type of operation can result in a cost savings of 20% and a reduction of 32% in the company's CO_2 emissions.

The value of an open platform

The findings from report 1 show a substantial reduction potential in emissions. Providing an open platform is an important design principle as this allows maximizing emissions reduction potential and creating opportunity for third parties to leverage the platform to enhance their own customer offers.

Figure 10: Road Freight Lab platform: One vehicle several companies' deliveries. This is being developed at WBCSD.



While the RFL platform may compete with other existing aggregators or CVRS providers, it has the potential to play a differentiated role within the ecosystem of road freight logistics planning and execution. As such, we have designed the architecture of the RFL platform to allow either freight exchanges, CVRS companies or other "application layer" companies to continue to offer their own targeted customer value propositions (CVP) and even build upon the capability of the RFL platform to further enhance their CVPs (see illustration below).

It is in this manner that the potential of the market to drive innovation and ever increasing GHG reduction performance is enabled rather than inhibited by a single large player in the market.

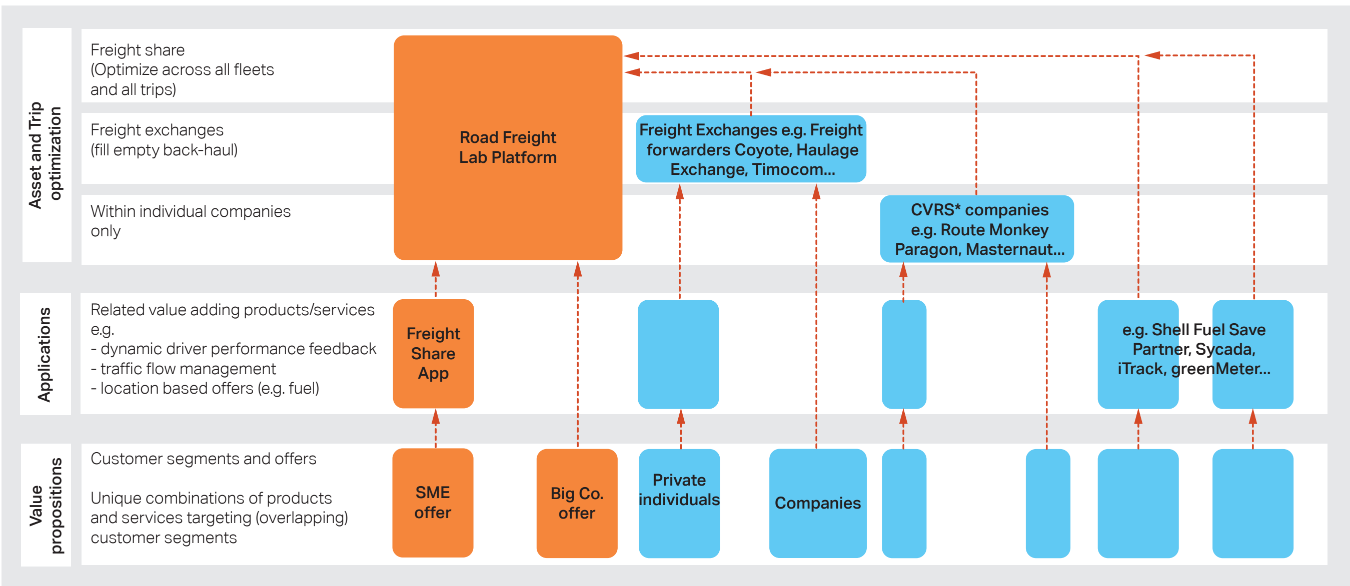
Trial location selection

There are three key elements to selecting a suitable trial location: Market readiness, strategic fit and available external funding.

In terms of market readiness, we selected eight indicators to assess the market and regulatory ecosystem in each location. These indicators are summarised below:

- **Truck emission targets:** Assessment of the extent to which delivery vehicle emissions are regulated or planned to be.
- **Truck access restrictions:** Assessment of the extent to which vehicle access restrictions are in place for road use (based on time of the day, zoning, vehicle emission standards etc.) or planned
- **Carbon pricing measures:** Assessment of the extent to which carbon pricing measures are in place (or planned) including e.g. fuel taxes, tolls, corporate reporting etc.
- **Green logistics initiatives:** Assessment of the extent to which relevant freight/transport initiatives are already underway (e.g. US Smartway).
- **ICT connectivity readiness:** Current penetration of smart phones and smart infrastructure including live transport data exchange platforms.
- **Pro-innovation & experimentation:** Government policies and support available for transport/ICT R&D or demonstration and private sector capacity to innovate.
- **Alternative fuel vehicle initiatives:** Assessment of the extent to which alternative fuels are deployed or planned, including public support available.
- **Private fleet sharing initiatives:** Assessment of the extent to which precedents exist for vehicle fleet or freight infrastructure sharing.

Figure 11: Illustrative open architecture of the Road Freight Lab platform



*Computerized vehicle routing and scheduling

Each location on the "long-list" of potential trail locations was scored across these indicators with one point being the lowest and five points being the highest score possible for each. These scores were then summed.

To assess strategic fit, each participating company was asked to indicate how each location matched with their current resource base and market strategies, using the below criteria which will be critical to a successful trial:

- Availability of subject matter expertise and local staff resources to execute the trials
- Availability of vehicles and infrastructure to execute the trials
- Existing strong relationships with local government
- Existing relevant trials or demonstration projects
- Existing strong relevant customer or supplier relationships

Based on the strategic fit criteria, each location with a match was awarded a further 10 points to its total score. Based on this methodology, two locations scored over 40 points. These locations along with their scores are shown below:

Table 6: Breakdown of points scored for the top 2 trial locations

	Los Angeles	London
Truck emission targets	5	5
Truck access restrictions	2	5
Carbon pricing measures	2	5
Green logistics initiatives	5	4
ICT connectivity readiness	5	5
Pro-innovation and experimentation	4	4
Alternative fuel vehicle initiatives	5	2
Private fleet sharing initiatives	2	3
Sub-total	**30**	**33**
Strategic fit	Yes	Yes
Sub-total	10	10
Total	**40**	**43**

Necessary agreements for trials

The question of agreements such as Memoranda of Understanding (MoU), Non-Disclosure Agreements (NDA) and supplier contracts was agreed not to be relevant at this stage of the demonstration project design. The main argument in favor of delaying these discussions was that external funding has terms and conditions which may dictate or over-ride any agreed strategy on these topics. The member companies agreed that this work stream should be kicked off only once external funding was secured. As such, the current agreement between members was kept in place, namely:

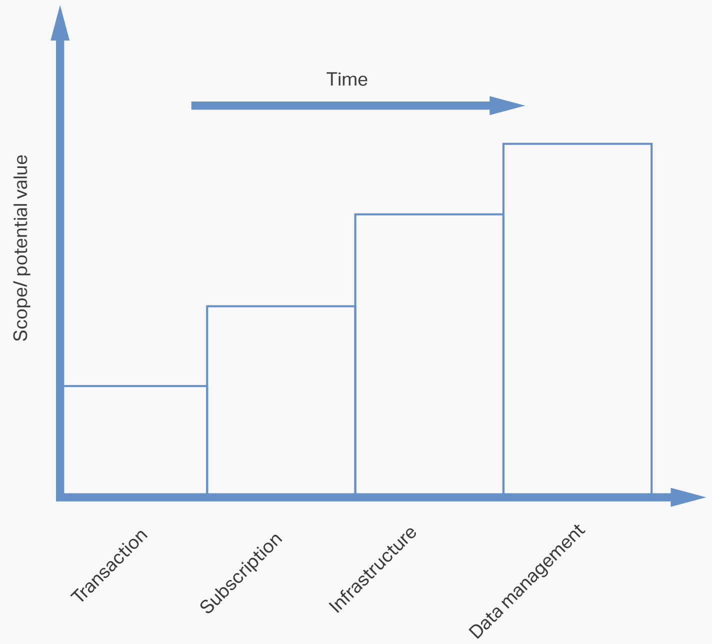
"Given the collaborative nature of the project, it is expected that information and insights will be shared freely between project participants as well as with partners and stakeholders."

"We request all project participants not to share any proprietary or other information that they would not want to be made public."

6. **A LOOK INTO** THE FUTURE

There are many avenues to generate future revenue and value. A visual of a strategic staircase depicting possible avenues according to their potential added value can be seen in figure 12.

Figure 12: Avenues that will create present and future value



A transaction fee model will be used at first to build scale and trust between customers and the platform. By using this model, we remove the cost barrier and the sense of commitment the customer must make. After growing the user base and building a strong reputation for delivering results, a subscription based model can be introduced. This model will give the RFL improved revenue stability since the revenue does not rely on how many trips each customer makes. This also allows innovation in CVPs through the packaging of products and services in customer offers.

A following logical step in this model is to build out relevant infrastructure such as co-parceling sites and could also help to build out alternative fuel and EV infrastructure. Such sites already exist, usually at the periphery of major urban centers but have not been widely adopted. The most significant value may be when there is a critical mass of users and the data can be leveraged and used for tasks such as active traffic flow management and other high-level tasks.

7. RISKS

The commercial, operational and technical risks can be seen in tables 7 to 9.

Table 7: Commercial risks facing the Road Freight Lab

COMMERCIAL RISKS	IMPACT (H/M/L)	MITIGATION
Project cost	H- Having sufficient funds and time to fully develop all aspects of the project is paramount to the final product and its commercialization.	Careful resource planning and weekly review meetings to ensure the costs of the project stay on track will mitigate the risk of overspending. However, we feel to give this task the time and resource necessary to make it highly successful.
Fleets see no benefit in participating	H- if Fleet owners, our target audience, do not understand what the platform can do for them, there will be no customer base.	By offering a pay as you go service; the service will be self-funding from the outset and mitigate the risk of low use. The innovate funding brings the advantage of bridging the cost between design and development of the platform and its operation. Funding also de-risks the ramp up phase of the operation, therefore fleets will have demonstrable benefits from pilot participating companies.
Lack of data	H- Data modeling is an approximation of a real scenario. The accuracy depends on robust and defensible methods, appropriate assumptions and accurate data.	The analysis team selected for this project is highly experienced in the development of scheduling and optimisation applications and emissions models for cities and institutions. We have specifically chosen our team based on their technical expertise. Our model will be based on recognized logistics modelling and real-time optimization methodologies. All assumptions will be checked with stakeholders to ensure the robustness of the model. Initial data will be carefully reviewed by our analysts before input to ensure accuracy.
Competing platforms	M – the competition of the platforms or incorrect setting of the market may have a slowdown effect and impact the ramp-up phase of the platform.	Our carefully considered and chosen consortium and main sector representatives from logistics and transport industries are representing in it. We also do this jointly with Transport Systems Catapult, who has recognized the need to operate such platform independently from software vendors and enable transparent and fair access to all businesses to support and maximize value under public control. These measures provide a reasonable guarantee to boost the freight share ecosystem.
Failure to build eco-system	High-impact risk due to the crucial nature of the ecosystem and technical platform co-existence.	Similar to the risk mitigation of competing platform, this proposal suggests a transparent approach. Multiple competing service providers and vendors will have access to the businesses on the platform. This will ensure the best value for the participating fleets and shippers. Under such circumstances and together with the dissemination and public sector as well as international support, we believe in creating a vibrant eco-system so needed for a success of this project.
Regulation changes	M – due to need for platform rules and optimization constraint change impacting the freight share rules.	Can be addressed by architecture allowing for agile development to conform to changes during the operation. The impact to stakeholder structure needs to be assessed and mitigated separately.
Insurance/ contracts/driver contracts	M	Examine existing business models and commercial agreements to identify best practice.

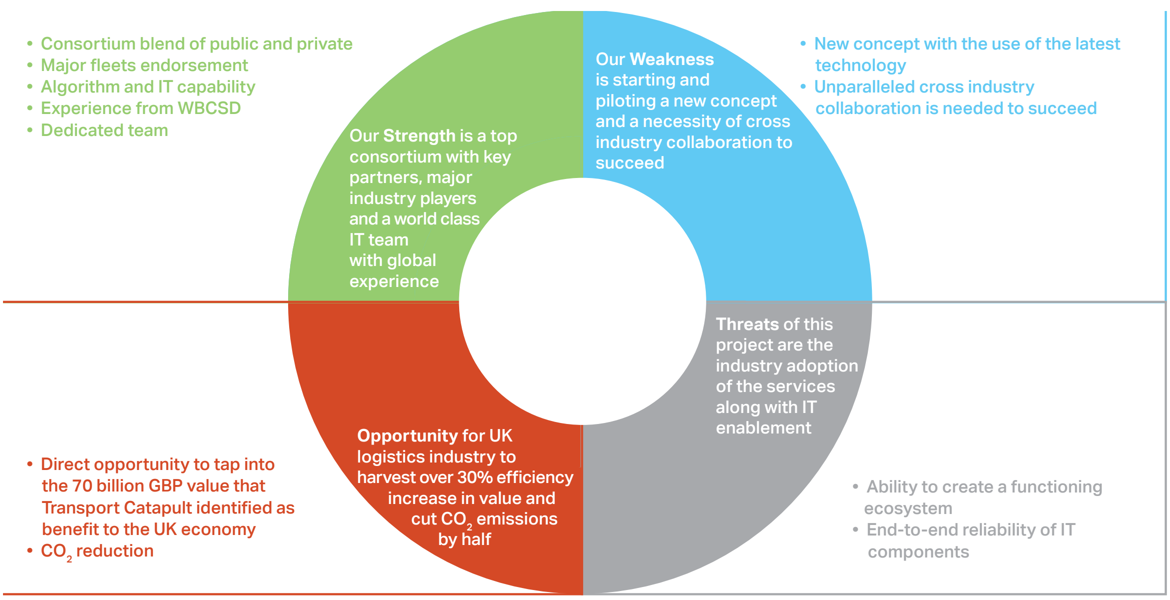
Table 8: Operational risks faced by the Road Freight Lab

OPERATIONAL RISKS	IMPACT (H/M/L)	MITIGATION
Hardware integration issues	H	HW integration strategy and strict execution
Security breach during operation	H	Penetration testing and methodology ahead of the launch of the pilot, as well as the pilot itself, which will serve as a testbed to log and mitigate any security breaches.
Support failure	H	SLAs with independent / tendered IT vendor or system integrator to ensure continuous Level 1, Level 2, and Level 3 support.
Unexpected third party failures	M	IT systems, that are integrated as a third party can cause downtime and possibly operation issues (e.g. connection to telematics backend). The pilot phase of this project will, together with the above-mentioned support failure mitigation, account for the key strategies to minimize any third party systems failure and its impact on this project and the surrounding business ecosystem.

Table 9: Technical risks faced by the Road Freight Lab

DEVELOPMENT RISKS	IMPACT	MITIGATION
Timeline of work packages	H	The timeline for the initial project is tight. Thorough project management, review of architecture by the industry experts from the lead fleets and testing
Migration failures between env's	M	Methodology based on the Route Monkey vast system integration experience
Security breach during development	H	Methodology based on the Route Monkey vast system integration experience and project IT development and best practice coding in secure environments on confidential projects
Management of development environments failure	M	Methodology based on the Route Monkey vast system integration experience
End to end failures	H	End to end testing of the platform with the physical devices. All system components including the algorithms, server applications, enterprise service bus, cloud environment, physical devices head-end, APIs and device firmware will all be subject to multiple scenarios of end to end tests.
Go-live failures	H	End to end testing and sign-off by the consortium partners as well as the lead fleets. The experience of Route Monkey with go-live of multiple large (and B2C publicly co-funded projects) is also vital to ensuring smooth go-live and to mitigate any failures.

Figure 13: SWOT analysis



8. POLICY RECOMMENDATIONS

During the process of developing a concept and working through to the design of a demonstration project, two main principles have become very clear. The first is the simple fact that GHG emissions from freight transport are set to grow significantly in any business as usual scenario. This is primarily driven by expectations of economic growth and therefore demand for transport. The second fact is that climate change is not a rate problem, it is a cumulative problem given the long life of CO_2 in the atmosphere. This is central to the trillionth ton concept that states we cannot emit more than a trillion cumulative tons of carbon into the atmosphere if we are to stay below a 2-degrees average temperate rise compared to pre-industrial times.

Following on from this, and given the complexity of supply chains and local variations, there is also no one single solution to tackling emissions from freight transport. The scale of the challenge to decarbonize freight transport is of such proportions that all solutions must be pursued in parallel. Although there are some solutions which show great promise in reducing emissions, such as electric vehicles powered by 100% renewable electricity, these are neither technically nor economically available to all road freight transport modes, duty cycles, operators and geographies. Since climate change is a cumulative problem, we cannot delay action across other measures while waiting for the perfect solutions. This is why all measures to reduce emissions must be pursued today, while continuing to develop and improve the solutions for tomorrow.

It is in this context that we note a distinct lack of economic and policy activity by either the public or private sector in pursuing the GHG reduction potential possible through both optimization and asset sharing. Through the work of WBCSD, we hope to bring increased attention to this area among business (particularly across fleet owners and operators), policy makers and academia.

Given the sparse information available about such solutions, there is a real case for public funding to explore the possibilities to reduce emissions from the road freight sector but also support demonstration and build out of both virtual and physical infrastructure that can bring these solutions to market. Where possible, policy makers would do well to now envisage the infrastructure necessary to deliver zero emission freight, and use those insights to inform both market and logistics network design. This includes, for instance, the potential need to establish new facilities for collaborative freight handling centers as well as regulation that rewards fleets operators who achieve top tier CO_2 per ton-kilometer performance by deploying a range of measures including those discussed in this report.

CONCLUSION

It is clear from the findings of this report that there is large potential to decrease carbon emissions in the road freight sector through a combination of solutions.

While many previous studies and efforts have focused on alternative energies and vehicle efficiency, we cannot ignore the emissions and energy savings possible through novel approaches including optimization and sharing assets. It is important to highlight the complementarity of different approaches. The measures of optimization, sharing assets and relaxing delivery time windows are additive and together offer the potential for over 50% energy and emissions savings. While some may argue that a priority should be to transition to alternative energies to tackle emissions, we believe that all the measures available need to be implemented in parallel. It will be imperative to reduce energy consumption in addition to emissions from road freight transport as this will support energy security and the ability of the clean energy system to cope with expected demand from different end-uses.

Another consideration in designing markets, policies and incentives is the phasing of solutions. There are readily available solutions to implement immediately and with speed. On the energy side these include fuel additives, so-called "drop-in" biofuels and electric (hybrid) vehicles for urban delivery. For efficiency, we can already ramp up solutions such as low roll resistance tires, driver training and route optimization. These and other early “quick-wins” can and should be implemented widely without delay.

At the same time, more systemic changes that require coordination among several actors and infrastructure investments should start now, recognizing that their full implementation will take longer, but that they must be available in the medium and longer term. These solutions include asset sharing platforms and hydrogen fuel cell vehicles to name but a few.

In each case, the solutions implemented will be chosen by the market and these choices will differ to some extent depending on the local circumstances (such as available resources). Policy-makers should take care to design frameworks that are technologically neutral but serve an environmental/climate outcome. Such an approach will stimulate the market and provide diversity in the solutions available for each end-use case. For the solutions that are pre-commercial and require significant coordination or infrastructure investment, governments can provide targeted incentives to kick-start deployment and market creation.

The findings presented in this report will be taken to the next stage by the companies convened by WBCSD. This next stage will focus on demonstration of a dynamic data and asset sharing platform to enable route and load optimization across multiple fleets of road freight vehicles. This focus has been chosen given the high emission reduction potential identified and the first-of-a-kind nature of collaboration for applying this concept in road freight.

While we will focus on this solution, it will be important to continue efforts on other complementary measures. To tackle climate change and the expected growth in demand for road freight transport, all solutions will be required.

Acknowledgments

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In collaboration with WBCSD
member companies: Michelin,
Nestle, Total and UPS

Under the WBCSD leadership
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