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PREDIT

Groupe Opérationnel 4 du PREDIT

EXECUTIVE SUMMARY

OF

PHYSICAL INTERNET SIMULATION

Contribution to its definition and stakes assessment

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Project objective

The objective of this research project is to investigate the interest for a novel organization of logistics: the Physical Internet. Indeed this approach, aiming to universally interconnect logistics services in a way similar to the Digital Internet is very recent and sufficiently different from the Digital Internet, and innovative relative to the current logistics organizations, that it is worth investigating its properties. To do so, a simulation model has been built, validated and then exploited. This work is motivated by the grand sustainability challenge that will require a significant improvement of logistics operations, such as in the field of emissions.

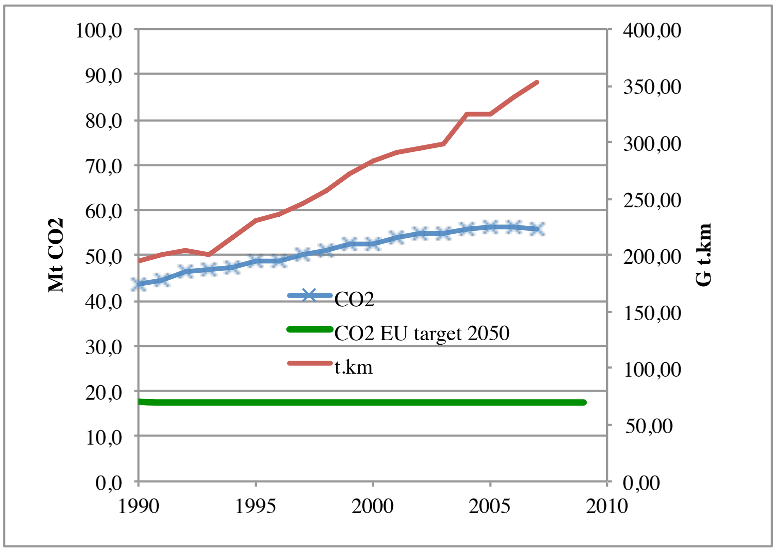

Figure 1: comparison of growths of flows, emissions and CO_2 emissions target by 2050

The flows tested in this project have been provided from the large-scale distribution sector and more specifically from the food sector. These flows have been divided in two databases due to availability issues. The first basis is the upstream basis. It groups the flows of a hundred of the most important suppliers, from their factories to the distributors platforms. For some, these flows also pass through the storage platforms from the industrials.

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The downstream basis takes the flows stemming from the same suppliers, yet rather at the distribution level, from distribution centers to the retail stores in their network: hyper, super and proximity. These flows correspond to two periods of 12 and 7 weeks respectively.

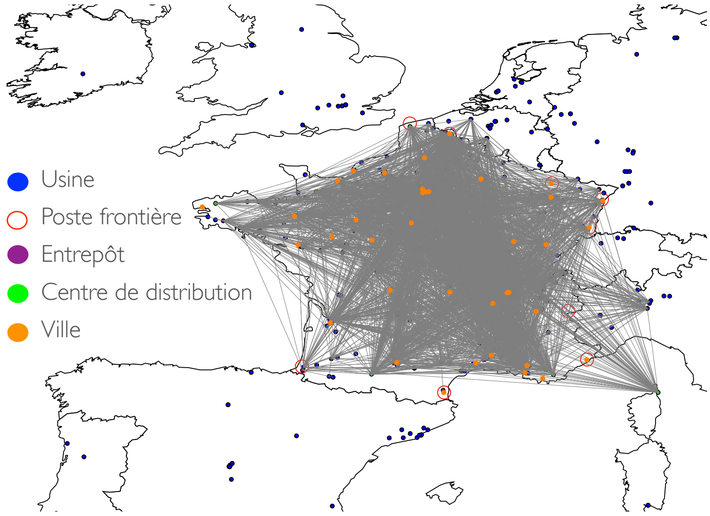

Figure 2: FMCG flows tested, domestic part only

So as to be as representative of the current situation as possible, the simulation model is built exploiting the location of the set of logistics centers, the roadway and railway infrastructures that link these centers, and groupings of orders by transportation means. This allows optimizing as much as possible the current situation that is used as baseline. In fine, the model has been deeded representative.

In parallel, a series of works have been accomplished so as to define the Physical Internet underlying network of hubs, to simulate various stages of its development and thus to explore its functioning and its performance. To do so, algorithms have been developed for piloting its operation and to make design decisions. The elements presented in the report do not pretend to offer more than proposing reasonable solutions in terms of complexity and performance to support the demonstration goal. Hence they should not be regarded as solutions to be implemented directly. The constructed tools have rather a vocation to serve as an experimental platform fro the specification of containers, hubs, algorithms, etc.

Two tools have been developed.

1. A Physical Internet network design tool optimizing hub locations and logistics service interconnection sites, as a function of flows and infrastructures.

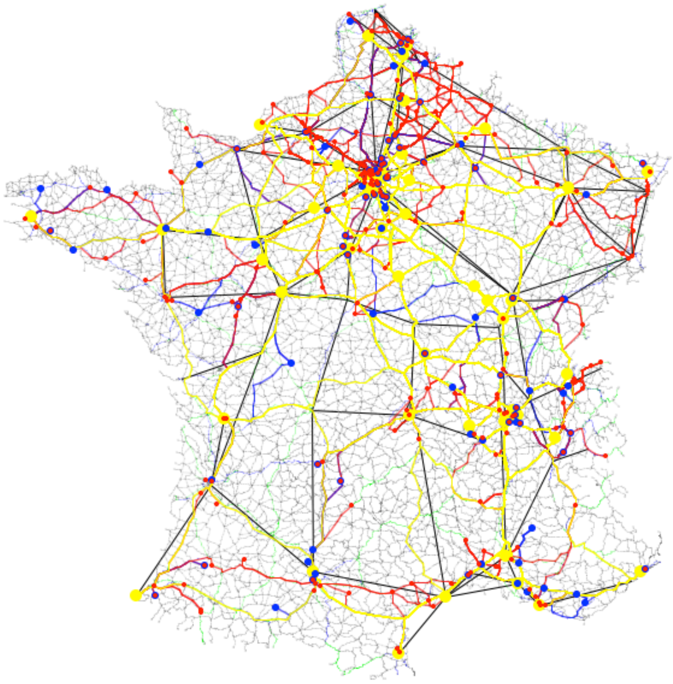

Figure 3: Physical Internet network defined according to flows

2. A tool for simulating Physical Internet exploitation aiming, in regard with the supply demands, to route these demands (volume, mass, cost, delay, etc.) towards their destination with as best as possible efficacy conditions, in a decentralized approach. The simulation tool notably allows to construct scenarios. Each of these scenarios tests an hypothesis on materials, deployment level, and so on.

Ident.	Route	Fer	~~Entrepôt~~	Critère	Conteneurs
0	✓			NA	Ø
1.1.C	✓			Coût	$2.4 \times 2.4 \times \{1.2, 2.4, 3.6, 4.8, 6.0, 12.0\}$
1.1.T	✓			Temps	$2.4 \times 2.4 \times \{1.2, 2.4, 3.6, 4.8, 6.0, 12.0\}$
1.2.C	✓			Coût	$2.4 \times 2.4 \times 1.2$
1.3.T	✓			Temps	$2.4 \times 2.4 \times \{1.2, 2.4, 3.6, 4.8, 6.0, 12.0\}$
2.1.C	✓	✓		Coût	$2.4 \times 2.4 \times \{1.2, 2.4, 3.6, 4.8, 6.0, 12.0\}$
2.1.T	✓	✓		Temps	$2.4 \times 2.4 \times \{1.2, 2.4, 3.6, 4.8, 6.0, 12.0\}$
2.1.E	✓	✓		Emission	$2.4 \times 2.4 \times \{1.2, 2.4, 3.6, 4.8, 6.0, 12.0\}$
3.1.C	✓	✓	✓	Coût	$2.4 \times 2.4 \times \{1.2, 2.4, 3.6, 4.8, 6.0, 12.0\}$
3.1.E	✓	✓	✓	Emission	$2.4 \times 2.4 \times \{1.2, 2.4, 3.6, 4.8, 6.0, 12.0\}$

Table 1: Scenarios and options guide

Results

Model development has necessitated to define principles for designing and exploiting interconnected networks. These principles lead to advances in the thinking about designing the Physical Internet. Specifically, algorithms have been defined so as to allow :

⇨ defining the interconnections et locating the road based or road-rail physical routers (hubs) ;

⇨ filling containers and transport means as a function of real demands;

⇨ routing containers through interconnected networks, with various levels of containerization;

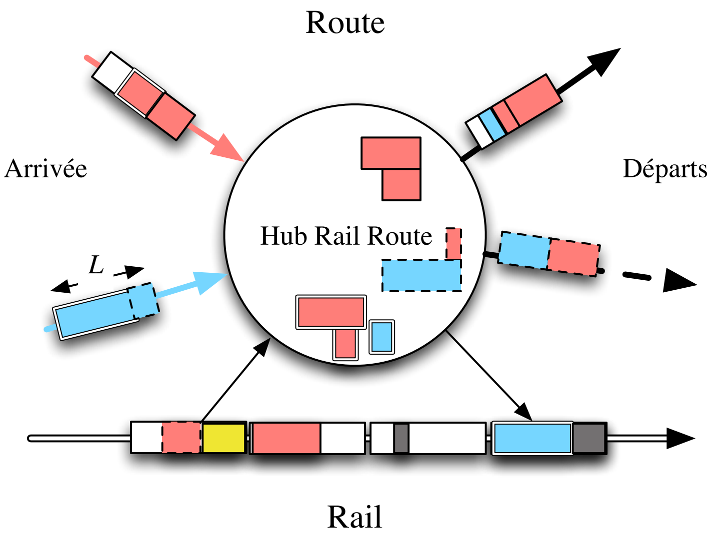

Figure 4 : hub multimodal transshipment model

In addition the following results are seek:

⇨ build the credibility of such a new organization considering its operation efficiency compare to existing situation and solutions;

⇨ set the targets in performance and costs for others Physical Internet projects : container cost, maximum time allowed to transit a container in a hub, etc.

The achieved results are really encouraging as we notice:

- A strong increase in transportation means load ratio around +20% depending of scenarios;
- A major switch of freight from road transportation to rail transportation on main axis despite very fragmented orders and limited volumes;

- A net economic saving coming from the great efficiency gain from transportation not overcame by the handling costs at transhipment points. The cost reduction is between 4% and 26% according to hypotheses and scenarios (one scenario excepted on transportation and on transportation cost only);

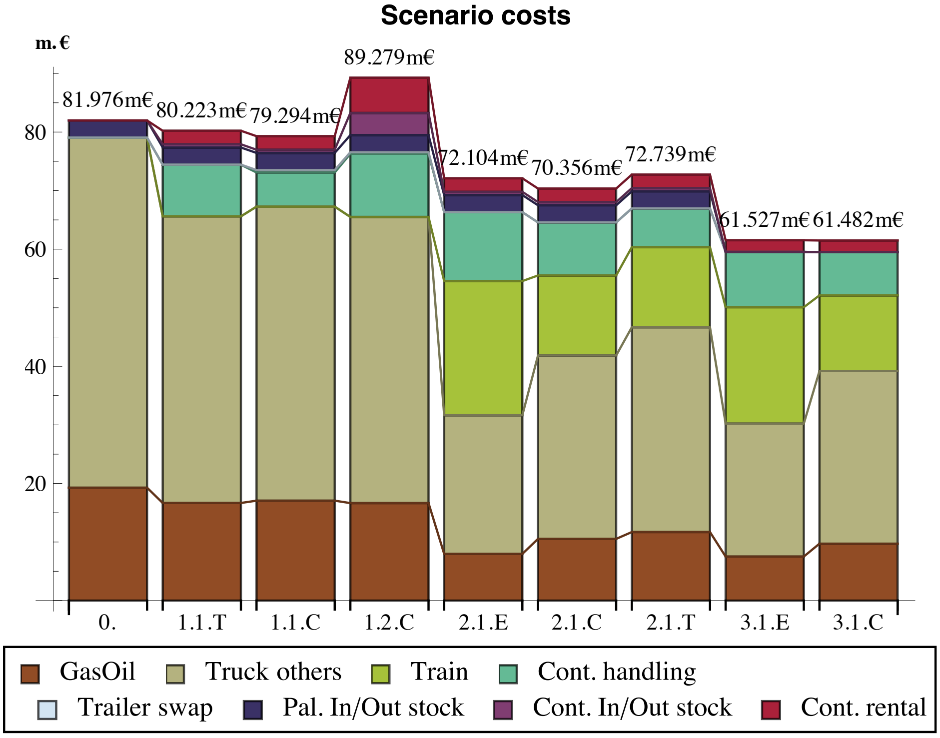

Figure 5 : coût des opérations logistiques par variante des scénarios

- One or two additional transhipments compare to actual current situation;
- A transportation lead time increased by few hours, fairly negligible compare to the duration of the complete order process;
- A potentially foremost reduction of CO_2 emissions thanks to a better use of transportation means and a shift to electrical trains. In France it is close to a factor 3 reduction.

Perspectives

Perspectives are at two levels: extend research and experimentations.

The proposed routing herein is mainly based on best path. However this best path could be jeopardized by the traffic of containers, the hub congestion or others unexpected events. The development of a more dynamic and decentralized framework is already forecasted to improve the current performances. At least we can look forward to a more advance utilization and deployment of the Physical Internet concepts overcoming the actual structure of supply networks to better fit with the Physical Internet network and especially the distribution web where the stock is set up in potentially all hubs.

These very encouraging results are also an incentive to expand our association with executives in these sectors to prepare experimentations to validate theoretical results with a business and operations perspectives as well to prepare the functional requirements essential for deployment on a global scale.

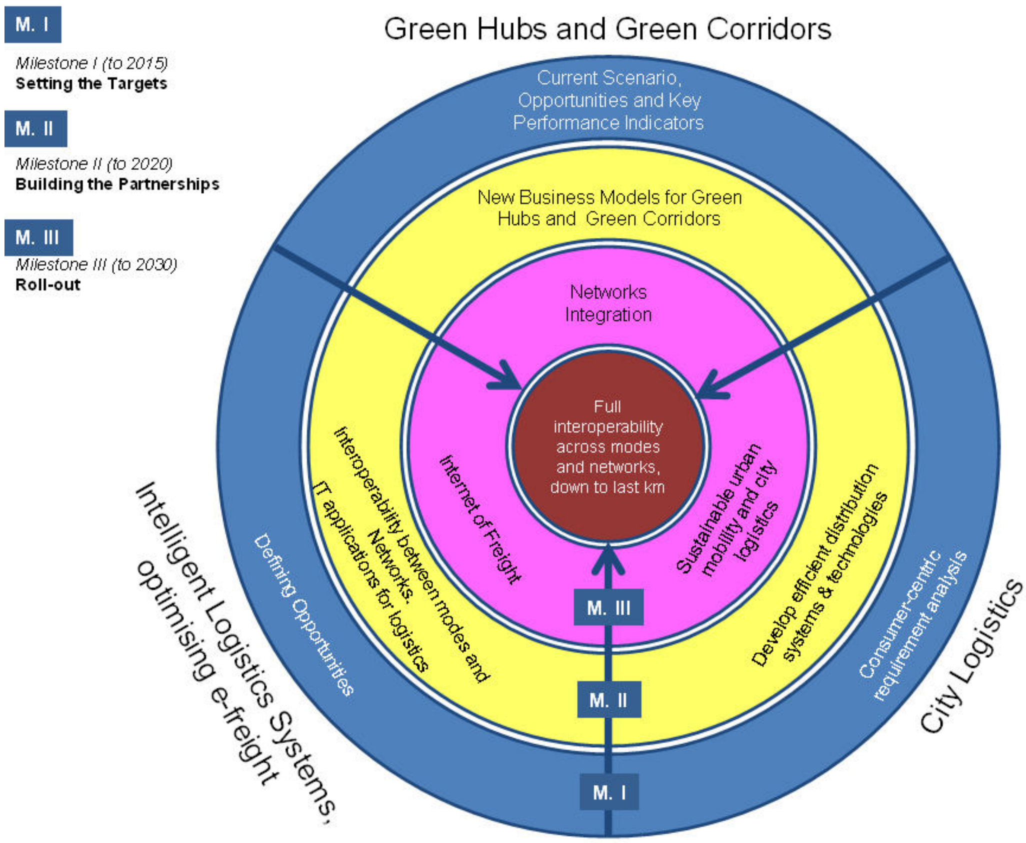

Figure 6: Multiannual logistics strategic Roadmap - European Green Cars Initiative PPP