Physical Internet
Efficient Sustainable Logistics
An Open Innovation Initiative

4th International Physical Internet Conference

Towards Hyperconnected Distribution: the Retail Supply Chain Reengineering

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Presentation plan

- **Motivations and Business case challenges**
- **The current distribution system of the retailer company**
- **Exploring several reengineering scenarios**
- **Optimization-based Results**
- **Conclusion & Future work**

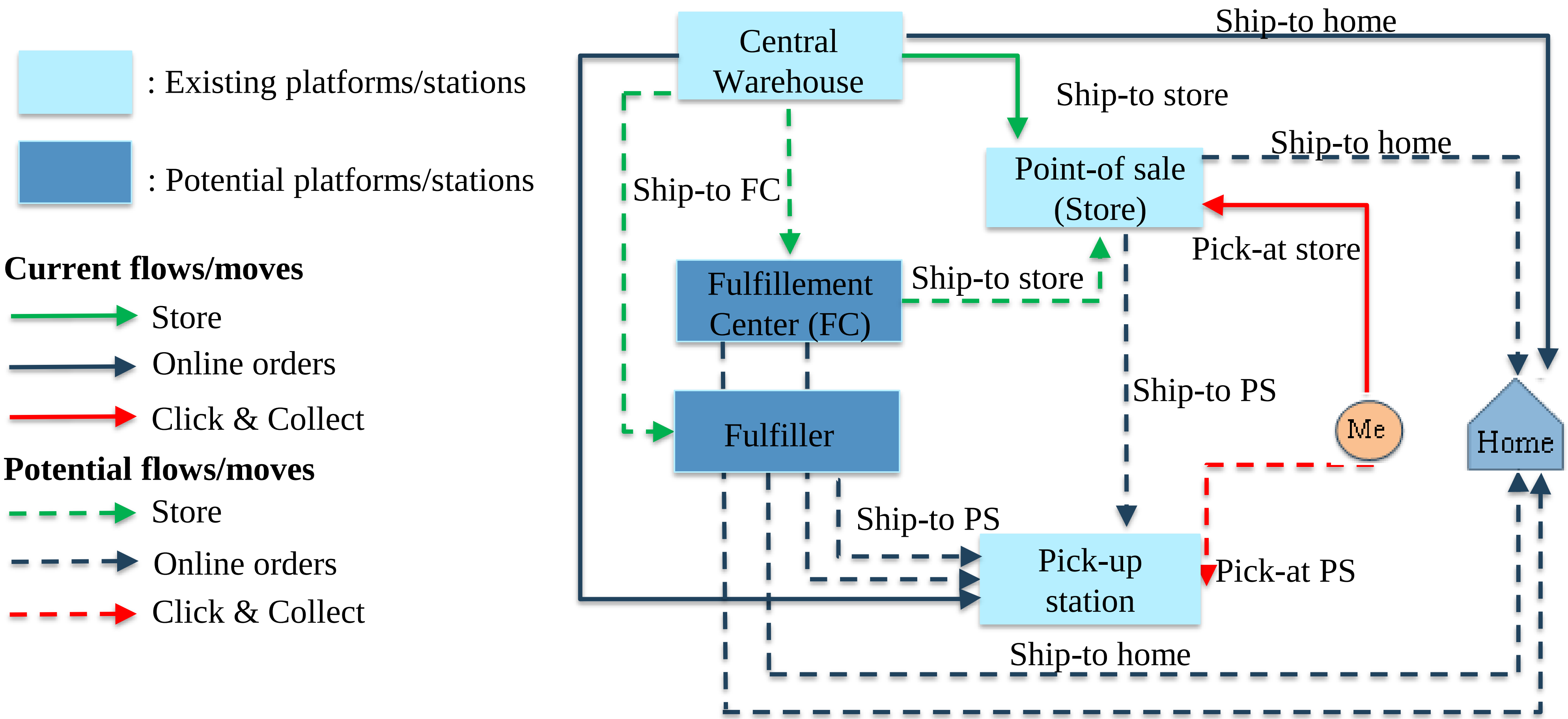
Motivations : Omnichannel Business & City Logistics

The Omnichannel Business seeks to provide the customers with a seamless shopping experience, allowing them to order anytime from anywhere, in person or through digital devices and be delivered at their preferred time and location.

City logistics aims to **minimize** the **negative impact of freight-vehicle** movements on city-living conditions and to reduce the number of **empty vehicles** getting in, through and out of the city. It also seeks to improve **last-mile delivery management** and pre-position deployment of goods in cities.

A Generic Vision of OmniChannel Distribution in the City

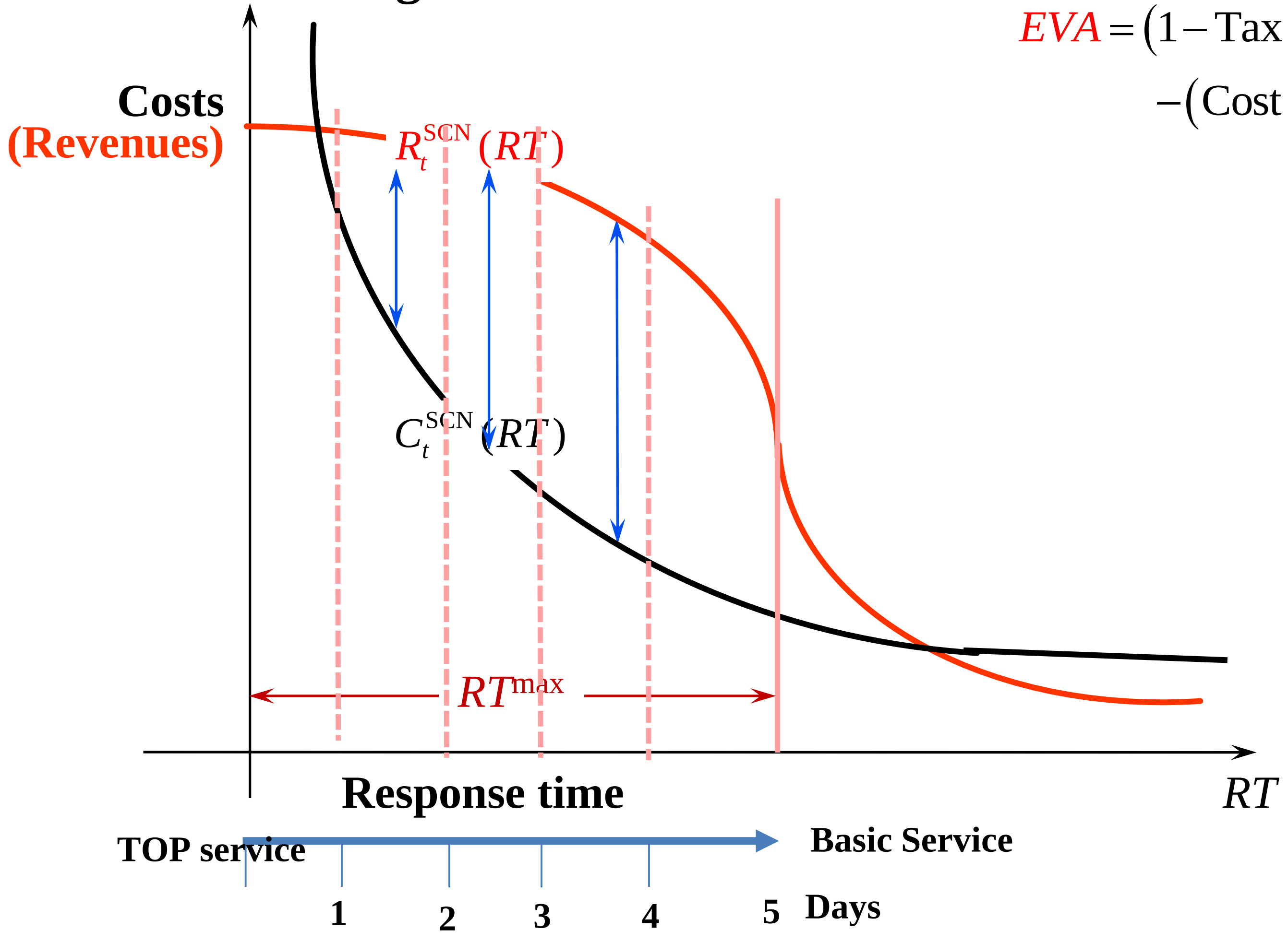
Adapted from Montreuil (2016)



The need of a Hyperconnected Distribution Strategy

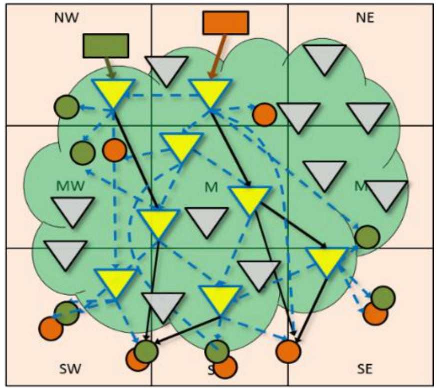
- **Distribution Network Design drives Revenues**

$$EVA = (1 - \text{Tax rate}) \times (\text{Revenues - Expenses}) - (\text{Cost of capital} \times \text{Capital employed})$$



The need of a Hyperconnected Distribution Strategy

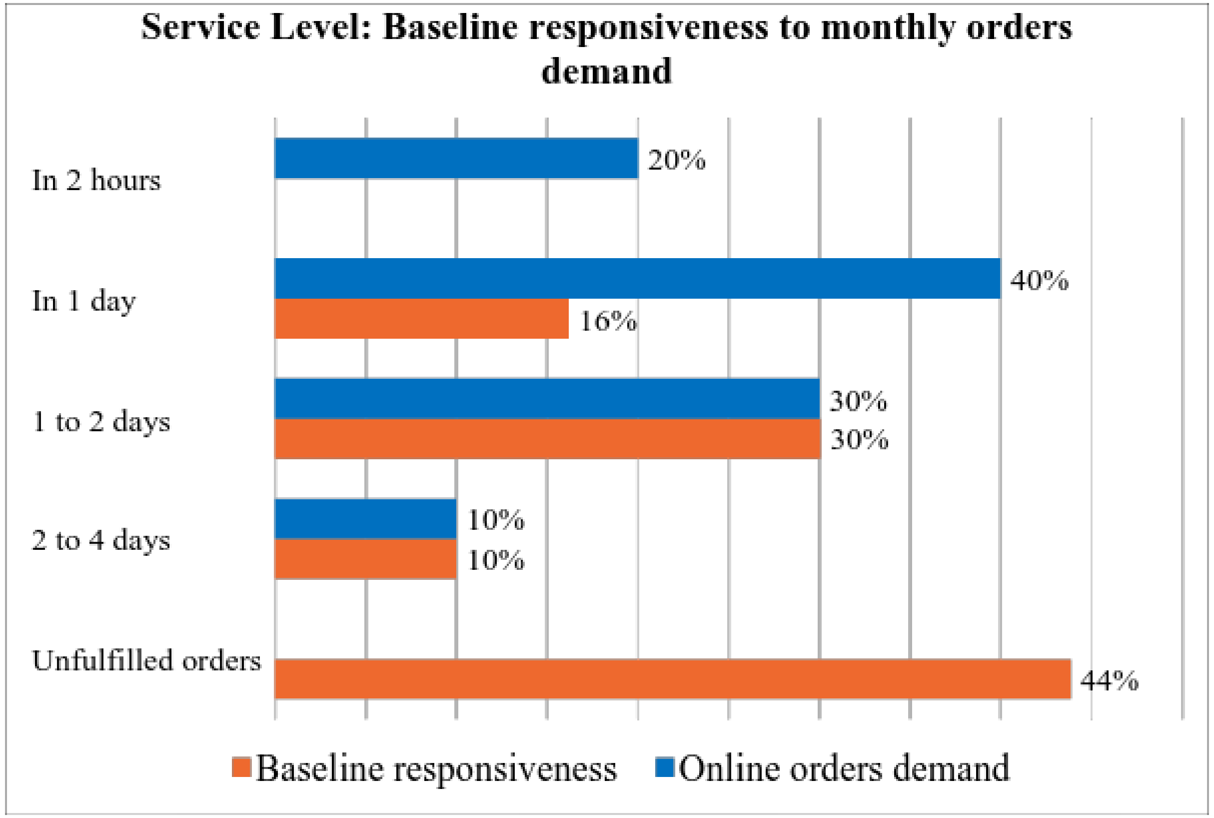
Exploiting **Physical Internet** and **interconnection in B2C goods deployment, pickup and delivery** is expected to create potential for drastic **fulfillment online orders process**, **profitability** and **ecological** performance improvements.



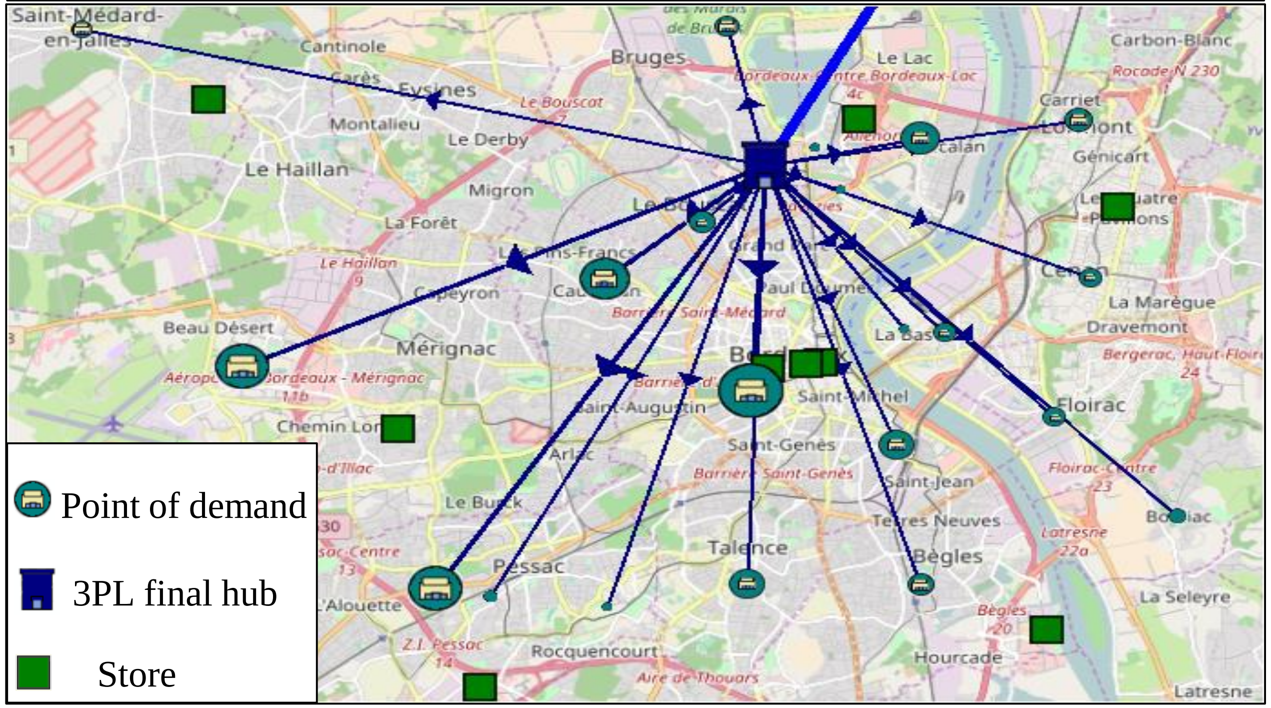
Hyperconnected distribution web

- **Distribution Web Strategy drives Revenues**
  - Mid-term Planning Horizon (1 to 2 years)
  - Design a flexible distribution schema (configuration & contracts).
  - Own/rent/share/exploit a distribution web
  - Offers are modulated by product-market (Prime response time)
  - Plan to deploy flows dynamically (a variable mission for each DC)

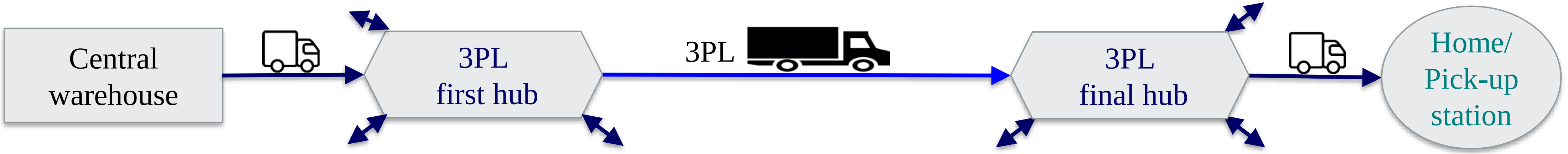
Overview on the current Distribution system



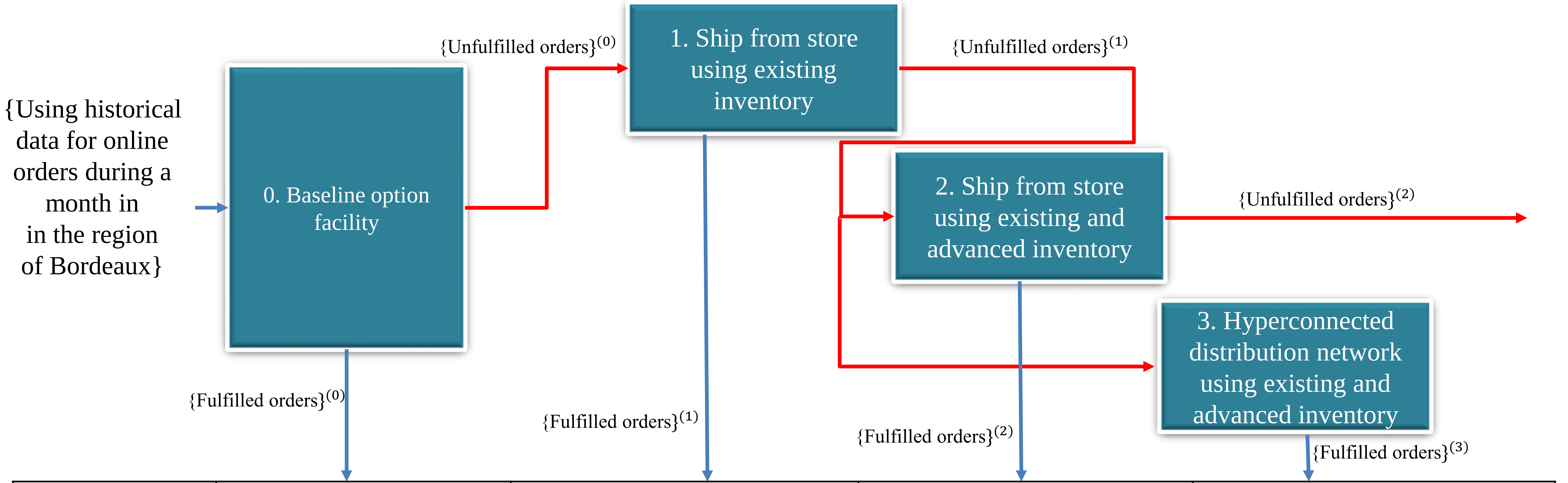
Flow mapping of fulfilled online orders shipped from the central warehouse



- 921 online orders / month
- 653 clients
- 9 stores



Methodology

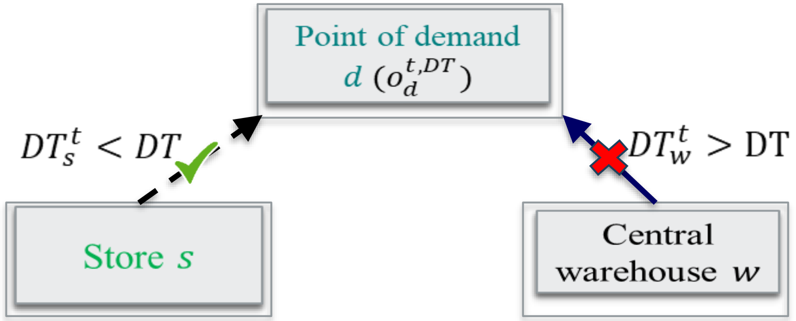


	Baseline	Scenario 1	Scenario 2	Scenario 3
Percentage of fulfilled orders	{Fulfilled orders}$^{(0)}$	{Fulfilled orders}$^{(0)}$ ∪ {Fulfilled orders}$^{(1)}$	{Fulfilled orders}$^{(0)}$ ∪ {Fulfilled orders}$^{(1)}$ ∪ {Fulfilled orders}$^{(2)}$	{Fulfilled orders}$^{(0)}$ ∪ {Fulfilled orders}$^{(1)}$ ∪ {Fulfilled orders}$^{(3)}$

Distribution design models

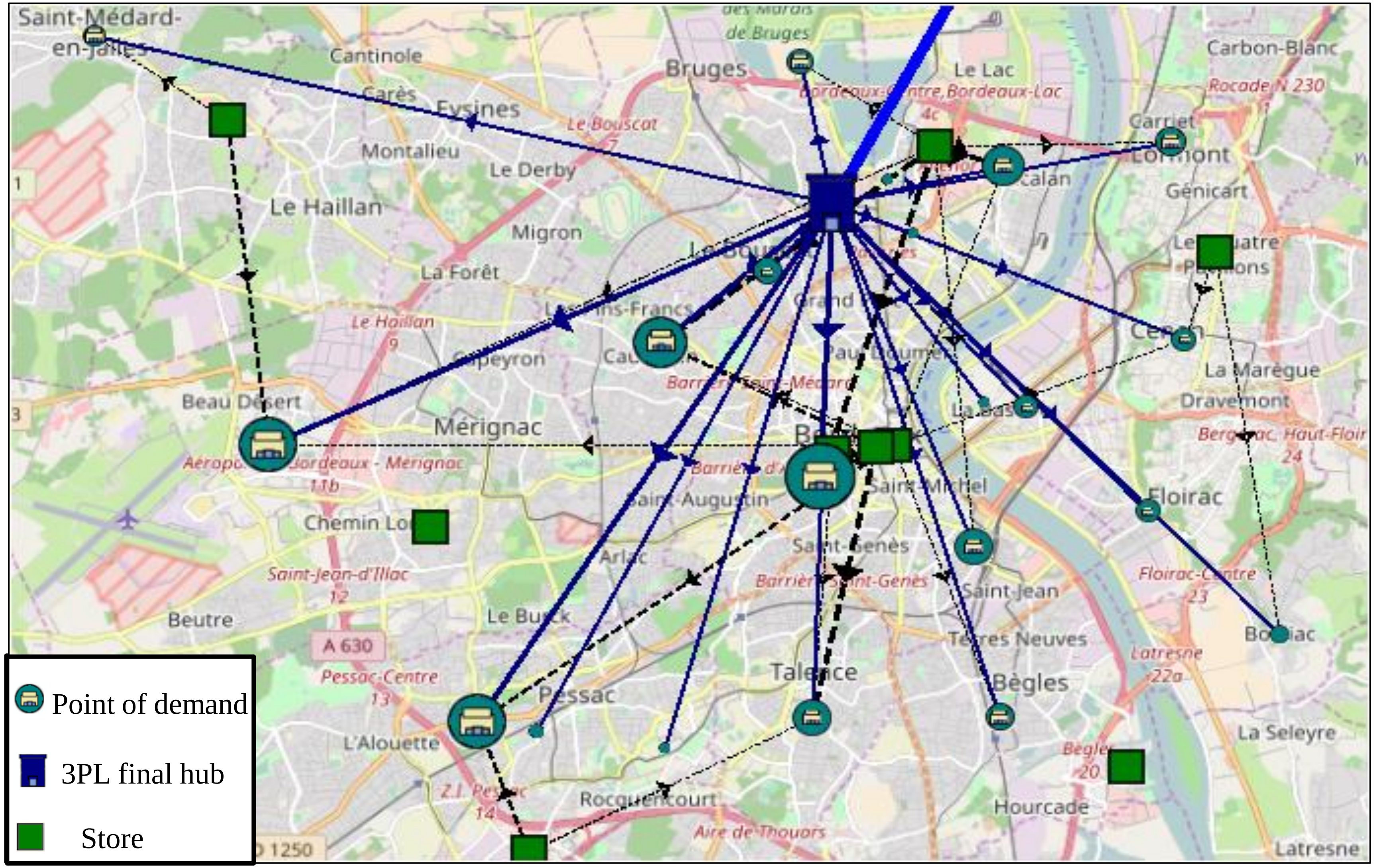
Scenario 1: Ship from store using existing inventory

If the online order **could be met** from multiple stores, then it is shipped from the most convenient one.



- $o_d^{t,DT}$: Online order placed from point of demand d, at time t with a required delivery time DT.
- DT: Delivery time required for the online order $o_d^{t,DT}$.
- DT_w^t: Delivery time provided by the warehouse w for servicing point of demand d at time t.
- DT_s^t: Delivery time provided by the store s for servicing point of demand d at time t (Exceptions such as working time schedule (normal days of working/weekends) were considered.)

Scenario 1 : Ship from Store



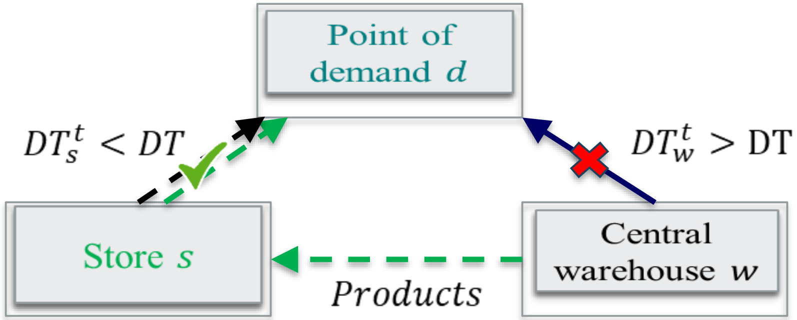
Flow of orders shipped directly from the warehouse

Flow of orders shipped from the store using existing inventory

Distribution design models

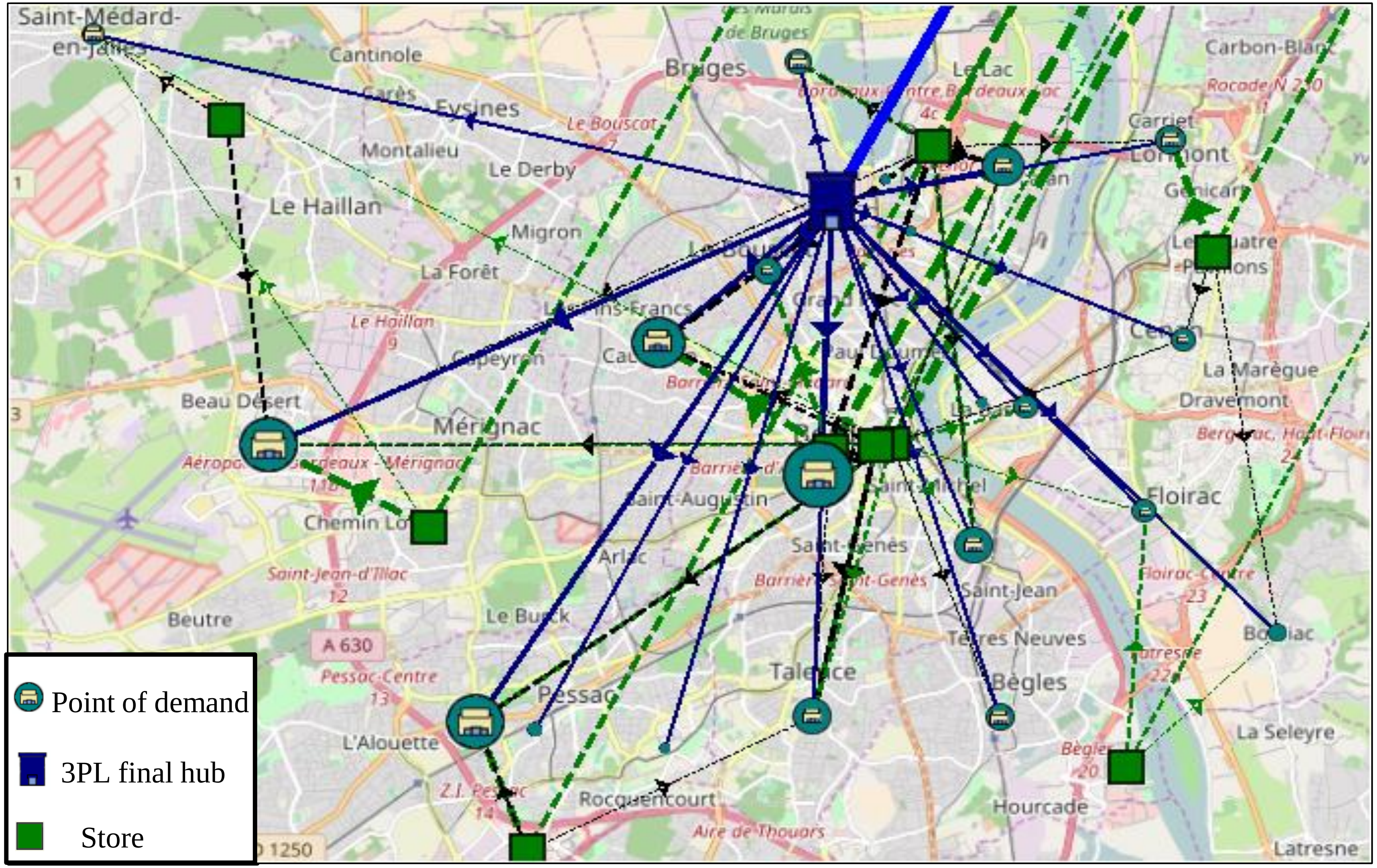
Scenario 2: Ship from store using existing and advanced inventory

In addition to the first scenario option, if the online order belongs to the **fast moving high-quantity** and **doesn't exist in any store**, then we **anticipate/forecast** its optimal location in stores.



- $o_d^{t,DT}$: Online order placed from point of demand d, at time t with a required delivery time DT.
- DT: Delivery time required for the online order $o_d^{t,DT}$.
- DT_w^t: Delivery time provided by the warehouse w for servicing point of demand d at time t.
- DT_s^t: Delivery time provided by the store s for servicing point of demand d at time t (Exceptions such as working time schedule (normal days of working/weekends) were considered.)

Scenario 2: Advanced inventory & Ship from stores



Flow of orders shipped directly from the warehouse

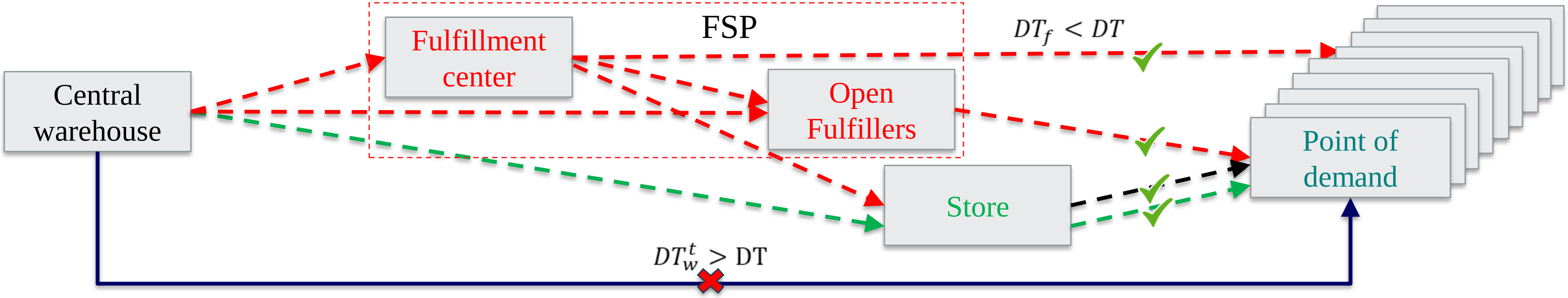
Flow of orders shipped from the store using existing inventory

Flow of orders shipped from the store using advanced inventory

Distribution design models

Scenario 3: Hyperconnected distribution network using existing and advanced inventory

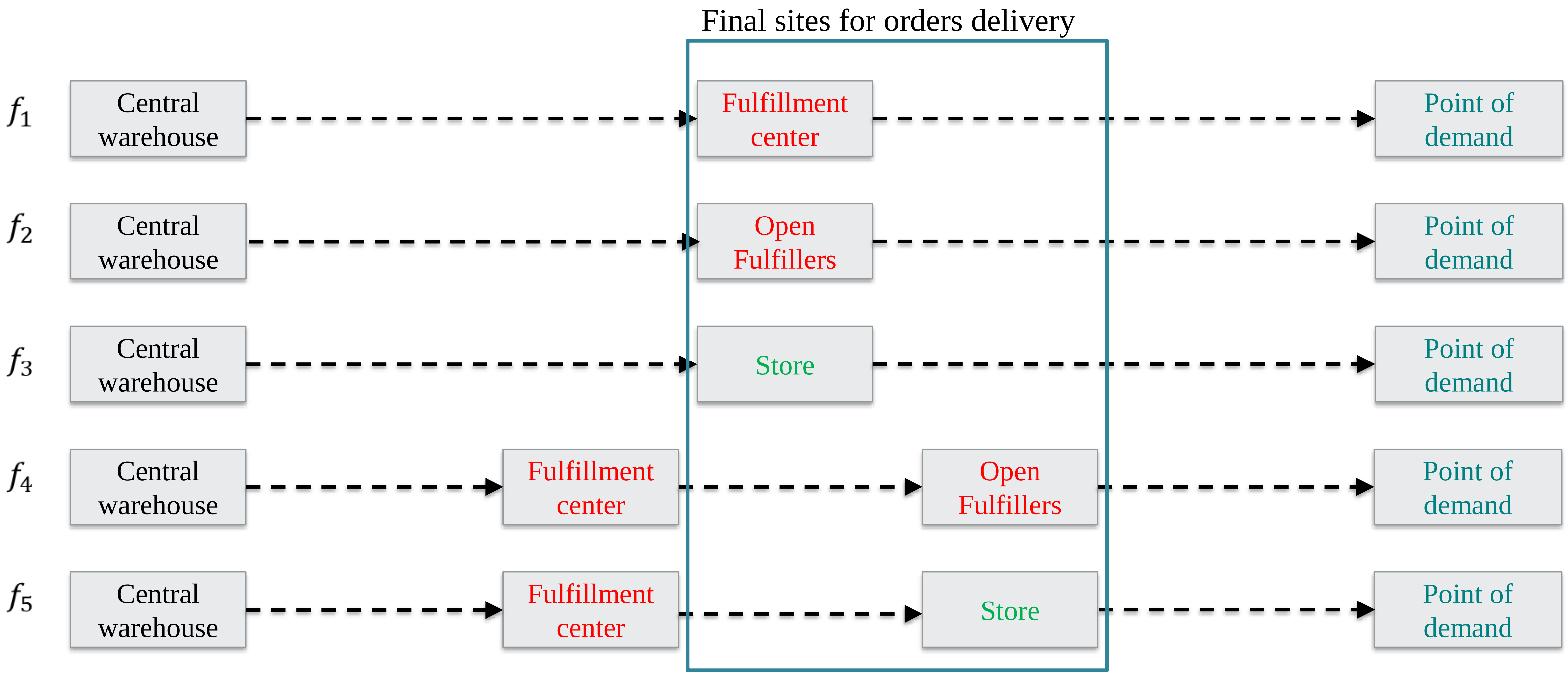
The business imparts a part of its operations to a **fulfillment service provider (FSP)**. The FSP allows to cross-dock the business products in **open Hubs**, spread over the region and fed from the business central warehouse. The **advanced** inventory is based on **forecasted deployment** of products in all sites.



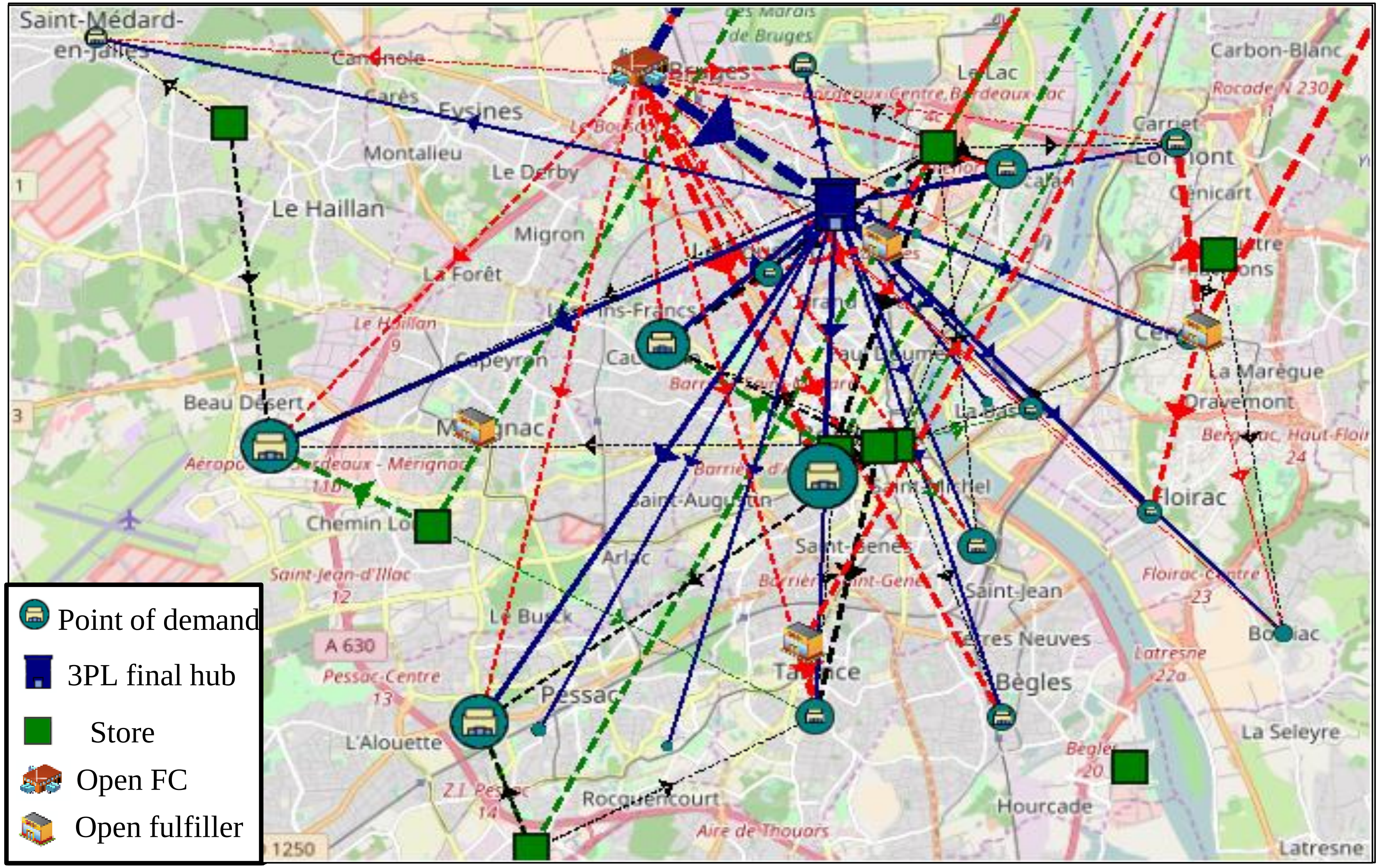
- $o_d^{t,DT}$: Online order placed from point of demand d, at time t with a required delivery time DT.
- DT: Delivery time required for the online order $o_d^{t,DT}$.
- DT_w^t: Delivery time provided by the warehouse w for servicing point of demand d at time t.
- DT_f^t: Delivery time provided when selecting the facility f for servicing point of demand d at time t

(Exceptions such as working time schedule (normal days of working/weekends) were considered.)

Scenario 3 : Fulfillment centers-based distribution



Scenario 3 : Fulfillment centers-based distribution



Flow of orders shipped directly from the warehouse

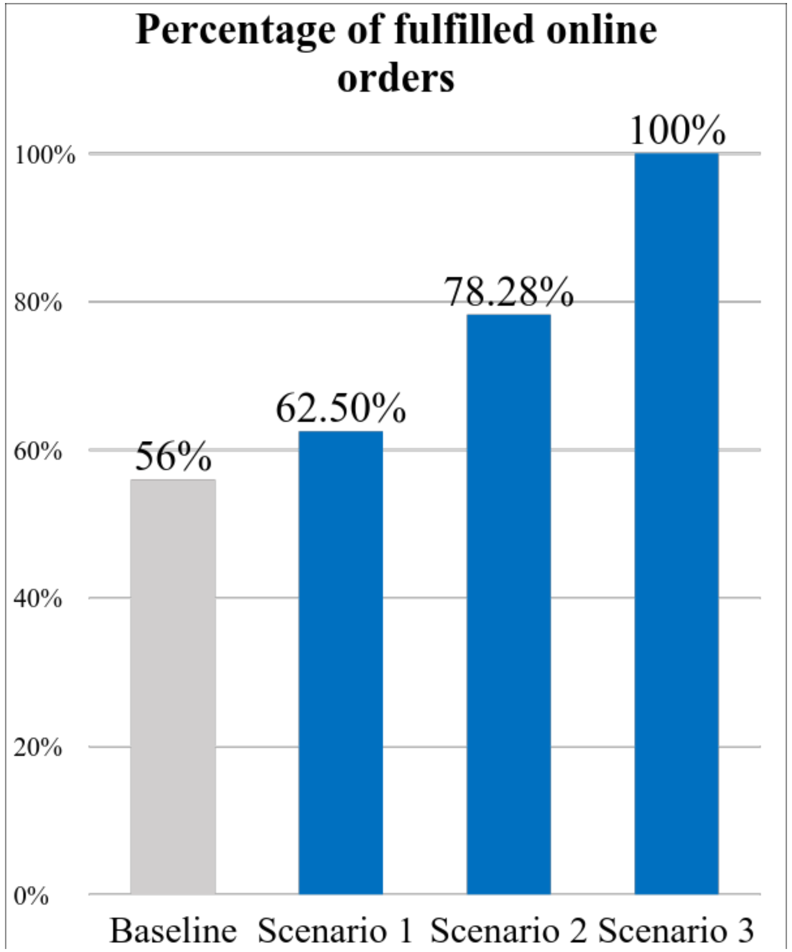
Flow of orders shipped from the store using existing inventory

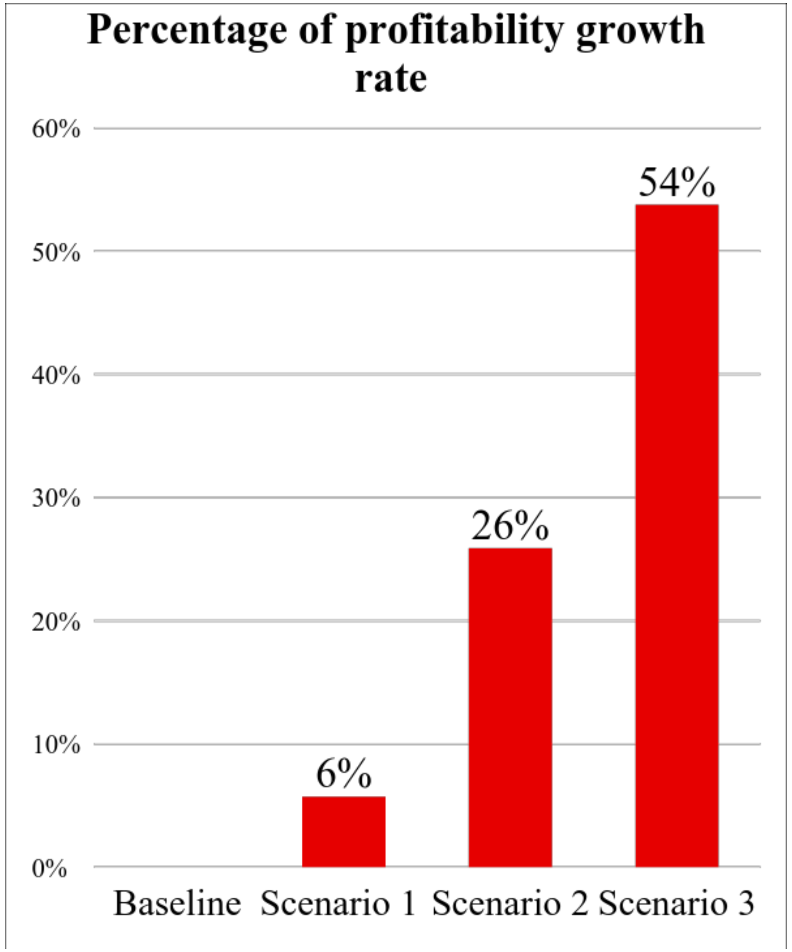
Flow of orders shipped from the fulfillment center

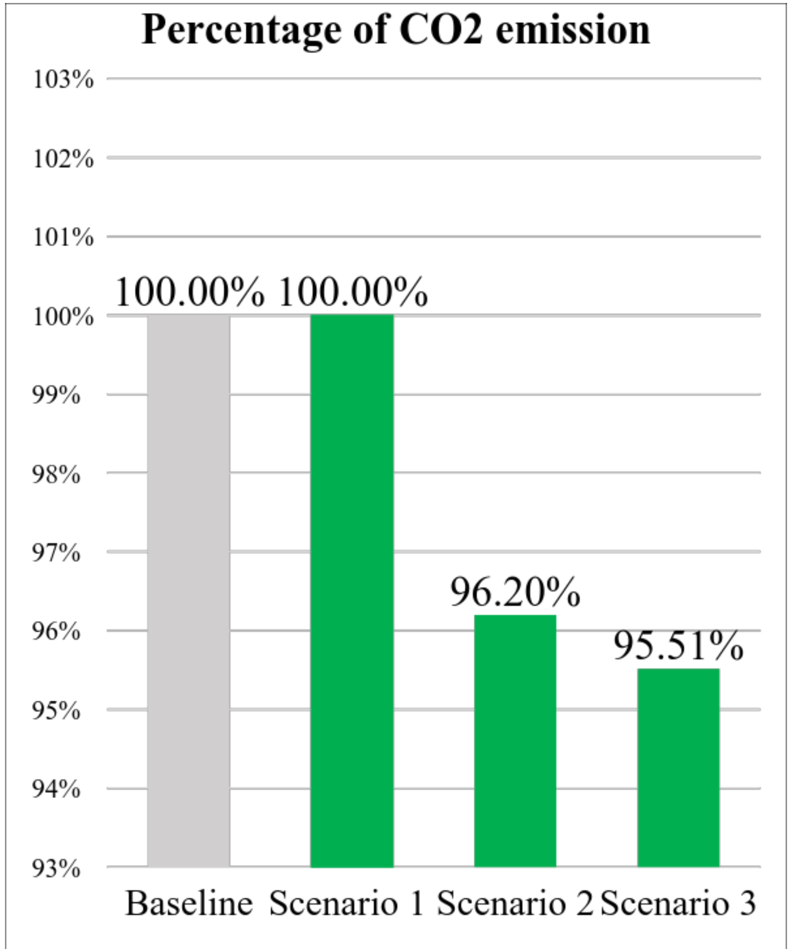
Flow of orders shipped From the store using advanced inventory

Flow of orders shipped from the openly FC/fulfillers using advanced inventory

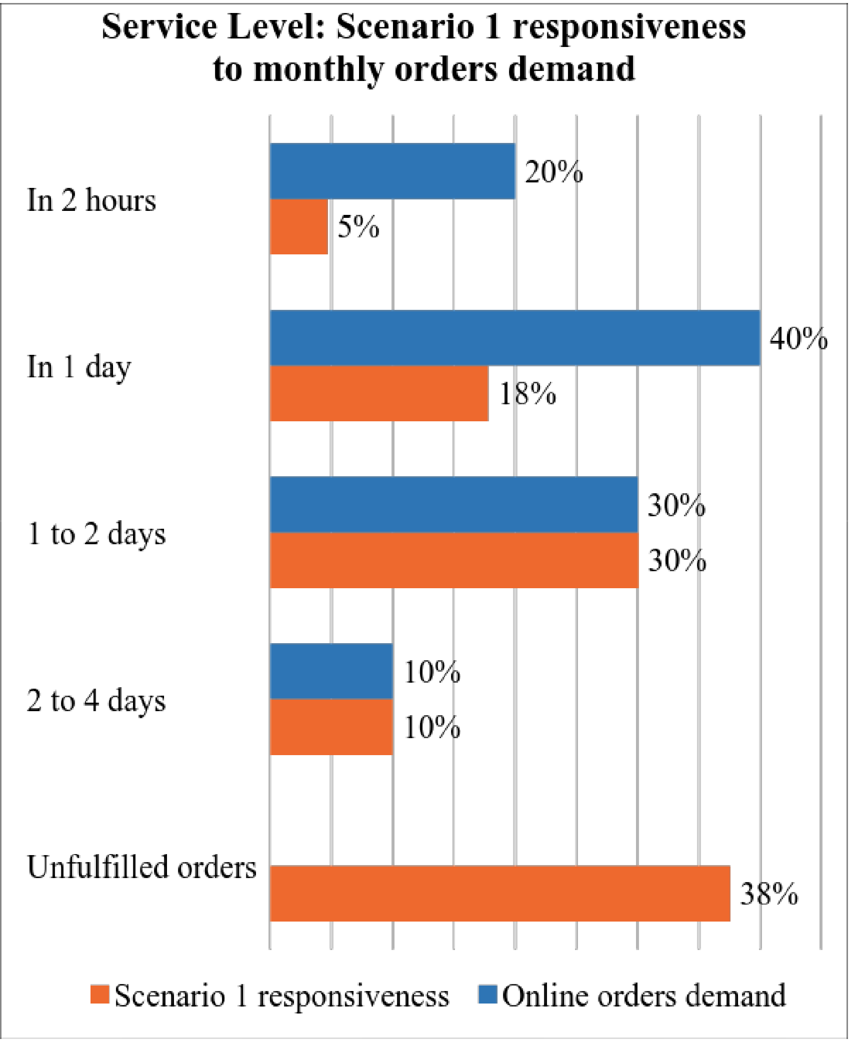
Results

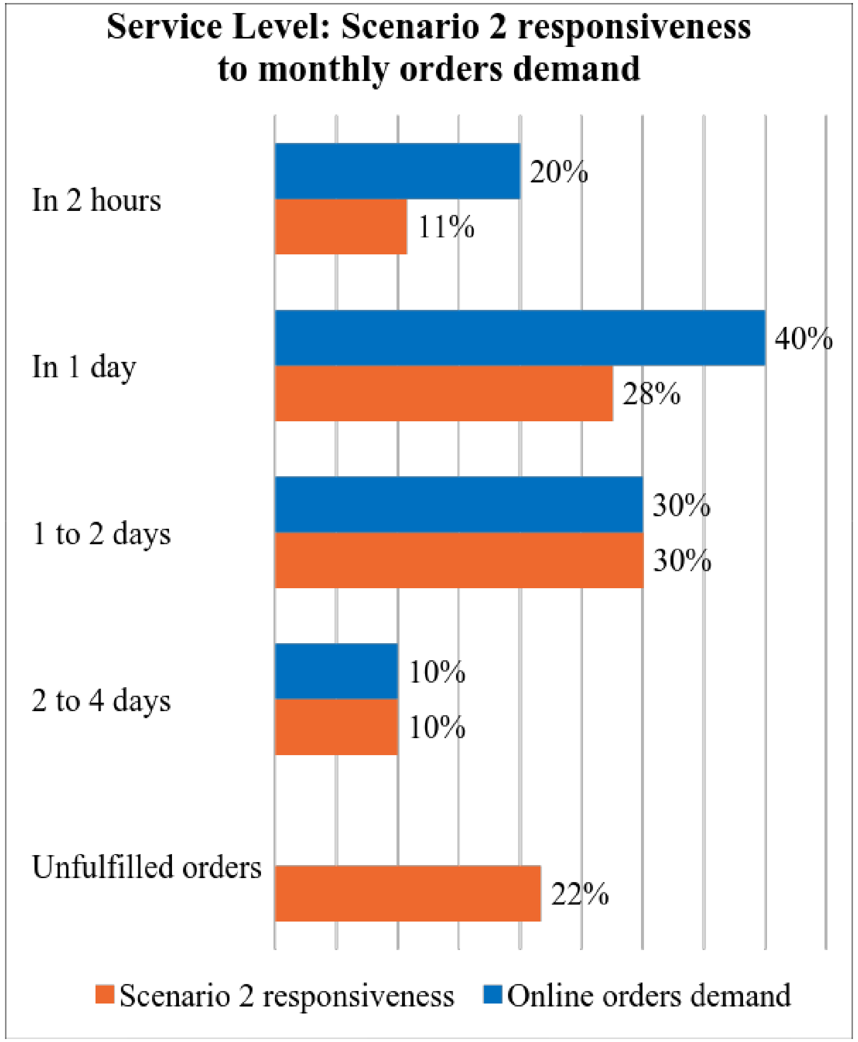

Percentage of fulfilled online orders
100%
80%
60%
40%
20%
0%
56%
62.50%
78.28%
100%
Baseline
Scenario 1
Scenario 2
Scenario 3

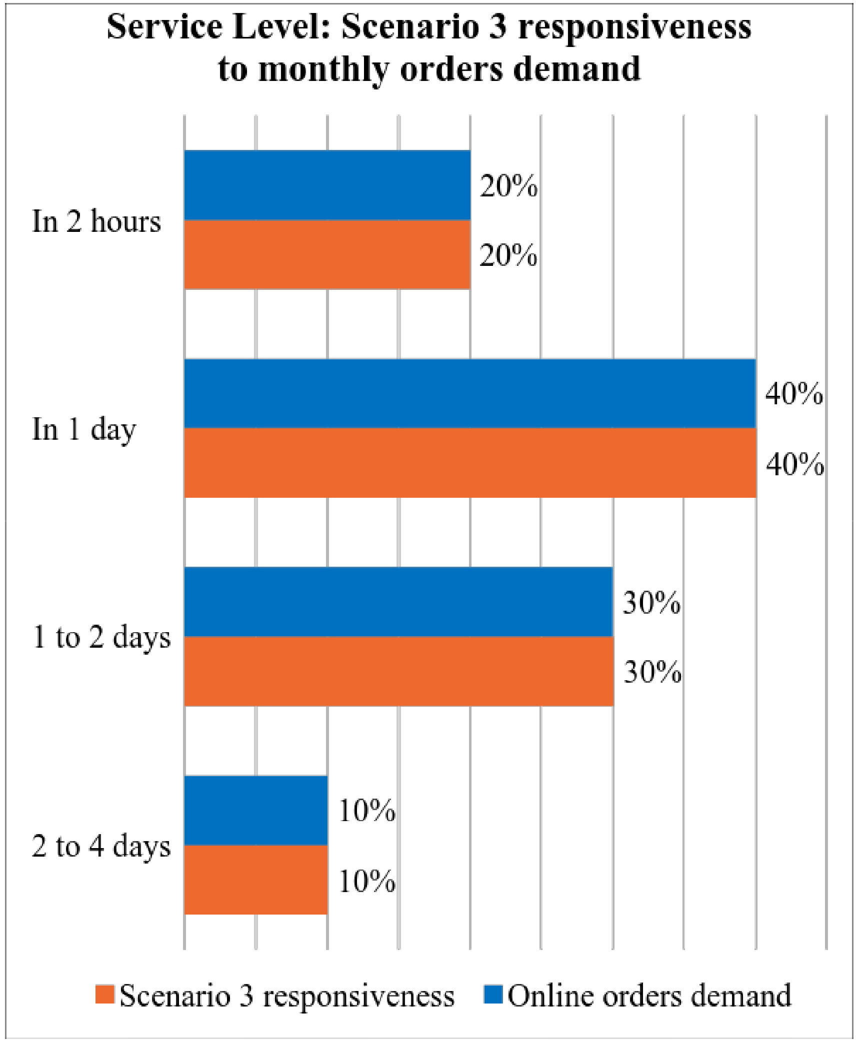

Percentage of profitability growth rate
60%
50%
40%
30%
20%
10%
0%
6%
26%
54%
Baseline
Scenario 1
Scenario 2
Scenario 3


Percentage of CO2 emission
103%
102%
101%
100%
99%
98%
97%
96%
95%
94%
93%
100.00%
100.00%
96.20%
95.51%
Baseline
Scenario 1
Scenario 2
Scenario 3

Results: Impact of Hyperconnected distribution on service level







Conclusion & Future Work

- The percentage of fulfilled online orders increased by **22.2%** when the retailer stores were exploited; and by **44%** in a hyperconnected distribution network.
- The CO_2 gas emission of total hyperconnected network flows decreased by **220 Kg** in one month due to improvement of trucks fill rate.

- Scenario 1: we are exploring the idea to add pick-up and delivery lockers at stores
- Scenario 2 : we are working on Machine Learning algorithms to improve the forecasts
- Scenario 3 : we need to estimate the opening/warehousing cost of the fulfillment center
- A Simulation model is under development to strength the proof-of-concept

Thank you for your attention

APPENDIX

Upstream Transportation Cost Estimation

The **trinomial formulation of the cost price** makes it possible to calculate simply the cost of a Transport using three terms:

- **Kilometer cost term**: encompasses fuel, tires, maintenance-repairs and tolls costs
- **Hourly cost term**: includes the driver's salary and remuneration
- **Daily cost term**: covers the total indirect structural costs, Insurance and axle tax

$$\textbf{Transport operation cost} = \textbf{Kilometric cost} * \textbf{total number of kilometers traveled for the transport operation} + \textbf{Hourly cost} * \textbf{number of hours of service required by the operation} + \textbf{Daily cost} * \textbf{number of days of use of the vehicle for the transport operation}$$

$$\textbf{Transport operation cost}\ (A \rightarrow B) = \textit{Kilometric cost} * \textit{distance}(A \rightarrow B) + \textbf{Hourly cost} * \frac{\textit{distance}(A \rightarrow B)}{\textit{speed}} + \textbf{Daily cost} * \frac{\textit{distance}(A \rightarrow B)}{\textit{speed} * \textit{number of working hours}}$$

$$\textbf{Online order transport cost}\ (A \rightarrow B) = \frac{\textbf{Transport operation cost}\ (A \rightarrow B)}{\textit{Total freight}(A \rightarrow B)} * \textit{Online order weight}$$

Upstream Transportation Cost Estimation

Advanced store

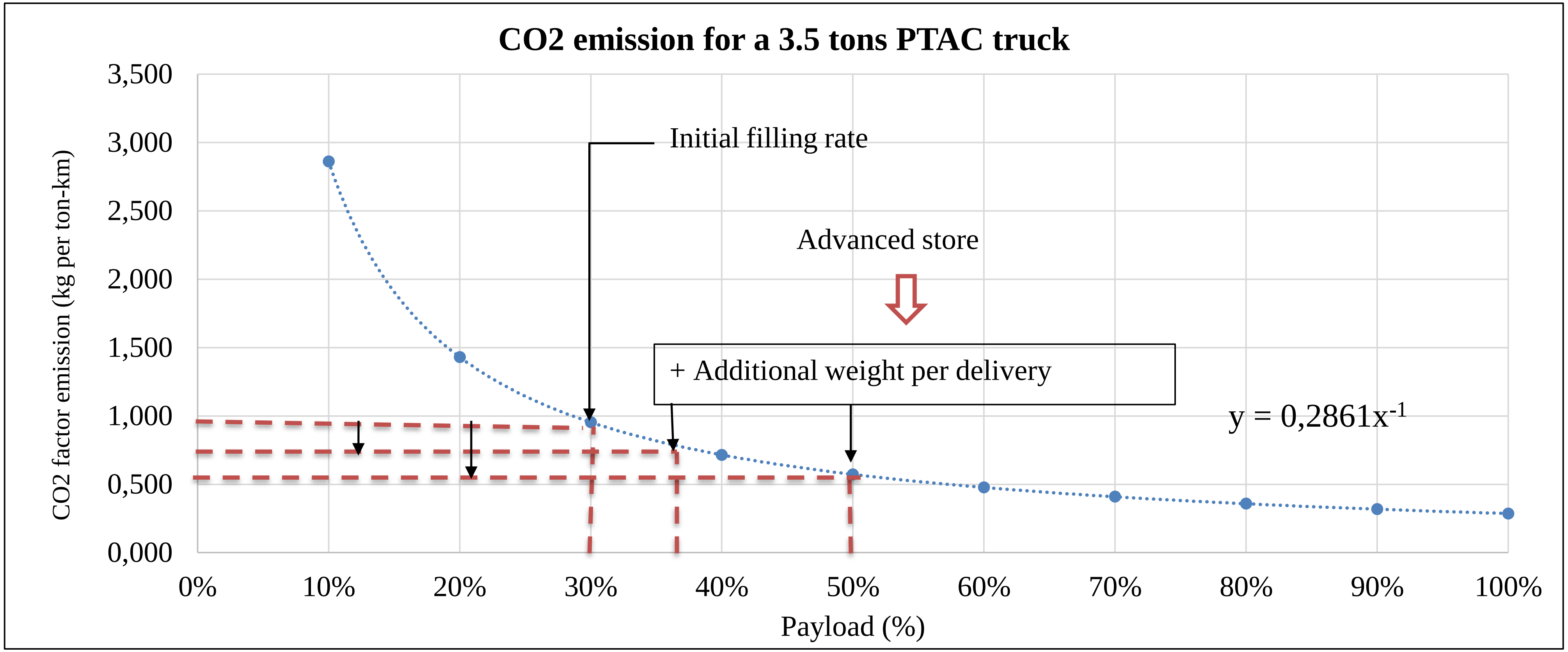
⇩

+ Additional weight per delivery

⇩

$$\textbf{Online order transport cost } (\mathbf{A} \rightarrow \mathbf{B}) = \frac{\textbf{Transport operation cost } (\mathbf{A}\rightarrow\mathbf{B})}{\boldsymbol{Total\ freight}(\boldsymbol{A}\rightarrow\boldsymbol{B})+\boldsymbol{Additional\ weight}(\boldsymbol{A}\rightarrow\boldsymbol{B})} * \boldsymbol{Online\ order\ weight}$$

Upstream CO2 Emission Estimation



$Online\ order\ CO2$ emission = CO2 factor emission ∗ distance ∗ Order weight

Potential of a cross-company reusable modular secondary packaging system in E2E FMCG chains

Yanyan YANG, Eric BALLOT
4th IPIC 2017, Graz

1. Context

Packaging: technology of enclosing and protecting products for distribution, storage, sale and use.

Logistics units (Units load): combines primary products into single shipping "units" to facilitate transport, handling and storage that represent 12-15% of retail sales price.

Primary packaging (sales unit): package to final consumers, e.g., . bottles, bags etc.

Scope of study

Secondary unit load: basic handling unit consisting a group of sales units, e.g., trays, crates, boxes etc.

Tertiary unit load: combines secondary unit loads or sales units, e.g., pallets, dollies, roll cages etc.

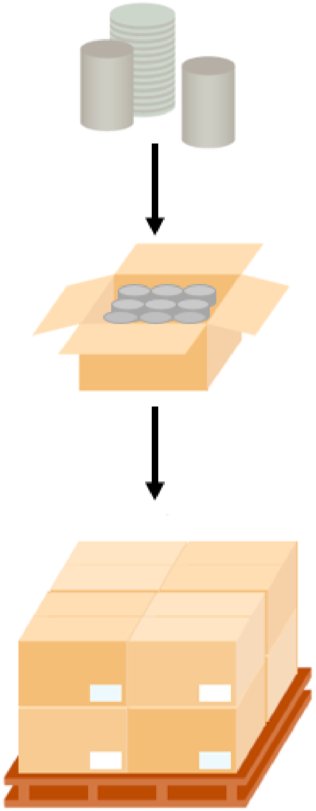


Fig 1. Three level of packaging

1. Context

Challenge ahead: Different solutions by different actors across the chain.



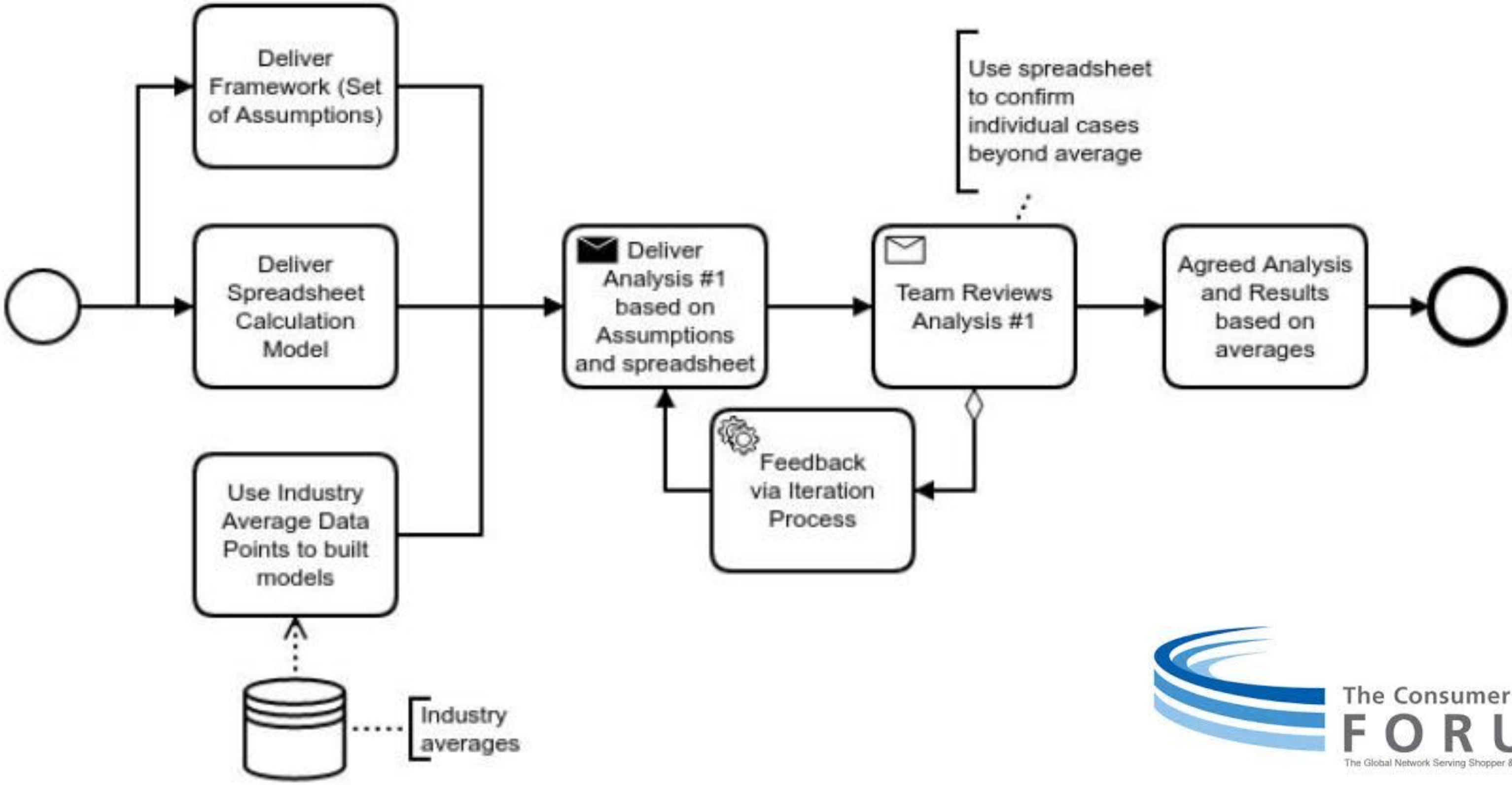
Global inefficiencies:

1) Poor fill level of packaging units and transportation means, e.g., averagely 42,6% average utilisation of trucks and containers at departure.
2) Poor storage space utilisation.
3) Negative impacts on environmental footprint, e.g., increased waste, CO2 emission.
4) Inefficiencies in handling, e.g., re-package of products to feed into new systems.

2. Objective and methodology

Objective: to provide a generic modular solution across categories and supply chain levels globally.

Method: global assessment of implementing a small set of standardized modular boxes throughout a reduced set of typical FMCG supply chains.



Methodology

3. Other projects related

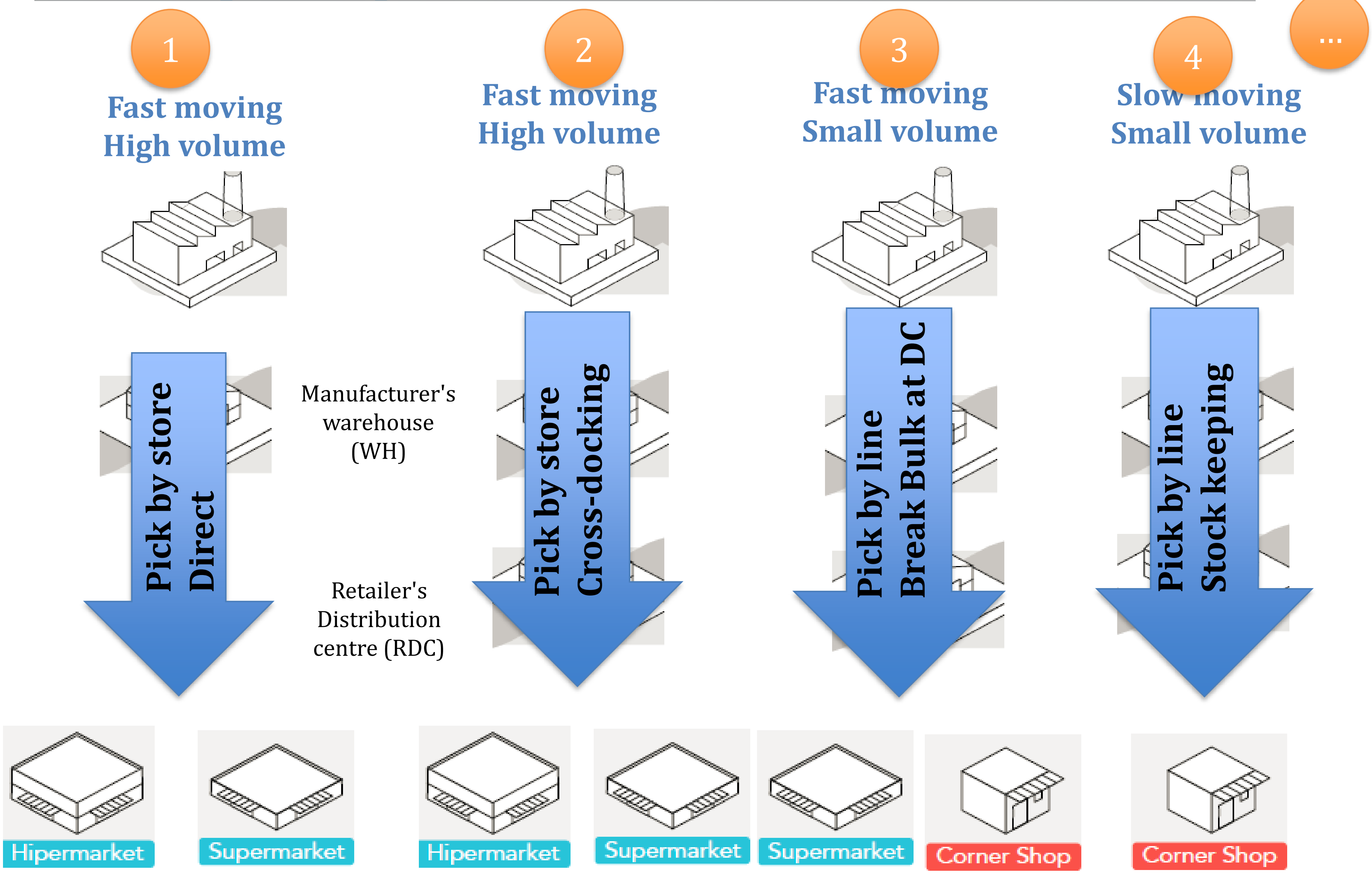
Project RTI(Reusable Transport Items): to define a practice approach to establish a cross-company returnable packaging system in the retail supply.

Project Orange Box: to identify quick wins and profit return of investment of standard containers across the chain with distributors.

Project NMLU: to develop and prototype New Modular Load Units (NMLUs), especially for the use of multimodal logistic clusters.

Our initiative: To quantitatively study the major differences of using modular boxes compared to actual solutions in end-to-end FMCG chains, eventually the global benefits and frontiers of modularization in secondary packaging.

4. Example of possible scenarios - typical FMCG chains



5. Assumptions and model

Assumptions

1. A set of four modular boxes by (Meller, Lin, and Ellis 2012): Sizes = {{600x400x240}, {400x300x240}, {600x400x120}, {400x300x120}} in mm
2. Recycling or disposal of packaging material: close loop (shipment back to origin) and open loop (shipment to nearest consolidation centre).
3. A product could be packed in boxes of different sizes according to the demand.
4. A modular box can contain a single type of product or different products
5. Average shipping unit height and weight will be used instead of actual loads.

....

5. Assumptions and model

Objective of calculation model: analysis of following key differences

1. Asset utilization (saturation of means)
   a) Boxes level
   b) Handling unit level
   c) Transportation means level
2. Handling productivity
   a) Loading and unloading at handling unit level
   b) Breakdown, when boxes are manipulated from one pallet to another
   c) Picking when a product is manipulated from one box to another
3. Circulation/Recycling of RICs or the support
   a) Re-utilization: close loop and open loop (wit)
   b) Disposal & supply of actual cardboard boxes

Objective for the pilots:

1. Quality : Does the switch from a dedicated cardboard to a plastic box change quality issues (contamination, break ratio, damage ratio, etc)?
2. Sustainability : product waste, means fill rate, raw material consumption, water

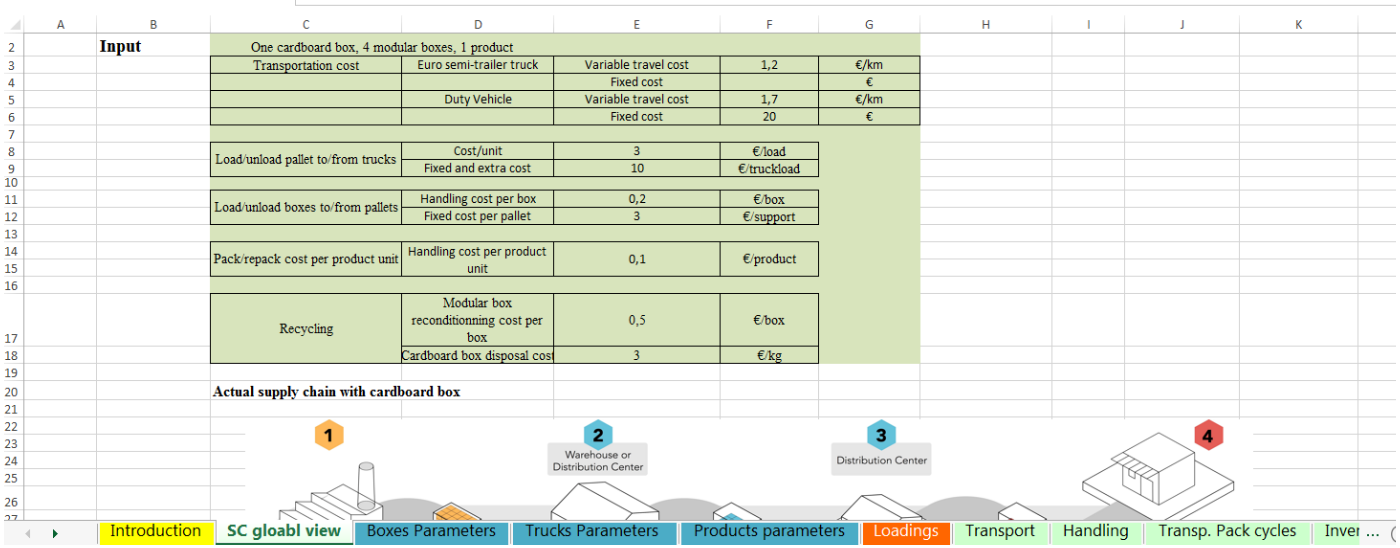
5. Assumptions and model – calculation model

Inputs:

- Distribution flows
- Information of products delivered (size, price, characteristics such as slow-mover or fast mover).
- Information of supports, packaging, and transportation (size, price etc).
- All cost settings: transportation cost, recycling cost, handling cost, etc.

Expected results:

1. Key differences such as asset utilization across the chain.
2. Average costs: transportation costs per item delivered, handling costs per item delivered, recycling or disposal costs, stocking cost per item delivered.



Input — One cardboard box, 4 modular boxes, 1 product

Transportation cost	Euro semi-trailer truck	Variable travel cost	1,2	€/km
		Fixed cost		€
	Duty Vehicle	Variable travel cost	1,7	€/km
		Fixed cost	20	€
Load/unload pallet to/from trucks	Cost/unit	3	€/load	
	Fixed and extra cost	10	€/truckload	
Load/unload boxes to/from pallets	Handling cost per box	0,2	€/box	
	Fixed cost per pallet	3	€/support	
Pack/repack cost per product unit	Handling cost per product unit	0,1	€/product	
Recycling	Modular box reconditionning cost per box	0,5	€/box	
	Cardboard box disposal cost	3	€/kg	

Actual supply chain with cardboard box

6. Conclusions and next steps – main levers

Key Drivers

High handling productivity

Via:

- Less non-value adding handling operations, e.g., pallets breakdowns, repackaging.
- Automation handling system through standardisation.
- Adapted quantity directly to shelves.
- Avoid extra manipulation

Low cost reverse logistics

Via:

- Significantly reduced transportation costs through standardisation of boxes, e.g., open loop for recycling modular boxes vs. close loop for disposing current packaging units.
- Open loop: shipment to consolidation centre via standardisation.

High space utilisation

- High storage space utilisation
- High Box fill rates
- High fill rates of transportation

Via:

- Less void of space utilisation through modularity
- Stackability of modular boxes
- Capability of containing different products in the same box.

Improved service

Via:

- Reduced lead times, especially for slow moving products and small quantities.
- Improved shelf availability

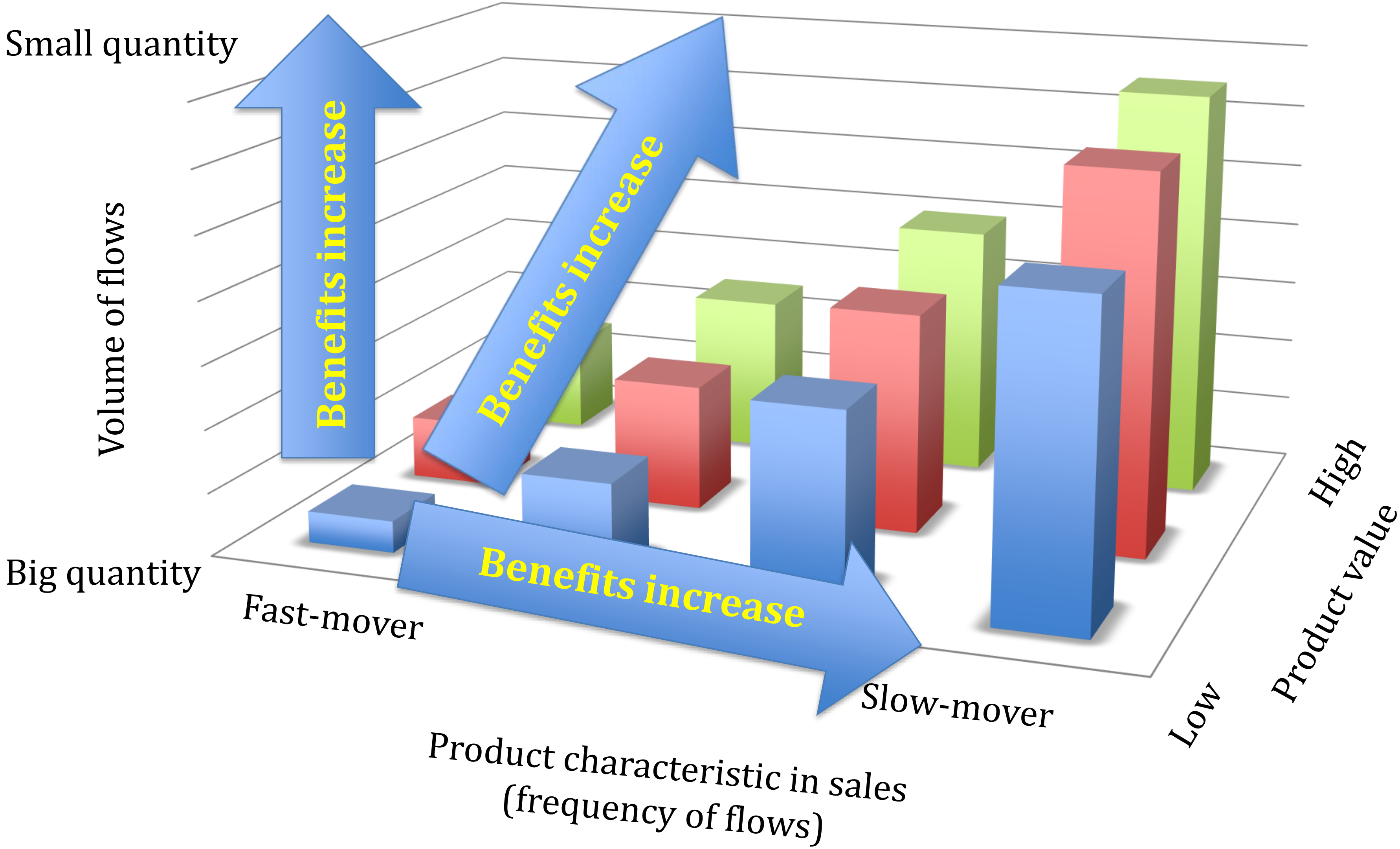
Improved quality

Via:

- Reduced damage through automatic handling.

6. Conclusions and next steps

Qualitative analyse of potential benefits:



6. Conclusions and next steps

What is done:

- ✓ A calculation model developed in the Excel and need to be further applied in France or European horizon.
- ✓ Qualitative analysis is taken out to study the potential drivers of modular boxes.

Next steps:

- ✓ Encourage more partners to join to have a vision of the whole chain.
- ✓ Case studies of different categories of product from different industrial partners as to demonstrate the qualitative results.