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“ФІЗИЧНИЙ ІНТЕРНЕТ” ЯК НОВА ГЛОБАЛЬНА ЛОГІСТИЧНА КОНЦЕПЦІЯ

Наведено загальний огляд логістичної концепції “фізичного Інтернету”. Особливу увагу приділено ключовим принципам цієї концепції. Наведено дефініцію поняття “фізичний Інтернет”. Аргументовано доцільність упровадження принципів концепції у діяльність та функціонування глобальних логістичних систем, зокрема на рівні логістичних фірм. Окремо висвітлено стан реалізації у Європі, США та Канаді проектів, розроблених на основі цієї логістичної концепції.

Ключові слова: глобальна логістика, “фізичний Інтернет”, логістичні операції, крос-докінгові термінали, фізична мобільність об’єкта.

“THE PHYSICAL INTERNET” AS A NEW GLOBAL LOGISTICS CONCEPTION

The general overview of the logistics concept of “the physical Internet” is provided. Particular attention is paid to the key principles of this concept. The definition of the term “the physical Internet” is determined. It is reasoned the expediency of implementation of the concept principles in the activity and functioning of global logistics systems, including the logistics companies level. The state of projects implementation developed on the basis of this logistics concept in Europe, USA and Canada is provided separately.

Key words: global logistics, “the physical Internet”, logistics operations, cross-docking terminals, physical mobility of objects.

Problem formulation. Through assessment of the role of the Internet in the development of the logistics industry it should be noted the importance of its existence for logistics activities. Software in logistics has become available not only for controllers, allowing them to control the logistic processes around the clock, but also for the suppliers who provide assistance in case of problems in logistics operations based on warehousing and transportation software that integrates and optimize data providing them online access at any time of day or night.

However, processes of logistics management are not perfect yet and new concepts of global optimization of physical mobility of objects need to be implemented.

Analysis of current research and publications. The way physical objects are moved, handled, stored, realized, supplied, and used throughout the world is not sustainable economically, environmentally,

or socially. Vehicles leaving loaded get emptier and emptier as their route unfolds from delivery point to delivery point. This inefficiency has a huge impact on the environment and on the profitability of both manufacturer and carrier. Products commonly travel thousands of kilometers, which can be avoided by making or assembling them much nearer to their point of use [1].

Thus, it is needful to implement some new way to solve these problems. The concept of the physical Internet under condition of its full-scale implementation may be the best resolution of the problems with the way physical objects are moved, stored, realized, supplied and used.

Jean-François Rougès, Yan Cimon and Diane Poulin consider that the Physical Internet, building on the analogy of data packets within the Digital Internet, is a concept that dramatically transforms how physical objects are designed, manufactured, and distributed. This approach is open, efficient, and sustainable beyond traditional proprietary logistical solutions, which are often plagued by inefficiencies. The Physical Internet redefines supply chain configurations, business models, and value-creation patterns [1].

The concept of "the physical Internet" is described by such scientists as Benoit Montreuil, Russell Muller, Kimberly Ellis and other scientists of Canada and USA.

In Ukraine, the term "physical Internet" has not found its reflection in the scientific literature, the articles or publications Ukrainian scientists yet.

Article objectives. The purpose of the article is revealing the meaning of "the physical Internet", representation the characteristics of the main principles of this logistics concept and definition of existing projects based on "the physical Internet" and the state of their implementation.

Presentation of main materials. The Internet provides timeliness and efficiency of global data distribution. Now the researchers want to do the same for the physical distribution of products by creating "the physical Internet". The aim of the "physical Internet" is to ensure the stability of the global mobility of physical object as well as its storage, sale, supply and use [2]. Basically it is the ability to provide the most effective way to move goods to any place in a short time. Professor at the University of Laval in Quebec (Canada) Benoit Montreuil, who first introduced the concept of "the physical Internet", based on the analyzed statistics, concluded that modern logistics system uses less than half of their transport capacity, and therefore there is a need to implement a new model of this system [3]. Thus, the physical Internet was the brainchild of Benoit Montreuil, a member of the College-Industry Council on Material Handling Education (CICMHE). In 2006, Montreuil began wondering how distribution and logistics would be improved if we applied some of the principles of the digital Internet to the physical movement of goods. Since then, he has been joined by other researchers in the US and abroad to explore that possibility. The idea for a Physical Internet took shape in June 2006, when Montreuil picked up a copy of The Economist magazine. The issue included a series of articles about contemporary logistics titled “The Physical Internet” .

"The Physical Internet" is an open global logistics system that uses physical and operational interconnected supply chains of goods through the standardization of packaging and interfaces, common protocols and modular containers. Russell Meller, professor of industrial engineering at the University of Arkansas and director CELDi (Center for Excellence in Logistics and Distribution), said that the purpose of future joint logistics research is to study the potential use of modular containers in the distribution of goods in logistics system [4]. "The Physical Internet" is aimed to transfer products in standardized packages through a global network with great efficiency. From an environmental point logistics and transport are among the largest energy consumers in the world. Emission of harmful gases raises from year to year while the majority of countries wants to reduce these figures. Logistics and transport in their present form are inefficient and wasteful. Even with routing and scheduling software there are a lot of "free travels", which, according to the new model, should be used efficiently [1].

The Physical Internet proposes an efficient system in which global supply-chain logistics are enabled by an open, intermodal (transportation by land, rail, ship or barge) system that uses standard,

modular and re-usable containers, real-time identification and coordinated routing through shared logistics facilities. In other words, all supply-chain stakeholders – manufacturers, transportation providers and retailers act independently to use a shared logistics network that increases the size of trailer loads and reduces or eliminates miles traveled by empty trailers.

The new logistics concept is based on several principles. The first principle is the interrelatedness which means that the logistics of many countries have unique standards, for example, 48X40 inches pan is commonly used in the USA but not in Europe or Asia. Similarly, conveyor of the supplier may not coincide with the parameters of another one, and the goal is to standardize the material means of providing logistics activities.

The second principle is the encapsulation, which means that "the physical Internet" will not handle the cargo, but only with packages of goods, just as ports serving only the containers. Logistics processes are taking place not only within the logistics centers and ports, so beyond them is difficult to identify exactly how distribute further the supply chain of hundreds of different packaged goods. It is supposed the standardization of sizes of containers that will be used worldwide. For a start, it refers to maritime containers and truck trailers. The space inside them will be increased as much as possible and regardless of their size they must be environmentally friendly.

The third principle provides the safety of cargo. Regardless of size and design, the containers will be stamped just as shipping container is.

Attention is also given to cross-docking terminals where goods in the warehouses of the incoming transport are unloaded, sorted and transported in specially designated for each client place where they are loaded directly into the output transport for immediate delivery to the customer. The concept of warehouse management aims to implement economy of transportation cost by consolidating shipments differences without requiring excessive inventory of goods.

Warehouses will be able to receive containers from other companies as well as ports. Cargos will no longer be delayed in stock within a few days or weeks. Within an hour after arrival at the warehouse container will be loaded and shipped according to the supply chain.

Table 1

Physical Internet Founding Principles

Founding Principles	Organization Principles	
Instrumentality	Interconnectivity	Encapsulation
Responsibility	Uniformity	Contracting
Metasystemization	Accessibility	Certification
Openness		
Universality		

Source: [5]

Logistics concept of "the physical Internet" is reflected in the projects in the USA, Canada and EU. Together with Kimberly Ellis, represented the Polytechnic University of Virginia, Russell Muller received a grant of $197,000 from the National Science Foundation to study the effectiveness of introducing the concept of "the physical Internet". Project partners include such companies as HP, P&G, Boeing, Walmart, RedPrairie, ATRI, Menasha and others.

An American research team confirms the high potential of the physical Internet. They estimate that if 25 % of the US supply chain would use the physical Internet, It could boost profits by $100 milliards per year and cut greenhouse gas emissions by 33 % [5].

Russell D. Meller (Arkansas) and Kimberly P. Ellis (Virginia Tech) in their paper "Establishing the Physical Internet Based Logistics System Gain Potential for the U.S." consider that with the Physical Internet (at 25 % adoption):

- cost per load decreases 29 %;
- average fullness increases 34 %;
- drivers can return home every 2–4 days at approximately the same cost as today [5].

The EU initiative of "the physical Internet" gained support and was reflected in the program Modulushca [2]. Its aim is to ensure the global synchronization and simultaneous implementation of similar projects in the USA and Canada as part of the international initiative "the physical Internet".

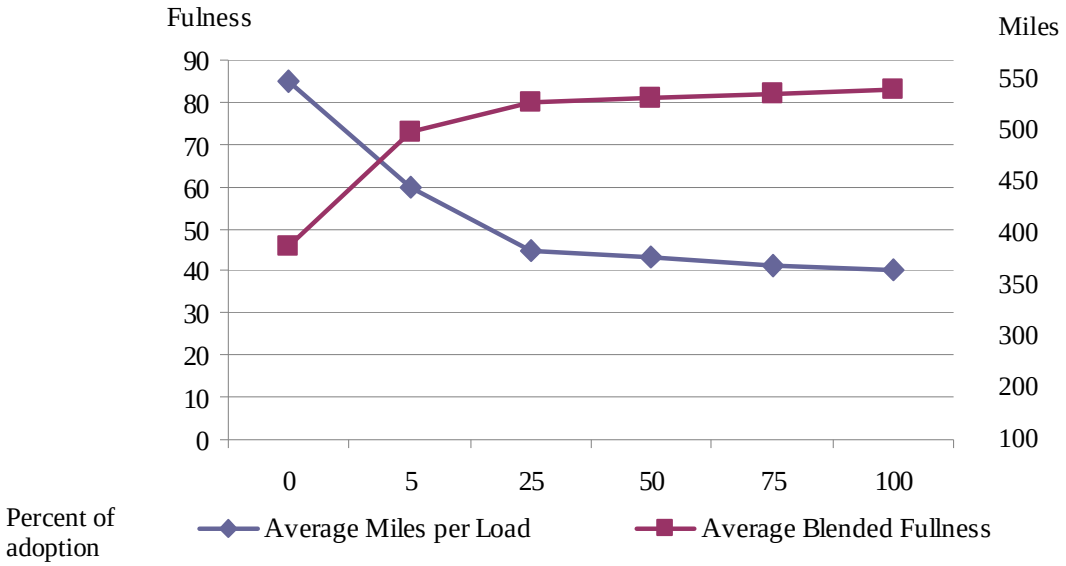

Fig. 1. Load Planning Modeling Summary

The main benefits can be summarized as follows:

1. Demonstrate the technical, digital and operational feasibility of seamless handling of cargo within supply chain operations across companies and transport modes.

2. Recommending industry standards for ISO modular logistics units to be deployed along the entire supply chain of different branches for a European wide and global market introduction.

3. Develop models to assess the supply chain benefits providing a methodology for cross process and cross company supply chain analysis for industry and policy makers.

4. A clear information handling approach, including data consistency and transport monitoring along the journey as model contributing to extend and enhance standardization developments in eFreight and iCargo.

5. Developing optimization algorithms for loading capacity optimization and scheduling transferring especially to SME user groups.

6. Enhance the innovation process at the interface material and transport flow to stimulate a gradual market take up and implementation process.

7. Stimulate the market uptake of new interconnected logistics systems and other innovations developed and tested within the project and thereby increasing the viability of the implementation [2].

It should be noted that the project is clearly structured and includes 8 items:

1. The project management;

2. Creation of interconnected script optimization of logistics processes;

3. Determination of size and interfaces for small and medium-sized logistics modular units;

4. The development of information structure for modular logistics units, which will provide consistency of data and information management, reliability, and privacy (digital relationship);

5. Constructing solutions to reduce costs and emissions of CO_2;

6. Implementation of pilot projects with the participation of stakeholders;

7. Dissemination and exploitation of project (simultaneously with the embodiment of those in the USA and Canada);

8. Engineering management [2].

Modular logistic may be built upon existing systems, integrating the current processes with the needed data and the related operation. The introduction of the modular containers and the related processes may be seen as an evolution rather than a revolution.

A structured network is the conceptual approach that may allow in realizing the modular logistics, as proposed by the physical Internet, i.e. considering the Digital internet as a driving example. The idea of a structured network is related to a configuration of logistics nodes, hierarchically interconnected by: backbone connections or inter-regional (the coach layer), regional (the bus layer) and last mile (the taxi layer) [6]. Conceptually it may be seen as a directed graph. The nodes provide an abstraction of the logistics centre (or hub) while the edges, oriented in the direction of the flow, model the transportation routes between nodes. In analogy with the internet, which is composed of several kind of networks, the logistic network is considered as composed of sub-networks. Each sub-network, owned by a LSP (logistics supporting system), has its own IT systems, for managing planning, booking, transport, capacity, and so on. The LSPs may be considered as 4PL or they may be postal services, anyway they are organization capable of maintaining their own IT systems and able to handle modular logistic [6].

The basic idea focus on IT protocols for handling unitized movements from source-to-sink, considering the handling of the M-Boxes (modular boxes) in the operations of pick-up and drop-off, and the reverse logistic for the empty boxes delivered within a business process, using a structured network, with a common carrier approach across multimodal logistics domains [6].

Considering dispatching of items, M-Boxes delivery may be accomplished handling the modular containers with a black box approach, and tracking the box for tracking the content. Modular container should be assembled on three levels: physical level, electronic level and computing information level, in order to be handled as a unique container.

The main concept that emerges from this consideration is that the modular units, like internet packets, are the element that enables the revolution promised by the physical internet. The e-Freight project represents an interesting work for the modular logistics. It defines the appropriate framework to allow goods tracing in real time, ensures intermodal liability promoting clean freight transport, by creation and deployment of a single transport document in electronic form (electronic waybill), and an appropriate framework for the deployment of tracking and tracing technologies (RFID, etc.) [6]. In Modulushca project an effort for defining a reference software architecture is ongoing. It is worthy to note, however, that this activity is still in execution and have yet to obtain a final result.

The approach may lead to the integration of existing logistic networks, in order to build a structured interconnected network in which the base for the interconnection is the modular unit. Like the digital internet data packets, the modular units are the way of interacting between diverse platforms. In the same way, different logistics supporting IT systems may interact one with the other loading, unloading, storing, grouping, ungrouping, tracking and tracing, and so on, the modular units [6].

The technology that for sure has to be considered, in the road to achieve the Physical Internet, is the EPCIS (Electronic Product Code Information Services). EPCIS may be considered as a complete approach for tracking and tracing goods and all the other elements of the logistic networks using unique universal identification numbers. The important advantage, from an IT point of view, is the open nature of the ECPCIS framework, which may use different tracking and tracing technologies [6].

Compared to the USA and Canada, the EU initiative Modulushca has significantly more partners such as European research institutes, universities, international organizations and industry partners, coordinated by PTV (Germany). These include Technical University of Graz (Austria), Mevare (Italy), JAM De RIJK (Netherlands), Institute of Logistics and Warehousing (Poland), Inception Consulting (UK), CHEP (UK), Poste Italiane (Italy),

Kirsen Global Security (Germany), Technical University of Berlin (Germany), Laval University (Canada) Federal Polytechnic School of Lausanne (Switzerland), ARMINES (France), P&G (Belgium), ITENE (Spain) [2].

Modulushca was presented at Interpack last May 2014, in ITENE's booth. Interpack is the most important packaging trade fair in the world and takes place in Düsseldorf (Germany) every three years. The aim of the project is to enable operating with developed ISO-modular logistics units of sizes adequate for real modal and co-modal flows of fast-moving consumer goods (FMCG), providing a basis for an interconnected logistics system for 2030. Many of these visitors were interested in the Modulushca project, which is being developed by a consortium composed of 15 organizations [2].

One of the active projects based on the physical Internet initiative is the KAYPAL initiative. It demonstrates that the using of RFID and EPCIS standards and technologies, associated with the physical Internet concept, coupled to Discovery Services and Business Web Services adapted and applied to an innovative and collaborative business model (KAYPAL Multi-Rotations). It significantly improves the efficiency, visibility, transparency, guidance and traceability of reusable container flux and of their content, evolving in an open loop in the wide distribution universe [7].

Objective of the KAYPAL is the improving of the traceability of flux of reusable containers and their content, in an open loop. Experiment research work on a new logistic support, the carton palette KAYPAL Multi-Rotations, will allow the optimization of transport capacities. Through trust proofs (guidance, traceability, visibility, transparency, standards, web services), decisions making about investing in new generation reusable containers will be facilitated [7].

Due to the Interuniversity Research Center on Enterprise Networks, Logistics and Transportation (CIRRELT) and Université Laval's Faculty of Business Administration (FSA ULaval) the 1st International Physical Internet Conference took place in May, 2014. There were more than 300 participants, coming from the Americas, Europe and Africa discovered the infinite possibilities of the Physical Internet [5].

Conclusions and further research prospects. The logistic concept of "the physical Internet" is a unique conducting innovation of logistic operations. The expected result of the project based on its use can be achieved by the global and synchronized implementation of the basic principles in the practical conduct of logistics activities. It is required the scale phased implementation of the basic requirements of conception concerning the standardization of logistics activities in all countries.

This concept goes beyond the classical logistic solutions, which often suffer from inefficiency. Companies can offer new hybrid products and services in the field of logistics and supply chain will be flexible and able to change the configuration in real time. Logistics is faced with innovative processes that require further research and implementation.

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