Simulating Physical Internet Enabled DistributionWebs

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Plan

- Introducing the Physical Internet concept
- Research objective
- Describing the existing simulator supporting the mobility webs
- Upgrading the simulation model to support distribution webs
- Conclusion

The Physical Internet Initiative

Using the Digital Internet as a Metaphor for the Physical World

The Physical Internet (PI, π) initiative aims to exploit the Internet metaphor so as to propose a vision for a sustainable and progressively deployable breakthrough solution to global problems associated with the way we move, handle, store, realize, supply and use physical objects all around the world

B. Montreuil, Physical Internet Manifesto, Version 1.10.1: 2012-04-05, available at : http://physicalinternetinitiative.org/

Enabling a Logistics Web

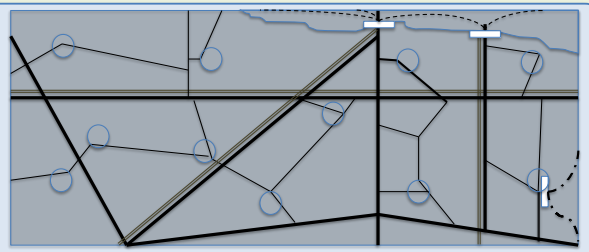
Logistics Web

Set of openly interconnected physical, digital, human, organizational and social agents and networks aiming to serve efficiently and sustainably the logistics needs of people, organizations, territories and society

Realization Web

Realizing products

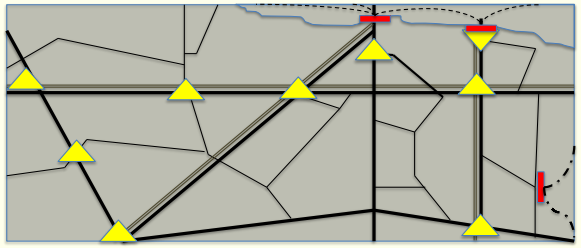
Interconnected open production, personalising & retrofit centers



Distribution Web

Deploying, storing products

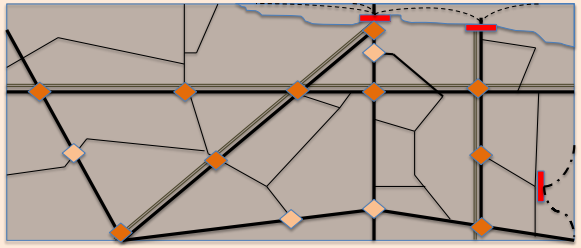
Interconnected open warehouses & distribution centers



Mobility Web

Moving goods & people

Interconnected open unimodal & multimodal infrastructures, movers, hubs and transits



Supply Web

Supplying goods

Interconnected open suppliers and subcontractors

Service Web

Enabling and sharing access and usage of services rendered by goods & people

Interconnected open users and service providers

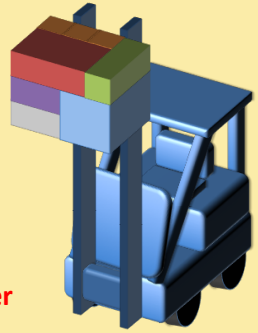
Port
Maritime route
Air route
Road
Railroad
Highway
Open it-Port
Open it-factory zone
Open it-store & it-distributor zone
Open multimodal it-hub & it-transit zone
Open unimodal it-hub & it-transit zone

B. Montreuil, Physical Internet Manifesto, Version 1.10.1: 2012-05-09, available at : http://physicalinternetinitiative.org/

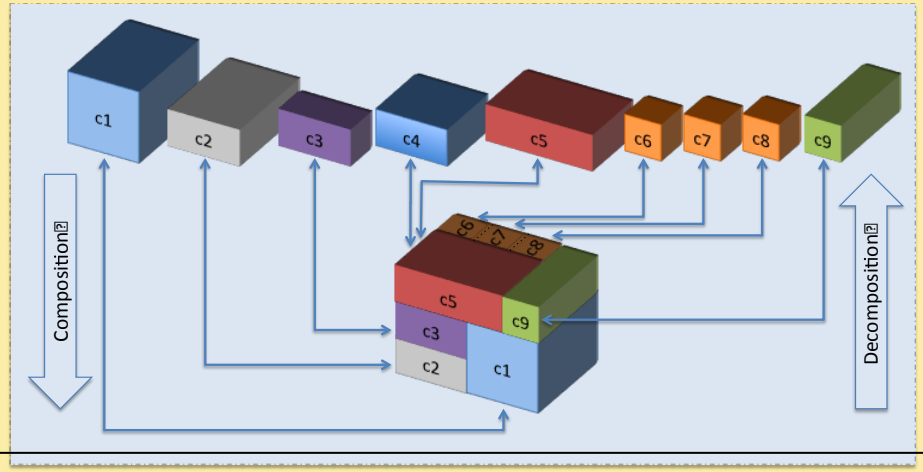
Supporting π-Containers

π-movers

A fork-less lift exploiting the snapping and interlocking functionalities of the **π-container**

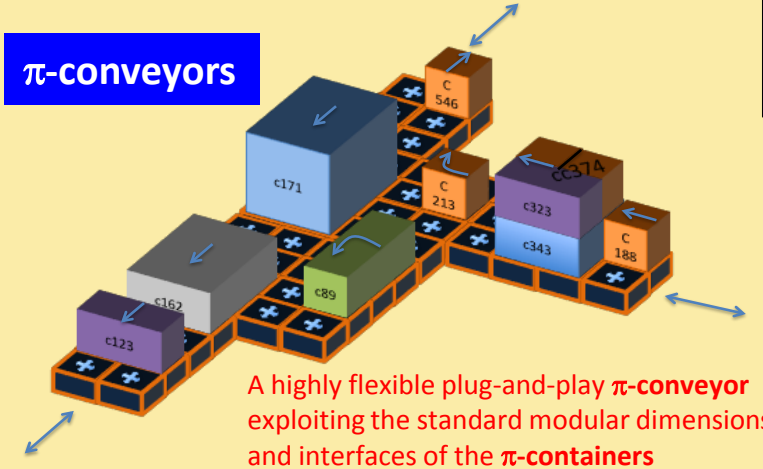


A **π-container equipped with wheels snapped through its standard modular interfaces**



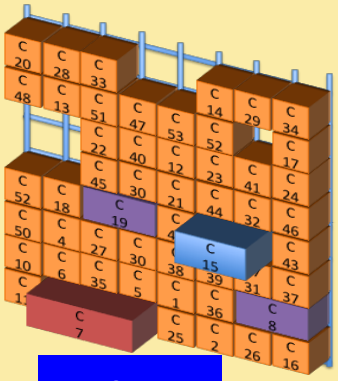
Modular and standardized worldwide in terms of dimensions, functions and fixtures

π-conveyors



A highly flexible plug-and-play **π-conveyor** exploiting the standard modular dimensions and interfaces of the **π-containers**

In **π-stores, contemporary racking can be used, however innovations in storage technologies exploiting the functional characteristics of modular π-containers are bound to be exploited**

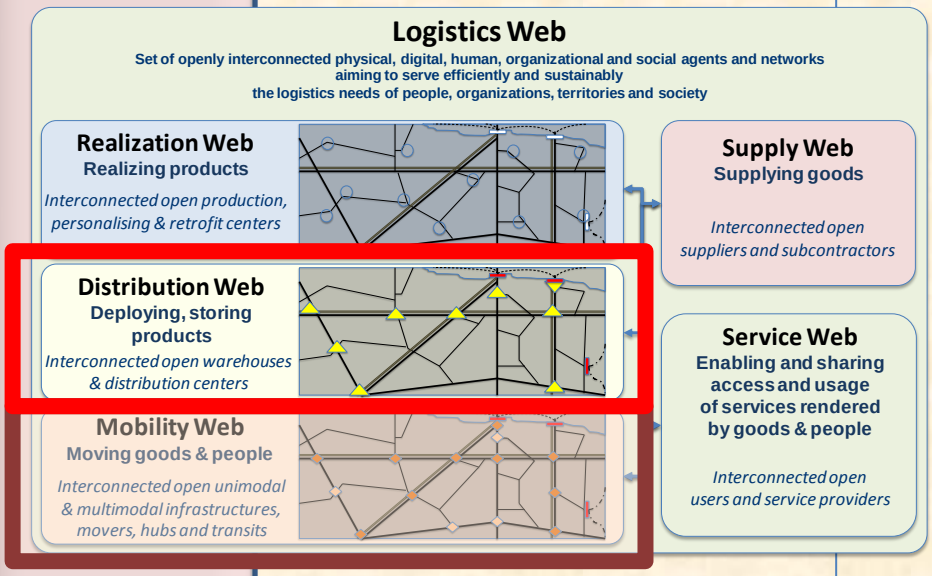


π-stores

In **π-stores, modular π-containers can be stacked as in container port terminals**

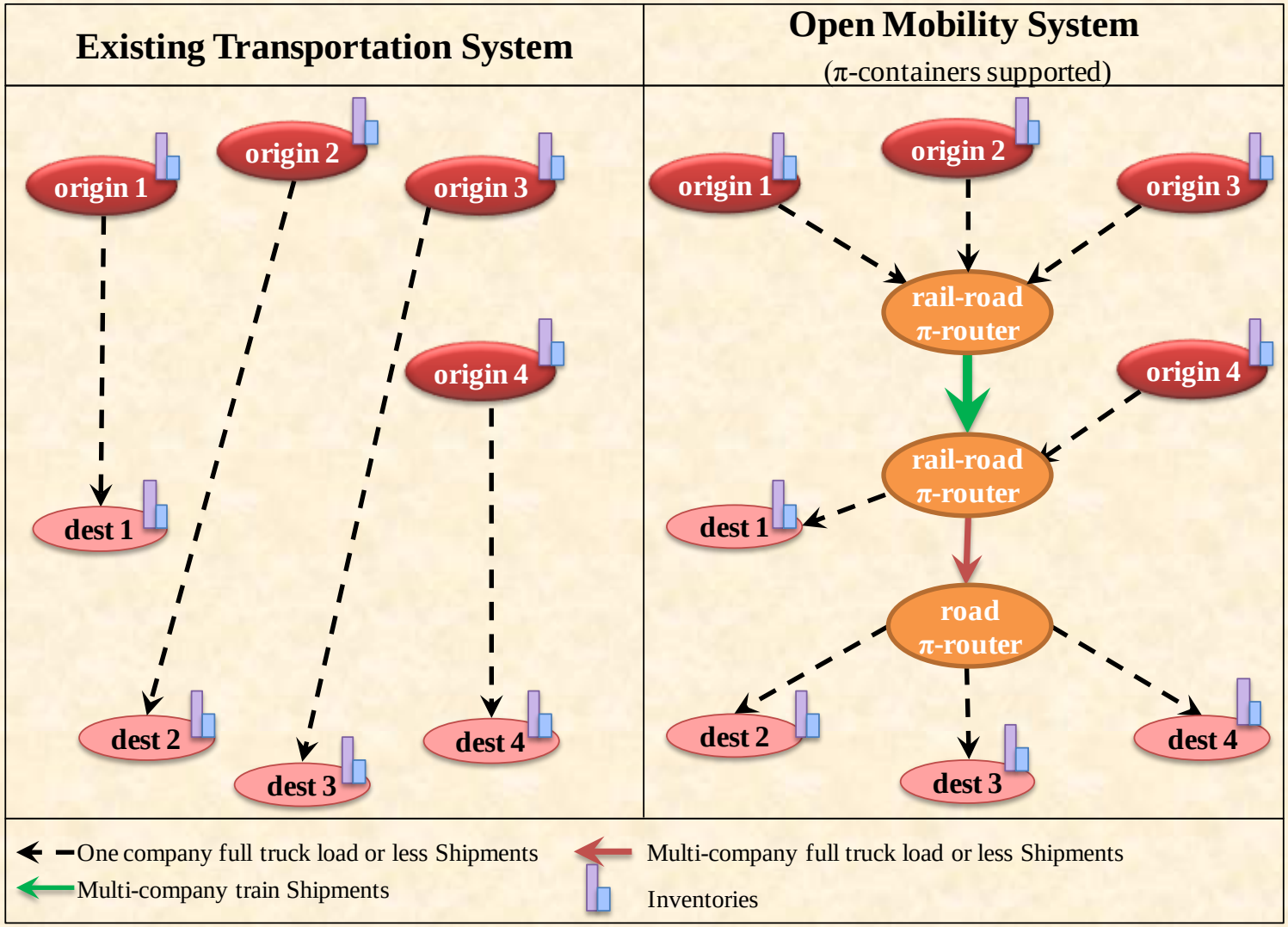
Reference: Montreuil, B., R.D. Meller, E. Ballot (2010) *Towards a physical internet: the impact on logistics facilities and material handling systems design and innovation*, in Progress in Material Handling Research, Edited by K. Gue et al., Material Handling Industry of America, 23 p., 2010.

Research Objective

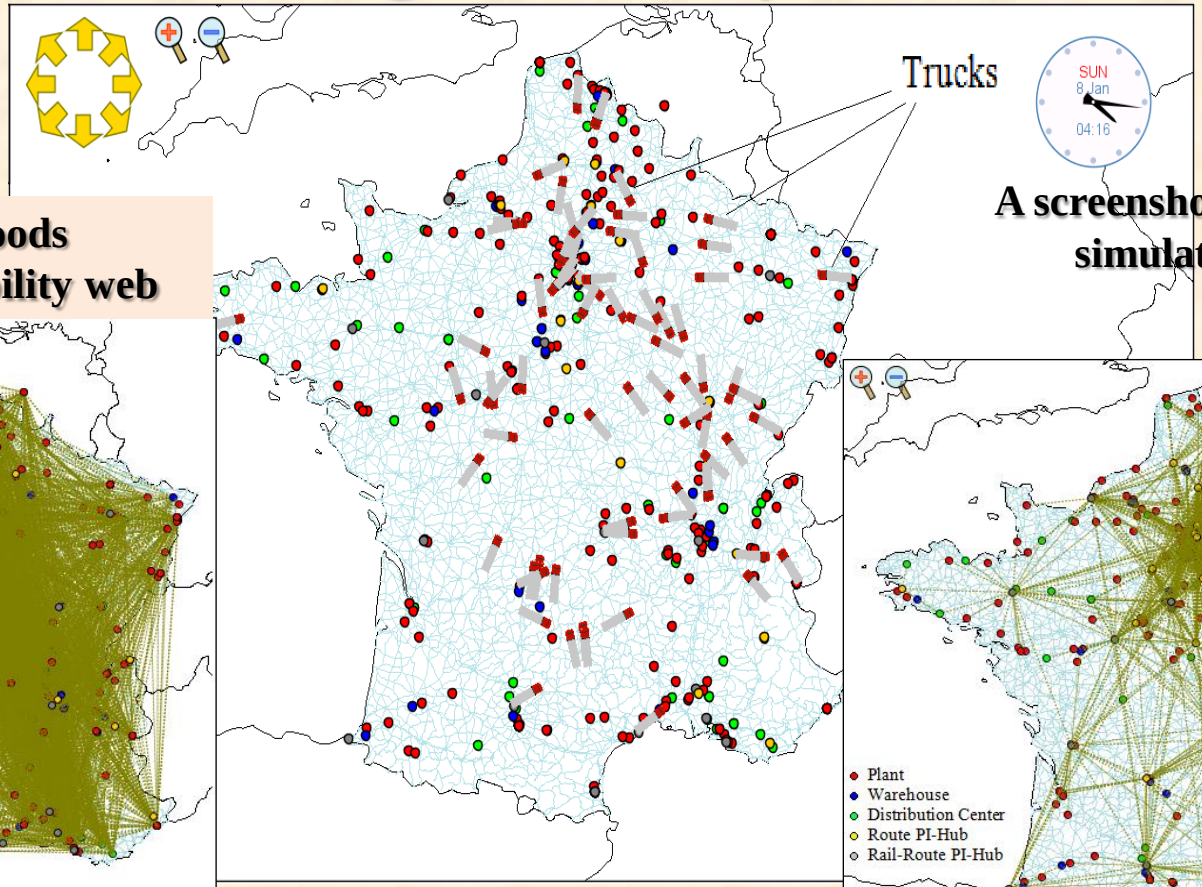


- General objective
  - Provide **holistic simulation** to study the economic, environmental, and social implications for evolving toward a **π-enabled Logistics Web** in France
    - **Mobility Web** simulations are **already supported**
- Objective of the current step
  - **Integrate** the simulation of **Distribution Webs**
    - **A multi-agent conceptual model**

Simulating Mobility Webs

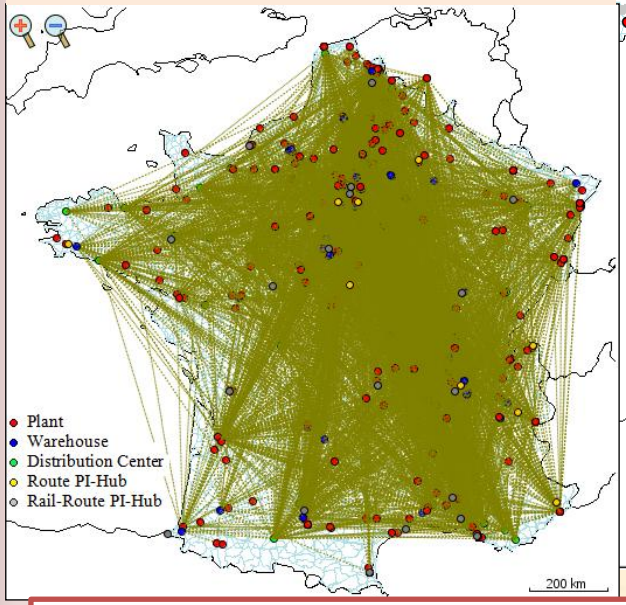


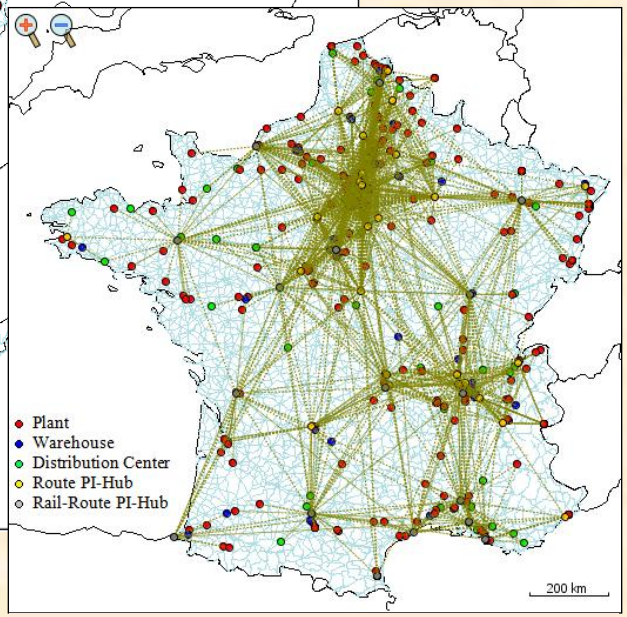
The Existing Mobility Web Simulator



A screenshot of the main simulation view

The flow of goods in the existing mobility web



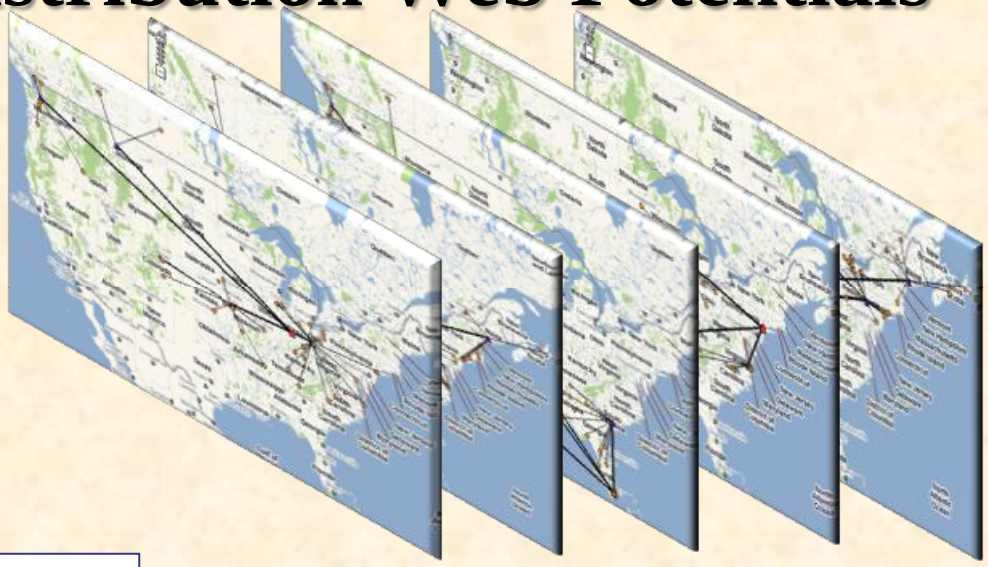


The flow of goods in a π-enabled open mobility web

- **Preliminary results:**
  - **Truck Fill rate: +15%; CO2 Emission: -12%~-55% (modal shift to electric train); Logistics cost: -4%~-30%**
- **Integrating distribution web is expected to result in even greater results**

Illustrating Distribution Web Potentials

Activate and exploit an Open Global Distribution Web

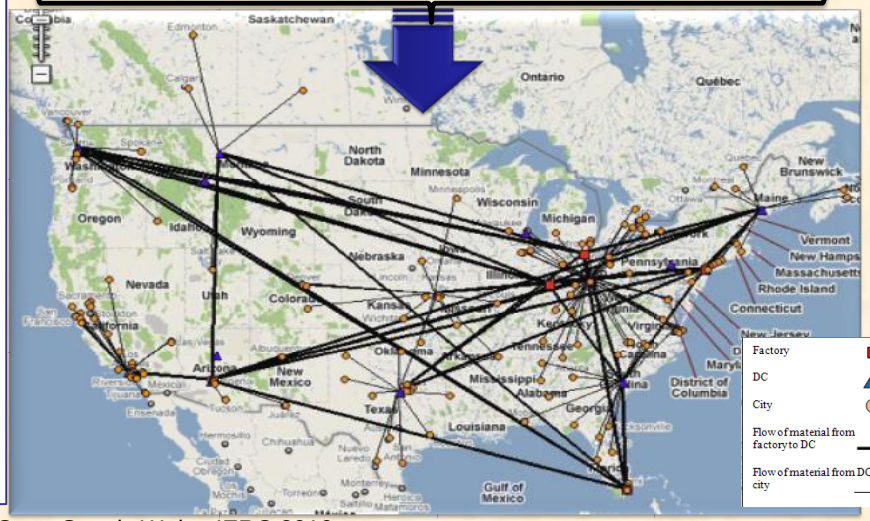


Most companies design, run and optimize independently their private distribution networks, investing in DCs or engaging in long-term leases or contracts

There are 535 000 distribution centers in the U.S.A. only

Most of them are used by a single company
Most companies use less than 20 DCs

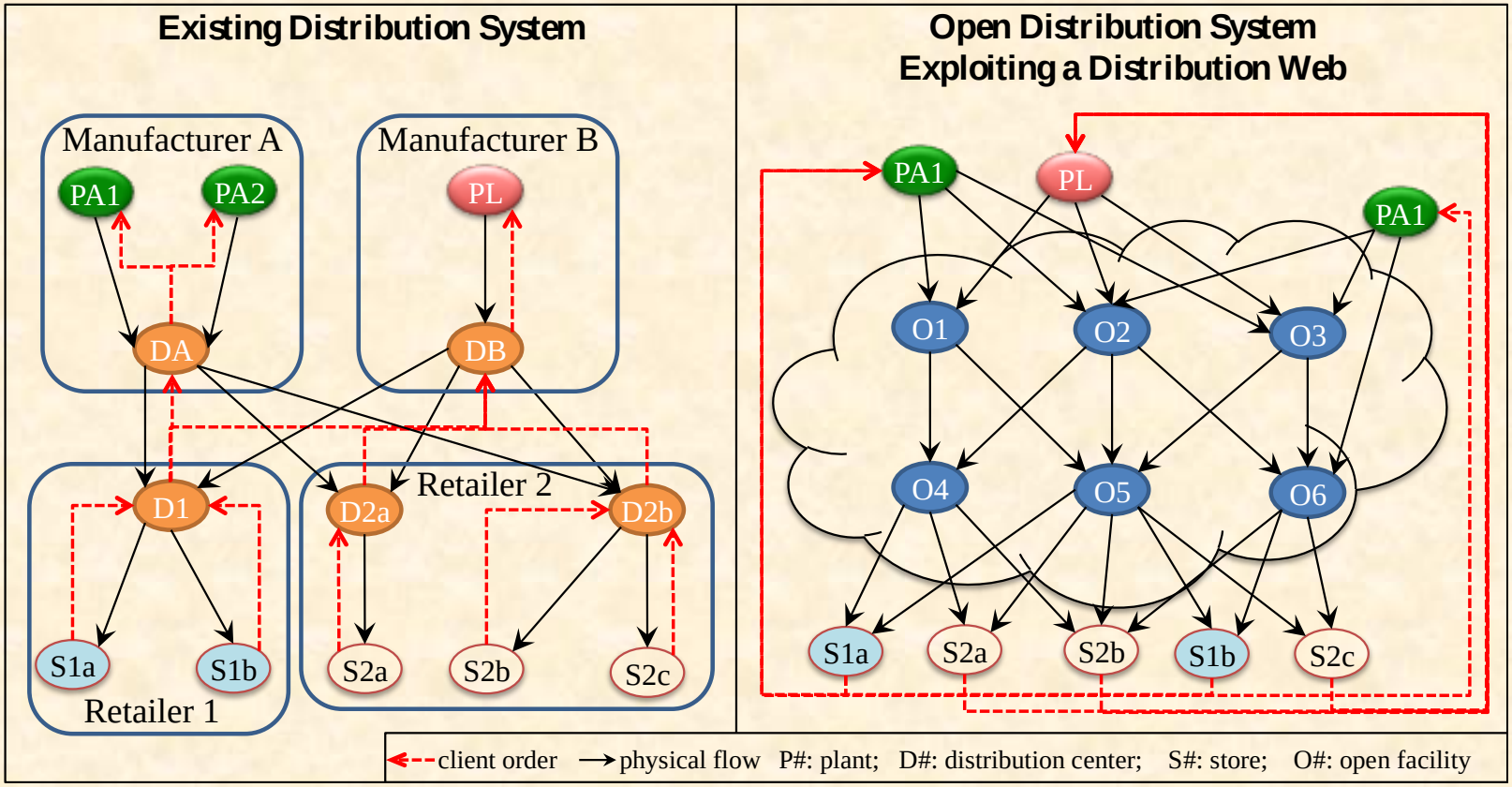
Imagine the potential if each company could deploy its products through a open web including 535 000 open DCs in the USA



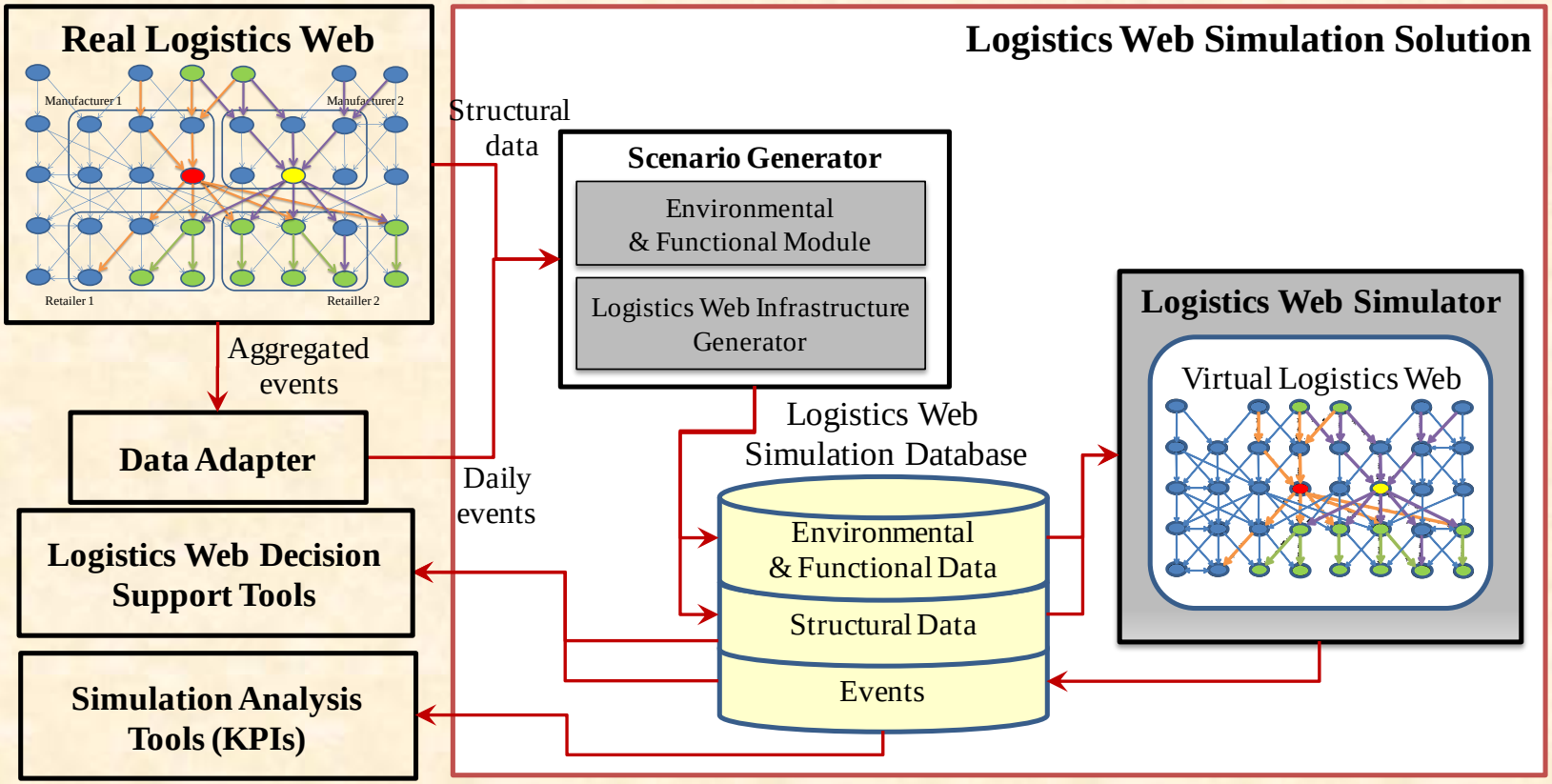
Reference: Montreuil and Sohrabi, From Private Supply Networks to Open Supply Webs, IERC 2010

Illustrating a Distribution Web

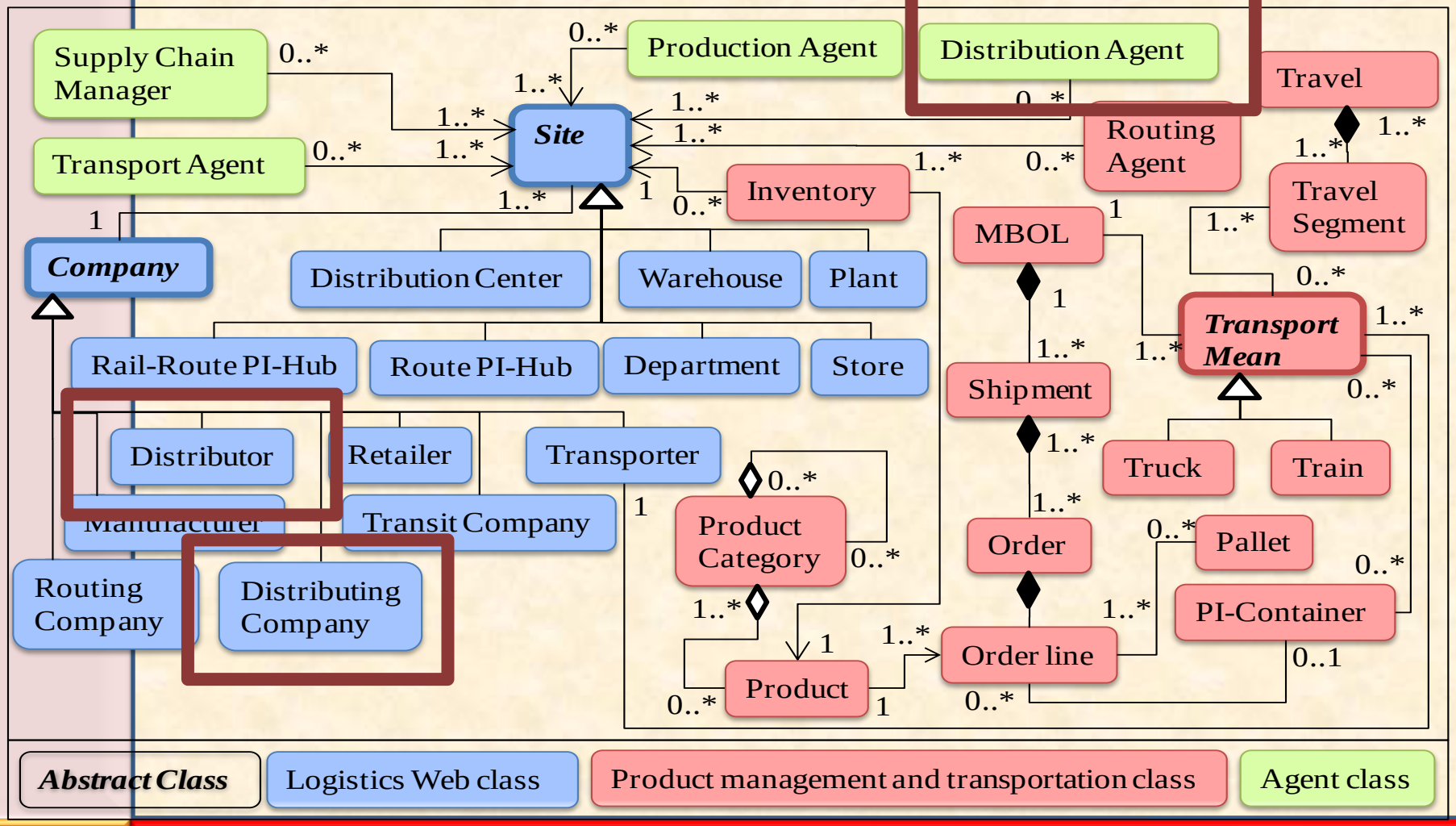
Dynamically Deploying Stock Across the Distribution Web for Efficient, Fast & Agile Customer Response



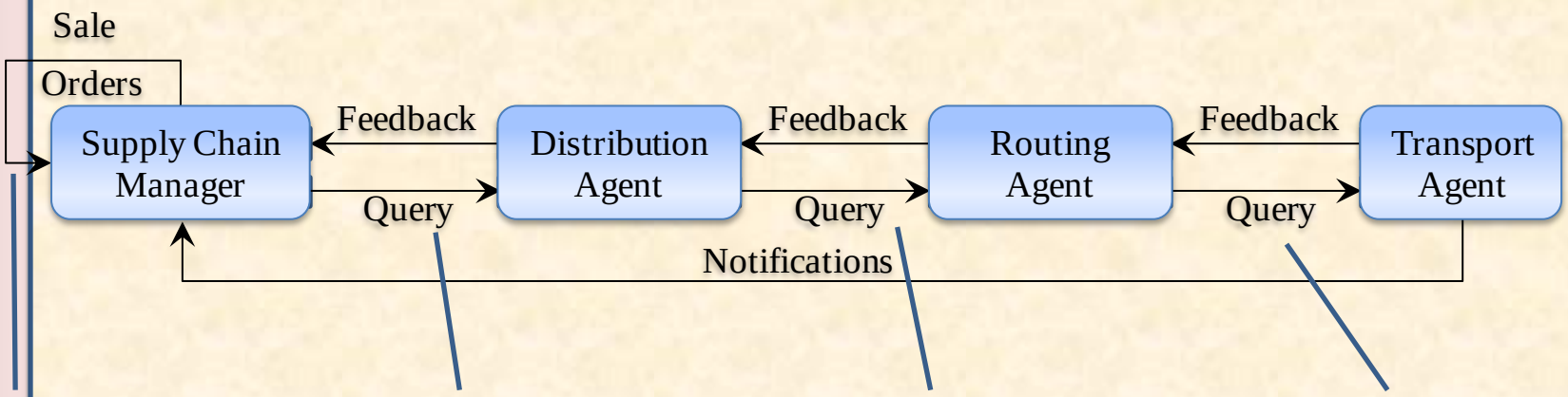
The Simulation Solution Architecture



Integrating the Distribution Web Capability into the Simulation Model

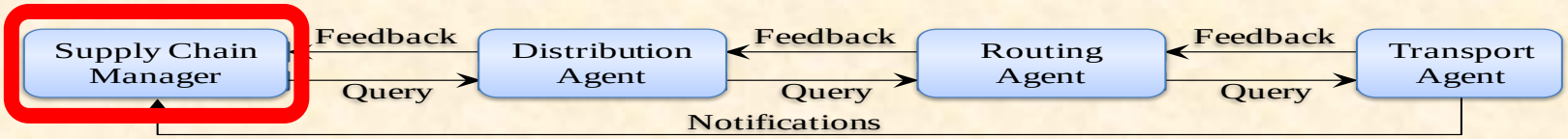


The Agents' Interactions



Place Orders, and Plan and manage shipments	Find a π-node where to store, deploy, or ship a π-container	Find the entire path for a π-container's travel from an origin to a final destination	Transport a π-container on a certain segment of the travel
Supply Web Functions	Distribution Web Functions	Mobility Web Functions	

Supply Chain Managers



Existing Logistics System

- **Placing orders** to suppliers
- **Managing the inventory** of their sites
- Handling **customer orders**

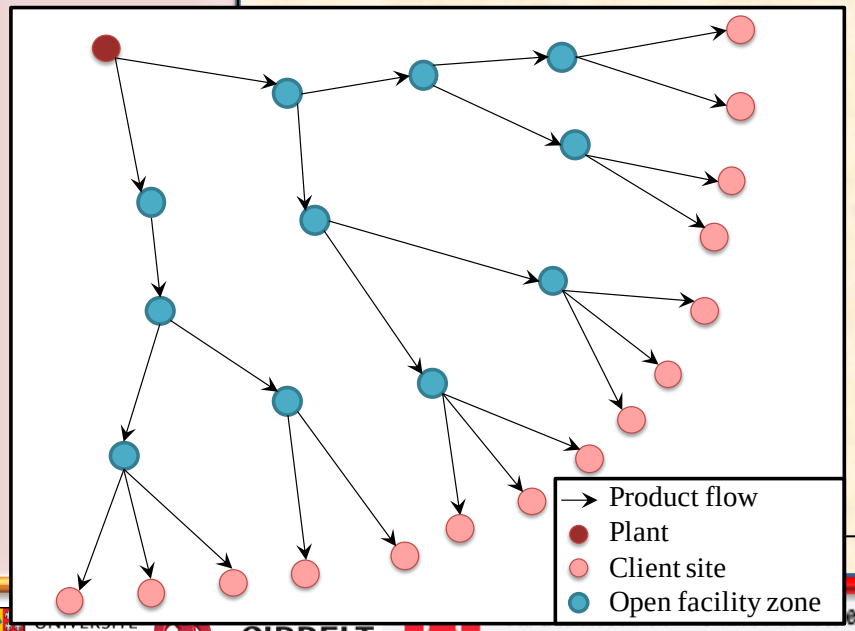
Logistics Web System

As customer

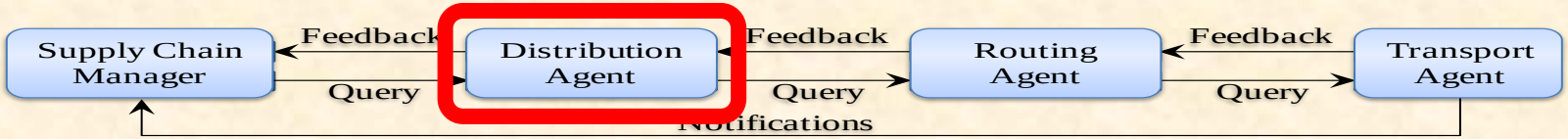
- Placing orders to plants
- Managing the inventory of their sites

As suppliers

- Designing the **distribution network** for their products
- Managing the **inventories** in each **open zone** of the distribution network
- **Placing orders** to control the inventories in each open zone
- **Monitoring the order handling**



Distribution Agents

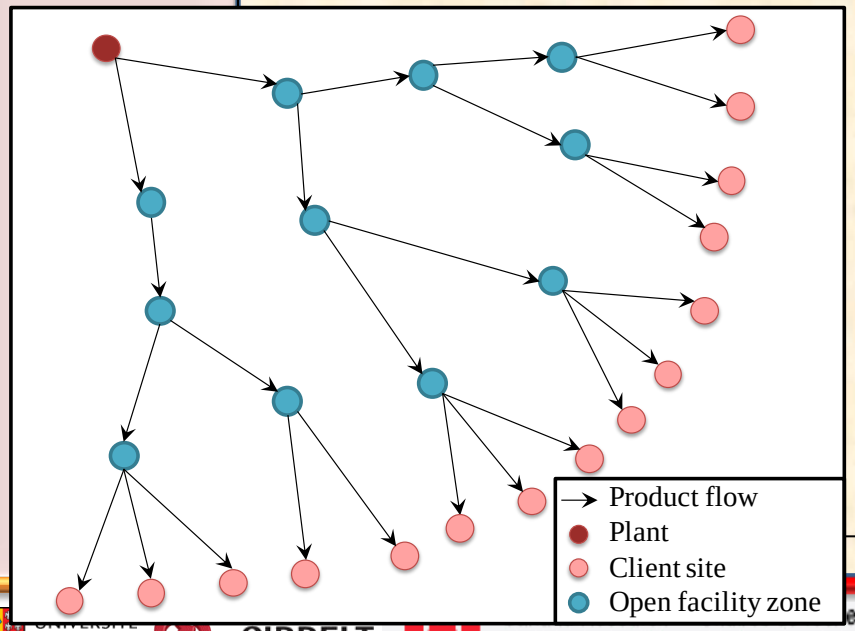


Existing Logistics System

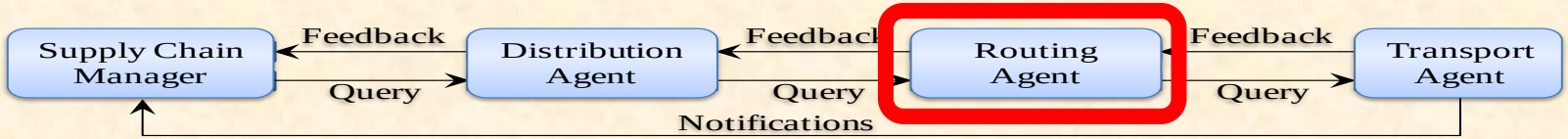
- Not applicable

Logistics Web System

- Put orders in **π-containers**
- Determine the **origins** of shipments
- Determine the exact **destination** site for each π-container if it's not already defined by the supply chain manager
- Manage the **excess of storage** space in sites belonging to their company.



Routing Agents



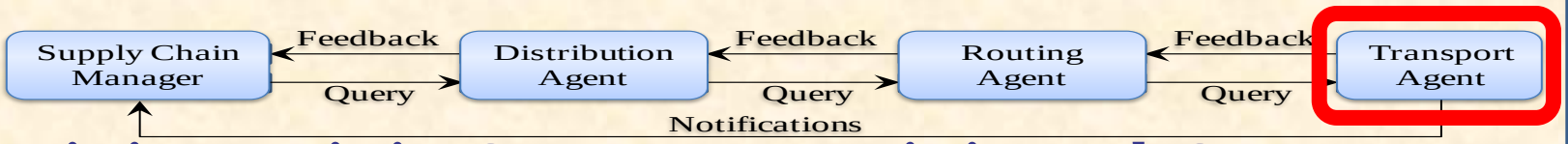
Existing Logistics System

- Not applicable

Logistics Web System

- Determining the path segments, the π-hubs, and, depending on the scenario, the transport means, of the containers travels
  - Estimations requested by distribution agents
  - Static vs. dynamic routing
- Making reservations

Transportation Agents



Existing Logistics System

- Associating master bills of lading with transport means
- Loading transportation means and authorizing their departures
- Monitoring travels
- Delivering and unloading products at destinations

Logistics Web System

- Associating π-containers with transportation means
- Managing transportation means' schedules
  - Maximizing loads
- Loading and authorizing departures
- Monitoring travels
- Delivering and unloading products at destinations

Conclusion

- **Holistic** simulation of Logistics Web
  - **Mobility** Webs (advanced versions)
  - **Supply** Webs (partially)
  - **Distribution** Webs (conceptual model)
  - **Realization** Webs (not yet)
- Study and quantify the impact in terms of **economical**, **environmental**, and **social** efficiency and performance of **evolving** from the current system of freight transportation **toward open logistics webs**
  - The simulation of mobility webs promises important gains
  - That of distribution webs will lead to **much higher level improvements**

Thank you for your attention!

Welcome to your questions and comments.

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www.PhysicalInternetInitiative.org