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Application of OSI reference model to the logistic systems

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ABSTRACT
The logistic services belong to the network services and it is possible to look similarity with other services such as transport and telecommunications. On this basis, the paper shows that by use of sufficient disaggregation, the logistic system can be analysed by network layers. This new theoretical approach will be represented by designed logistic system model based on three layers: logistic infrastructure, technology of transportation and passive infrastructure of logistic network.

KEYWORDS: logistic system, logistic services, layer model, OSI reference model

1. Introduction

The assurance of the basic functions for the logistics systems of which networks and their technical and technological equipment must enable interoperability with other logistics systems belongs to the complicated problems that are difficult to solve. It is necessary to consider the access safety to elements of logistic infrastructure or services. The question that arises is the determination of access points in the network of logistic service provider and the establishment of conditions for access and connection to other logistic operators. This fact leads to the idea to examine the logistic system not only from a procedural point of view, but also to look at it as an open communication system, what is typical for other departments of communication sector, e.g. electronic communication.

The aim of this article is to present the formation of layer model for logistic system, with the determination of the basic rules and tasks for mutual communication of individual layers for the purpose of interoperability assurance. The model for communication of open systems OSI (Open System Interconnection) seems to be an appropriate formula for this type of model, which was defined in 1978 by International Organization for Standardization (ISO) to avoid problems associated.

The OSI standards are available from the ITU-T as the X.200-series of recommendations. The recommendation X.200 describes seven layers, labelled 1 to 7. Layer 1 is the lowest layer in this model.

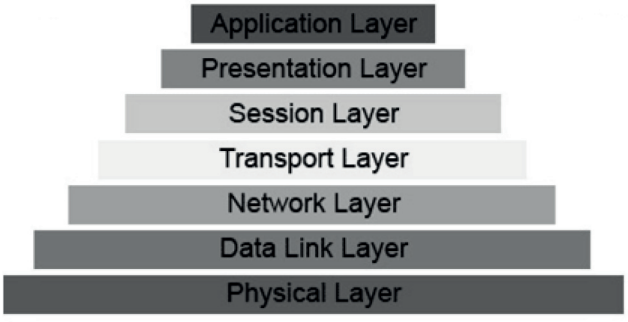

Fig. 1. Seven layers of OSI model [own study]

Layer 7: The application layer. This is the layer at which communication partners are identified, network capacity is assessed and that creates a thing to send or opens the thing received. This layer is not the application itself, it is the set of services an application should be able to make use of directly, although some applications may perform application layer functions.

Layer 6: The presentation layer. This layer is usually part of an operating system and converts incoming and outgoing data from one presentation format to another, e.g. from clear text to encrypted text at one end and back to clear text at the other).

Layer 5: The session layer. This layer sets up, coordinates and terminates conversations. Services include authentication and reconnection after an interruption.

Layer 4: The transport layer. This layer manages packetization of data, then the delivery of the packets, including checking for errors in the data once it arrives.

Layer 3: The network layer. This layer handles the addressing and routing of the data, sending it in the right direction to the right destination on outgoing transmissions and receiving incoming transmissions at the packet level.

Layer 2: The data-link layer. This layer sets up links across the physical network, putting packets into network frames.

Layer 1: The physical layer. This layer provides the hardware means of sending and receiving data on a carrier network.

2. Analysis

Logisitics is the management of all activities which facilitate movement and the coordination of supply and demand in the creation of time and place utility. It is defined as a business planning framework for the management of material, service, information and capital flows. It includes the increasingly complex information, communication and control systems required in today's business environment.

Another definitions of logistics referred to 'the positioning of resource at the right time, in the right place, at the right cost, at the right quality'. This definition can be expanded into what might be considered as the seven 'rights' of customer service. These are the right quantity, cost, product, customer, time, place and condition. All of these different aspects can be key requisites of a good customer service offering – indeed, each of them may be essential to ensure that a product achieves its expected sales in the various markets where it is made available. It is notable that all of these elements are affected by the standard and quality of the logistics operations that are an integral part of getting a product to market.

Logistic system is made up of a set of facilities linked by transportation services. Facilities are sites where materials are processed, e.g. manufactured, stored, sorted, sold or consumed. They include manufacturing and assembly centers, warehouses, distribution centers, transshipment points, transportation terminals, retail outlets, mail sorting centers, garbage incinerators, dump sites, etc. Transportation services move materials between facilities using vehicles and equipment such as trucks, tractors, trailers, crews, pallets, containers, cars and trains.

The logistics system consists from three fundamental parts: logistics services, information systems and infrastructure (resources).

Logistics services support the movement of materials and products from inputs through production to consumers, as well as associated waste disposal and reverse flows. They include activities undertaken in-house by the users of the services (e.g. storage or inventory control at a manufacturer's plant) and the operations of external service providers. They comprise physical and non-physical activities (e.g. transport, storage and supply chain design, selection of contractors, freightage negotiations respectively). Most activities of logistics services are bi-direction.

Information systems include modelling and management of decision making, and more important issues are tracking and tracing. It provides essential data and consultation in each step of the interaction among logistics services and the target stations.

Infrastructure comprises human resources, financial resources, packaging materials, warehouses, transport and communications. Most fixed capital is for building those infrastructures. They are concrete foundations and basements within logistics systems.

The logistics services can be analysed as a processes and sub-processes taking place in the networks. The network character of logistics services is not different from other network systems. Although we are accustomed to portrayal of logistics services through the processes and sub-processes, it is possible to see the logistic system at a certain level of abstraction also in layers as in the case of telecommunication services. Agreement is significant especially in terms of the service provided through the model of layers, in which the basis consists of the physical layer, network layer, and layer of services. The physical layer represents a means of transport or vehicle of transport and it is responsible for the physical realisation of transmission in the case of telecommunication. The network layer expresses mainly the creation of interconnection for transport requirements or for the transfer of message in telecommunication.

3. The proposal of layer model of logistic system

We will describe flow of goods through logistics systems and the way of its connection on the basis of the model principles OSI. We will describe not only the immediate shipment of goods between the systems, but also the abilities of the system to collaborate and to solve tasks of relocation with other systems, through which the materials is going during its transfer until the delivery. It is possible to characterize the interconnected logistics systems on the basis of grouping that consists of one or more access points, related hardware, terminals / hubs / depots, human features and vehicles used for the carriage of shipments, etc.

Communicating devices in the logistic system will be represented by the means of the layer architecture. This layer architecture is characterized by the hierarchical organisation of the functions (entities) that are needful for linking system. The highest layer allows the contact with the user interface (e.g. with network subscribers) and the lowest layer allows the contact with the physical transmission medium.

Different functions are allocated to the individual layers of model that enable the realisation of „the system interconnection". The architecture of the open system is made up from number of subsystems - layers that are stored on each other. Every layer contains interface between the nearest higher and the nearest lower layer. The highest layer has the interface towards the user environment and the lowest layer towards the transmission medium.

3.1. Basic elements of the layer model

A **layer** can be understood as a part of the network´s function. When we monitor the activities that take place in the distribution network, it is clear that those functions depend on each other - one function provides its services to another while using the services of other layers. Those categories can be called the layers of network. It is important to note, that only the same layers (equal) of the logistic system will communicate between the sender and the addressee during the relocation process and transport of the goods.

Function / functionality will constitute a certain functioning, security operation or determination of specific activities in the transfer process. It can also determine the relationship between two layers. It limits the layer competence, role and its importance in ensuring of goal achievement- the transfer of the goods from the sender to the recipient.

Identification of the sender, recipient, transmitted shipment and endpoints in network are related to the use of a suitable **protocol**. Protocol can be understood in two ways. It may be characterized as a register, report and record of the process or a result of the activity or operation, for example a book of records about the acceptance and dispatch of shipments. On the other hand, it may be a sum of the procedures and rules determining the operation of the installation or method of communication between endpoints in the logistic system.

Each layer (N) has specific functions that form a part of the management communication and defined way of communication with a neighbouring lower (N-1) and higher layer (N +1). This is the way, how the **interface** is formed. The interface is defined as a border between two layers. The interface in layer model is formed by a physical point (factories, warehouses, retail stores), but it is formed also as a set of norms, regulations and protocols defining characteristics of a connection that may be virtual/ electronic.

The determination of the **security** and qualitative characteristics is a very important part of architecture for the layer model. Security can be understood as a minimisation of the "vulnerability" whether of the shipments that enters the technological system or instruments and procedures that ensure the distribution of the shipments. It means that, if the shipment is secured for example by the cover, barrier or by another element of protection against loss or damage, but on the other side the access to the postal system does not include any physical security restrictions, the protection may be pointless [3]. The **safety** measures do not have to be set just at the technical and technological level, they can also be measures in the form of insurance, because it is not possible to achieve perfect technical and physical security. The goal of safety measures should be to reduce the risk of violation on acceptable level.

The **quality** of the logistic service is defined as a degree of achievement of the customer´s expectation with the provided service and as a disproportion between expectations and perceptions. The quality is determined by the normative requirements and its level is dependent not only on the perception of impact the output process, but mainly on the quality of the whole process.

3.2. Basic characteristics of the layers

The layer number 1: The physical layer (the lowest layer of architecture) is identified as a physical communication (shipment) in available infrastructure (road, rail, air, water), that is provided through physical media (a means of transport). This layer specifies the characteristics of individual vehicles, such as capacity, loading surface and it also defines the way of shipment. Another devices that belong into this layer are different types of nodes for example (depots, hubs ...).

The layer number 2: The line (data link) layer provides a connection between two neighbouring systems, respectively nodes. It identifies and organizes goods from the physical layer into logical units (e.g. containers) and it provides the connection of neighbouring nodes and enables the setting of transmission data between two nodes. Its function is also to ensure the formation of transport units on the basis of codes such as: (country codes, ZIP codes ...), and it announces the errors of loading. Its task is to ensure the functions in transport of shipment between the network units and the detection of errors that occur in physical layer.

The layer number 3: The network layer takes care about the direction of shipments within the network and network addressing. It provides the connection between the systems that are not neighbouring ones. Some open systems have functions of internode link (processing centres, warehouses, terminals ...) that ensures the handover of shipments to another system. The basic function of this layer is a collection of network-oriented protocols for the goal of correct shipment and crossing of different technological characteristics that are applied in individual networks. This layer provides a connecting path between endpoints, including the use of internodes. It is responsible for the selection of the best path between the terminals equipment and transport between them, as well as the delivery.

The layer number 4: The transport layer manages the transport of shipment from end node source (open system), into targeted end node (open system) that is not realised in internodes. This layer reminds us an illusion as if each node in the network had direct connections with any other node. It ensures the creation of transport units from expedition of goods and their deconsolidation in delivery. Its purpose is to provide such quality distribution that is required by higher layers. This required quality is maintained throughout whole time of the transport connection. Higher layer is informed in the case of quality failure (T & T service). This includes for example the application of protocols related to the requirements for distribution with guarantee (e.g. insurance) and the requirements for distribution without guarantee. The guarantee can be applied also to loss and damage of the shipment.

The layer number 5: The relational (session) layer organizes and synchronizes dialog between co-relational layers of both systems and it controls the exchange of data between them. It creates a connection between the sender and the recipient through the application of defined protocols - the selection of suitable cover for shipment and the presentation of personalized features, followed by submission of shipment - the enter into the distribution system. In the case of system´s failure to deliver the shipment, it may be

returned to the sender on the basis of referred synchronized data-address (sender, recipient).

The layer number 6: The presentation layer transforms the shipment into the shape that is used by application. It determines the conditions for the requested service and it sets rules for the choice and distribution of shipment. The protocols are based on legislative measurement. It deals with the formal aspect of shipment (cover, address information) and with the preservation of information content during the transport. Its task is to ensure the secrecy of correspondence between sender and recipient.

The layer number 7: The application layer includes the logistic service of which disclosure is required by the sender through the entry of the distribution system.

3.3. Formulation of layer model

We can divide layers on the basis of their characteristics and functional content into two basic groups: either in terms of their functions within the network, or from the perspective of user access.

In terms of functional load of the individual layers we can see several options to create a n-layer model. If we consider the division of layers from the user and network perspective, we will create a **basic 2-layers model**.

- Division of layers in terms of their functions within the network:
  - *End-oriented layers* - they are implemented only into the terminals (application, presentation, session, transport layer).
  - *Network-oriented layers* - they are dependent on the network technology that is used and they have to be at least partially implemented into the network (network, line/data link, physical layer).

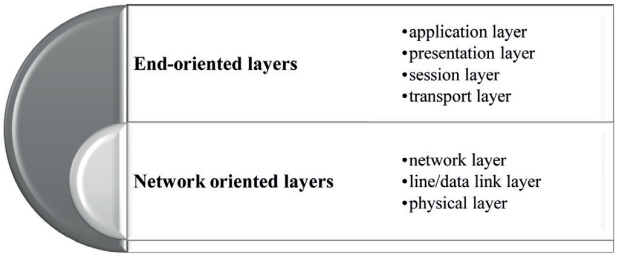

Fig. 2. Basic 2-layers model based on the function of layers [own study]

- Division of layers in terms of their users:
  - *User-oriented layers* (application, presentation, session layer) - they play important roles in interpretation of the data to user.
  - *Transport-oriented layers* (transport, network, line/data link, physical layer) - they are related to the distribution of the package.

The second option is the creation of a **3-layers model**, established on the basis of their functionality, in which the theory of network systems works with them on the basis of ISO/OSI recommendations. In this variant the transport layer can be described also as so called interlayer that forms an interface between user-oriented layers and network-oriented layers.

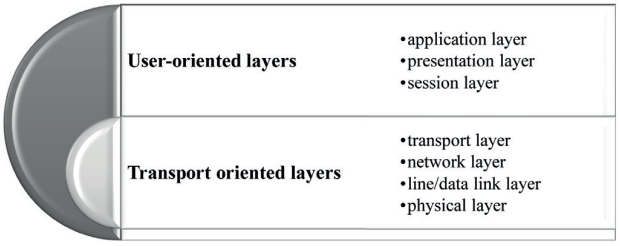

Fig. 3. Basic 2-layers model based on the layer's users [own study]

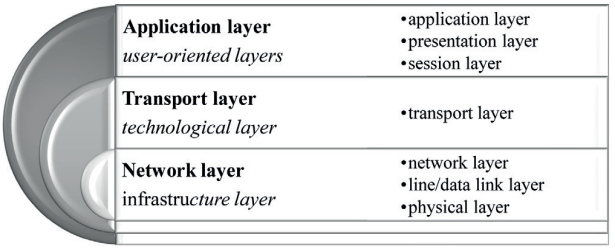

Fig. 4. Basic 3-layers model [own study]

During application of the layer model into environment of the logistic system, it is possible to think about the integration of chosen layers. This is possible just in the case of insufficiency of functional filler, or in the functional intersection of the individual layers, in which the interface identification between layers or setting of communicating protocols will be not possible.

4. Conclusion

The idea and the purpose of this paper consist in problematic solving of logistic system model through the decomposition into independent subsystems by the form of layer network model depiction. Logistic service that is generally understood as a sequence of processes for collection and distribution of shipments can be presented through the security functions in identified layers of logistic systems.

Another reason why to think about the logistic system in the forms of layers is its wider range of services and their penetration into the field of electronic communication, that are becoming necessary part of delivery services, mainly in the form of supplementary services that increase the positive perception of the customer (e.g. hybrid products involving ICT into the process of distribution).

These new possibilities and opportunities create space for discussion, especially in the field of service interoperability. Which regulating organ should solve interoperability and interconnectivity problems? Which orders or means will be redundant and which will be absent?

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Bibliography

[1] BOLDRON, F., et al.: Network externalities and the USO: a two-sided market approach. Article in book: Progress in the competitive agenda in the postal and delivery sector. Elgar, p. 184-195, ISBN 978-1-8484-4060-9, 2009.

[2] COREJOVÁ, T., COLL.: Economics of networks. Second Edition. Žilina: University of Žilina, ISBN 978-80-554-0155-3, 2010.

[3] COREJOVA, T., IMRISKOVA, E.: Convergence at the postal market. Eksploatacja i niezawodnosc-maintenance and reliability, Issue 3, p. 74-76, 2008.

[4] COREJOVÁ, T., et al.: Regional dimensions of knowledge processes in the sector of transport and logistics and ICT in the Žilina region. Communications. Vol. 15, No. 2, 2013.

[5] DROZDZIEL, P., KOMSTA, H., KRZYWONOS, L.: An analysis of unit repair costs as a function of mileage of vehicles in a selected transport company. Transport Problems. Vol 9, Issue 4, 2014.

[6] HEITZLER, S.: "Traditional Regulatory Approaches and the Postal Service Market", Competition and Regulation in Network Industries. In: Econ Papers. Vol. 10, Issue 1, 2009.

[7] HRUDKAY, K., SESTAKOVA, S.: Systemy riadenia terminalov intermodalnej prepravy. In: „Výskumné aktivity v doprave, staviteľstve a príbuzných odboroch", Herľany, 2014.

[8] KOLAROVSZKI, P.: Research of readability and identification of the items in the postal and logistics environment. Transport and Telecommunication. Vol. 15, Issue 3, DOI: 10.2478/ttj-2014-0017, 2014.

[9] KRIZANOVA, A.: The current possition and perspecives of the integrated transport systems in Slovak Republic. Eksploatacja i niezawodnosc-maintenance and reliability, Issue 4, p. 25-27, 2008.

[10] KUBIKOVA, S., KALASOVA, A., CERNICKY, L.: Microscopic simulation of optimal use of communication networkin Mikulski J. (ed) Telematics - Support for Transport, Springer Verlag, Berlin Heidelberg, CCIS 471, p. 414-423, 2014.

[11] MADLENAK, R., MADLENAKOVA, L.: Digital advertising system in urban transport system of žilina town. Transport and Telecommunication, Vol. 15, Issue 3, 2014.

[12] MADLENAKOVA, L.: Modelling of processes in postal services. Electronic scientific journal: Posts, Telecommunications and E-commerce. Vol. 8, Issue 2, ISSN 1336-8281, 2013.

[13] MADLENAKOVA, L.: Layer model of the postal system. Habilitation Thesis - University of Žilina - Faculty of Operation and Economics of Transport and Communications. Žilina: 112 pages.

[14] MADLENAKOVA, L., MADLENAK, R.: Layer model of the postal system In: Reliability and statistics in transportation and communication 2014, Riga, Latvia, ISBN 978-9984-818-70-2, 2014.

[15] MADLENAKOVA, L., MADLENAK, R.: The convergence of telecommunication and postal services and their impact on regulatory approaches. In: Reliability and statistics in transportation and communication 2015, Riga, Latvia, ISBN 978-9984-818-79-5, 2015.

[16] MAEGLI, M., et al.: Postal Markets and Electronic Substitution: What is the Impact of Convergence on Regulatory Practices and Institutions? In: ECPR conference: 'Regulation in the Age of Crisis', Dublin.

[17] PASTOR, O., TUZAR, A.: Theory of transport systems, ASPI Praha, ISBN 978-80-7357-285-3, 2007.

[18] POLIAK, M., KONECNY, V.: Factors Determining the Electronic Tolling Scope of Road Network. Ekonomicky casopis, Vol. 56, Issue 7, 2008.

[19] SVADLENKA, L., CHLAN, A.: Principles of the Proposed Czech Postal Sector Price Control Model. PROMET Traffic & Transportation, Zagreb, Croatia. No. 1, Vol. 21, 2009.

[20] VACULIK, J., TENGLER, J.: Potential of new technologies in logistics services. In: Carpathian Logistics Congress, CLC 2012, Priessnitz SpaJesenik; Czech Republic; TANGER Ltd., 2012.