Addressing Urban Congestion with Modular Logistics and Collaborative Networks
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Extended abstract

Objectives and motivation
Increasing freight delivery in urban areas is a major contribution to traffic congestion, and congestion affects the timeliness and reliability of freight delivery. At the same time, citizens moving in urban area are also contributors to congestion and suffer traffic delays in their movements. Urban mobility and related social and environmental aspects are negatively influenced by these events. Moreover, authors believe that nowadays e-commerce with door to door delivery to customers’ home, of goods bought on the internet, has increased urban area presence of express couriers vehicles. The consequence is that e-commerce call for multiple 3PLs, trying to satisfy strictly SLA and with reduced time windows, moving across the urban areas, with almost empty carriers, often double-parking and obstructing private cars and public transportation (Fatnassi et al., 2014). At the same time, citizens continue to move with their own cars for shopping in the city where public transportation are not well suited for supporting such needs. In fact, nowadays e-commerce logistic deliveries are based on the integration of private and closed distribution networks. The resulting systems suffer inefficiency and unsustainability symptoms such as lack of distribution centres, plurality of 3PL carriers using a lot of vehicles, travelling under-using their capacities (Naccache et al., 2014). So, while B2C is receiving an increasing popularity by the citizens, at the same time it is also a source of congestion and pollution increasing CO2 footprint. Improving the sustainability of city logistics requires the deployment of solutions that addresses the three big challenges: social, environmental and economic. Such challenges are considered in the base statement of the Physical Internet Initiative (Montreuil, 2013). Physical Internet consider getting products in and out of cities is a nightmare, in fact most cities are not designed and equipped for easing freight transportation, handling and storage, making the feeding of businesses and users in cities a big problem. Therefore one of the main point the initiative try to address is solving and reorganizing the supply chain network using modular containers (Montreuil, 2013). The urban logistics is the last link in the supply chain and involves the major number of stakeholders: the carriers, the citizens, the public administration, public transport operators, retailers, etc. It is a small part in the total distance covered by the products along the supply chain, nonetheless it can represent up to 28% of the total transportation cost. At the same time it may induce between 16% and 50% of the overall air pollution, caused by transport activities in a city area. Solutions to urban congestion and pollution is usually based on a try-and-see method, which results are evaluated only ex-post (Faure et al., 2014). Feedback and actions, consequences of the ex-post evaluation are often too slow regarding the processes they are intended to address. One option to address this problem has been based on integration of personal rapid transit and freight rapid transit in urban areas (Won et al., 2006). Summarizing, many ideas for optimizing the logistics in urban areas fall in two possible categories. One is the development and optimization of the existing transportation modes and service level. The other is to build innovative logistics initiatives, aiming at collaboration between participants in logistics processes and interoperability between different logistics networks. The objective of this work, then, is to consider which methodologies and procedures may be applied, to urban logistics, in order to harmonize freight delivery and people mobility. The intention of the authors is to provide a clear view of the principles that should be adopted for aiming at optimizing efficiency and sustainability of the urban mobility.

General description
The first concept we considered, is the reorganization of logistics networks inside the cities. Physical Internet (PI) call for structured networks, changing from an hub and spoke approach, with few distribution centers and many connections between them, to a network systems based on multiple nodes, interconnected with multimodal links, which is identified as mobility web. Nodes and links redundancy, coupled with multimodal options for carrying the goods, allows for spreading of delivery on multiple links, decreasing congestions. However, in order to avoid increasing in time movements, travelling almost empty (average 40%) further hypothesis are needed. There is the necessity for using modular containers (x-containers), another base idea of the PI. All the objects that have to be delivered have to be encapsulated in standardized containers easy to handle, store, transport, interlock, load and unload. They enable transport means optimal filling, while enabling an increasing of goods movement automation. Moreover, containers are interconnected to the ICT systems supporting PI, in order to track and trace them and have information on their status. Modular containers enable collaboration in performing the delivery of the goods in the urban area. 3PL may collaborate in delivering the shipments, using less vehicles while they are optimally filled. This objective may be achieved considering a resources pooling approach, in which 3PLs shares the responsibility for the deliveries.

One of the most relevant principles of the PI states that: the objective is the routing of goods not vehicles. The ICT supporting systems play a very relevant role in the management of the deliveries, in order to plan in advance the routing of the modular containers through the mobility web, booking space on the carriers, and coordinating the intermodal behaviour. Moreover, collaboration between partners have to be achieved through interoperability between ICT systems. Exchange and sharing of logistics data enable the application of data analytics approach in order to discover hidden relationships between data. Data and theirs relationships analysis provide information about performances of the deliveries, type of goods shipped and their localization, and so on. Extracting and organizing this information provide valuable knowledge on the logistics processes, which may be used for improving the efficiency and sustainability of the urban logistics. Authors participated in the project Modulushca, the first research project funded by the European Commission for the
application of the PI concepts, where they have contributed in defining a Common Data Model, for supporting PI data sharing, and an high level architecture, for handling logistics process with a collaborative approach leveraging modular containers. Another concept that is important is the integration of multiple services and of direct and reverse logistics, using modular containers. The principle to be achieved here is that the last mile of a delivery process may become the first mile of another process. Moreover, integration of multiple services may be also considered for integrating goods delivery with people mobility, i.e. public transportation vehicles may be shared for processing using, a network, transporting one kind of goods may enter and exit Hyperloop at stations located either at the ends of the tube, or pressure tube, supporting such a new mode of transport that seeks to change this paradigm by being both fast and inexpensive for people and goods. Hyperloop consists of a low pressure tube with capsules that are transported at both low and high speeds throughout the length of the tube. The capsules are supported on a cushion of air, featuring pressurized air and aerodynamic lift. The capsules are accelerated via a magnetic linear accelerator affixed at various stations on the low pressure tube with rotors contained in each capsule. Passengers may enter and exit Hyperloop at stations located either at the ends of the tube, or branches along the tube length.

Results and conclusions
In this work authors explore the viability of innovating the logistics networks for delivering goods, integrating services and modes, following the principles of the PI and exploiting the modular containers concept. Encapsulation, tracking and tracing, sharing of vehicles and facilities, are ideas that may improve urban logistics efficiency and sustainability, decreasing congestion. They proposes also a novel approach for introducing pneumatic tubes as a method for moving goods, in silent and clean way.

References
- Fatnassi E., Chaouchi J., Klibi W., "Towards creating sustainable urban areas: a shared passengers and goods on-demand rapid transit proposal", 1st Physical Internet Conference, Québec City, Canada, May 28-30 2014.

Keywords: urban logistics, physical internet, modular logistics, pneumatic tube, collaborative networks.