Slobodan Babic[1], Zoran Andjelkovic[2], Nikola Lekic[3]

THE CLEARINGHOUSE — A PATTERN FOR SUPPLY CHAIN INFORMATION EXCHANGE

This paper presents the clearinghouse pattern used within supply chain to control information exchange between companies or with a centralized data pool. The pattern will assist developers in the processes of modeling and analysis needed to meet the requirements of a future EDI Clearing Agency. A detailed implementation based on the EANCOM 2002 Syntax 4 standard is included as an example.

Keywords: clearinghouse, patterns, supply chain, modeling, EDI.

Слободан Бабіч, Зоран Андєлковіч, Нікола Лекіч

ЦЕНТР ОБМІНУ ІНФОРМАЦІЄЮ ЯК МОДЕЛЬ ІНФОРМАЦІЙНОГО ОБМІНУ В РАМКАХ ЛАНЦЮЖКА ПОСТАЧАНЬ

У статті представлено модель інформаційного центру для ланцюжку постачань та контролю обміну інформацією між компаніями або з централізованим сховищем даних. Це допоможе розробникам в процесах моделювання та аналізу, необхідних для задоволення вимог клірингового агентства з обміну електронними даними. Як приклад включено детальну реалізацію на базі стандарту EANCOM 2002 Syntax 4.

Ключові слова: клірингове агентство, шаблони, ланцюжок постачань, моделювання, обмін електронними даними.

Таб. 1. Рис. 7. Літ. 10.

Слободан Бабич, Зоран Анделкович, Никола Лекич

ЦЕНТР ОБМЕНА ИНФОРМАЦИЕЙ КАК МОДЕЛЬ ИНФОРМАЦИОННОГО ОБМЕНА В РАМКАХ ЦЕПОЧКИ ПОСТАВОК

В статье представлена модель информационного центра, используемого в цепочке поставок для контроля обмена информацией между компаниями или с централизованным хранилищем данных. Это поможет разработчикам в процессах моделирования и анализа, необходимых для удовлетворения требований клирингового агентства по обмену электронными данными. В качестве примера включена подробная реализация на базе стандарта EANCOM 2002 Syntax 4.

Ключевые слова: клиринговое агентство, шаблоны, цепочка поставок, моделирование, обмен электронными данными.

Introduction. Supply chain is the entirety of all business activities on behalf of producers, suppliers, wholesalers and other business subjects, as are transporters and retailers, with the purpose of providing products or services to final consumers. The supply chain unifies the flows of products, information and funding of all participants.

Because of the specificities of each individual vertical (Figure 1.), as for instance in pharmaceutical, car industry or others, there are different supply chains [4]. The supply chains exist apart from the technology used for the transfer of necessary data, major requirement of which is to provide accurate and timely information. Because

[1] Kompanija Dunav Osiguranje a.d.o. Makedonska, Belgrad, Serbia.
[2] PhD, Professor, Technical Faculty in Bor, University of Belgrade, Serbia.
[3] Dunav banka a.d., Bulevar Franse d'Eperea, Belgrade, Serbia.

of that, the majority of countries' legislation tends to get adjusted to new information technologies. These new information technologies can improve the accuracy and updating of information by means of implementing the legislation regarding digital signature, electronic document and e-business.
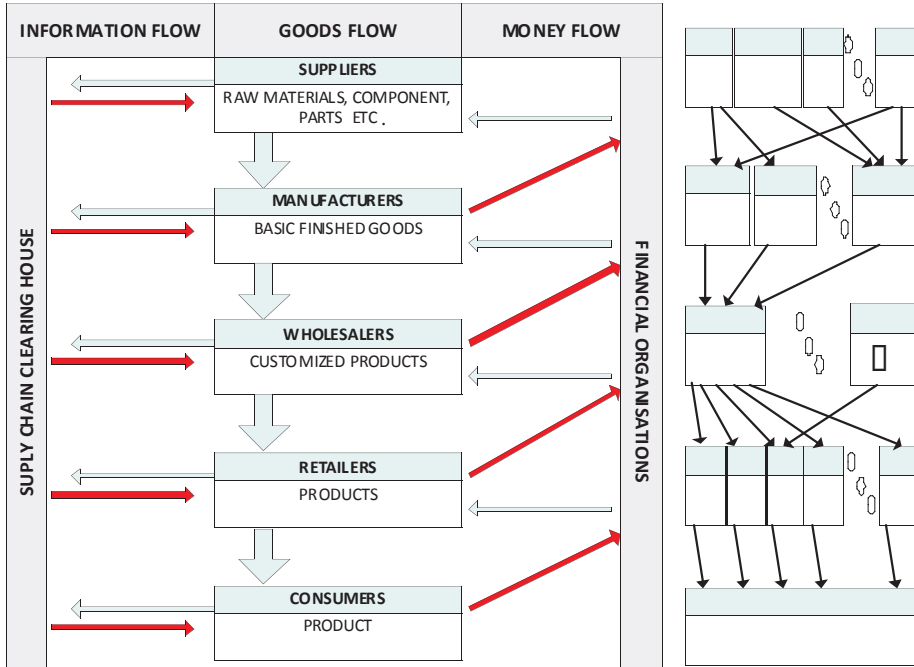
Figure 1. **Example of supply chain organization with basic resources flow (information, goods and money)**

Within supply chains there is a strong competition in promoting products and services. By all possible ways, participants try to win the best position at the market. Their strategies include lowering prices, heightening the availability of products and services etc. Besides, participants take care about the details ranging from unusual design to the placement and the form of the shelf offering a product.

In such a competitive environment, the possibility appeared for the automation of business processes through the introduction of addressable messages with included business logics. In this, the process automation needs to allow the possibility of transfer of full information in one context, and in another to allow that some information remains unavailable for broad environment, and maintain full availability for certain participants, or to a strictly defined group of supply chain subjects. The nature of one's business means that each individual participant wants to connect with lower or upper participants in the same vertical, yet one is opposed with all the participants that belong to the same level of the vertical. Therefore, during various business processes participants need to exchange confidential documents (orders, invoices, detailed specifications, quantities in stock etc.), or to propagate some documents (basic information, catalogues, product data etc.) as public by means of standard messages and make them available to everybody who wish to obtain them.

The Clearinghouse Context. Business partners are required to exchange their basic data, like their official names, tax numbers, as well as other identifications necessary for business: addresses, names of contact persons, products, their characteristics and prices, available quantity of goods etc. In addition, while carrying their business activities, they require information about the possibilities to order goods or services, and ask for payment procedures. These activities are commonly carried on through the usage of Post and Telco services. Recently, however, the most competitive resource is recognized in the modern IT equipment utilizing TCP/IP networks with standardized business messages. Their usage gains worldwide popularity as it provides an immediate opportunity for companies around the globe to exchange information in a uniform manner.

Problem. For information exchange, partners use standard messages and modern equipment utilizing network resources. In case of bilateral exchange of information, both partners have to negotiate the manner in which information will be exchanged. How can information exchange within a vertical supply chain be structured to be efficient and safe for the involved companies utilizing modern IT technology?

Forces. Modern companies perform information exchange about themselves, their products, and services as a part of their regular daily activities. Accurate information, quick exchange and timely usage of information are of utmost importance in business practice. If a partner wants to communicate with multiple parties, it will have to agree the manner of communication with each of them separately, which would require additional expenses of money, energy, and time.

Security. Need to be able to keep contents secret or unavailable to all parties while exchanging documents and other information with a partner. In case a supply chain participant wants to exchange documents with his partner in an efficient and safe way and to keep document content secret, the participant addresses the message to a partner and encodes the message content using the partners public key.

Information needs. Partners have to acquire information about each other, partner's products, their characteristics and prices. In case a supply chain partner has an assignment to make information in a message public, the participant addresses the message on clearing house, which in an agreed way publishes information to be available to everyone.

Communication channel. Partners need to have the means for establishing a communication channel for information exchange and valid feedback mechanisms. Goods flow is not separated from other flows, for example, information flow or flow of money. Figure 2 presents one basic goods flow example, which can be connected with any supply chain vertical. Here we can see the duality: any movement of goods is followed by adequate exchanging necessaries information about goods flow by the clearing house. Figure 2 presents separated information dual flow and flow about financial transactions which follow supply chain transactions. It is interesting that exchanging financial information is supported by adequate clearing houses in financial industry.

Uniform addressing. Especially important is to address messages with business logic on uniform way, no matter from which clearing house participants are coming.

Need for Master Data/Information storage and distribution. There will be always the need for data acquisition, storing and distribution of determinate data classes in

the systems where is impossible to synchronize all participants and their activities. Even, if it is possible to synchronize participants and their activities, asynchrony is even desirable. Mechanisms of sending to messages pool provide asynchrony for sending, storing and distributing data.

Search and information retrieval needs. There have to exist mechanisms for querying stored data and information retrieval needs.

Solution. Create a clearinghouse that encapsulates all challenges in a supply chain information exchange, and makes communication transparent to individual participants. "Clearinghouse is a central agency for the collection, classification, and distribution especially of information" [8].
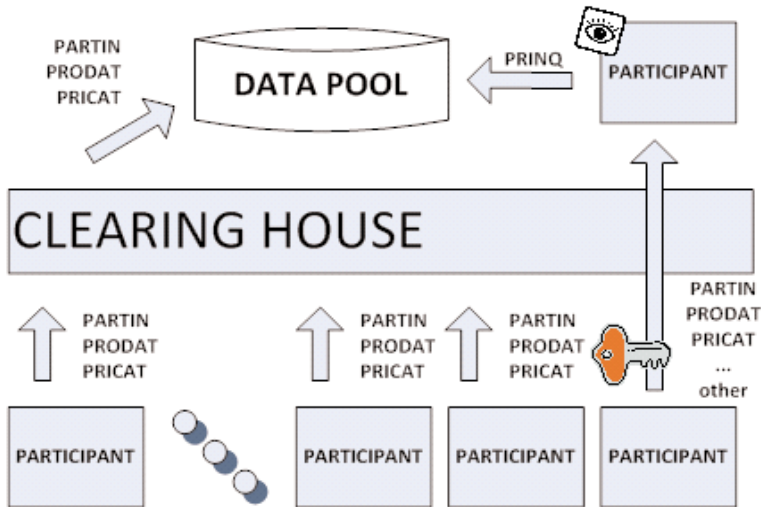

Figure 2. **Clearing house structure with a data pool and partners, and the main messages**

This paper treats the supply chain basic activities from the point of view of the business processes necessary for the beginning of communication on a separate business. Table 1 include 5 messages related to supply chain basic activities: data pool updating message (PARTIN, PRICAT and PRODAT), catalogue and product investigation message (PROINQ), and regular feedback message (CONTRL) in case that the action is invalid. Addressing, in fact, provides the mechanism for establishing the communication channel. Online data investigation establishes the mechanism for finding information about partners on the clearinghouse's web-site.

Addressing. The goal is to achieve a uniform treatment of the addressing information at all locations and by all involved partners and one communication channel for all partners and for all available clearinghouses' services.

Basic messages are intended for updating the data pool. Other messages can be composed and addressed for partners' business procedures. The message sender can convey the message to his clearing house or to another participant of his clearing house. The receiver of the message can be the participant of another clearing house. The clearing house itself can also send messages to another clearing house. The messages can be addressed for all mentioned message receivers.

Table 1. **Summary of the clearinghouse main messages (EANCOM 2002 Syntax 4)**

Activity			Name	Problem
Addressing		(1)	PARADR	Addressing a message for the supply chain
Data pool updating	Partner Information	(2)	PARTIN	Sending own information to the clearinghouse data pool or to a partner
	Price Catalog	(3)	PRICAT	Sending basic data about product and their prices to the clearinghouse data pool or to a partner
	Product Data	(4)	PRODAT	Sending detailed product data and specifications to the clearinghouse data pool or to a partner
Product Inquiry		(5)	PROINQ	Investigating product data presented in the clearinghouse data pool
Online data investigation		(6)	ONLINI	Investigating product data presented in the clearinghouse data pool online
Syntax and service report		(7)	CONTRL	Sending a mandatory answer on message received from a partner

In case the messages are addressed in a described manner, there is a possibility of sending secured documents by encrypting the entire message or its part, if needed. This allows for document abuse control on behalf of a previous clearing house, i.e. clearing house is prevented to systematically collect the data contained in messages (for instance, for the purpose of loyalty programs). The use of described addressing allows for optimizing of the transfer of information to business partners through the usage of unified network for all supply chains. The same network can be also used for distribution of addressable messages with business logics from other business systems, such as financial, governmental, health and other systems.

Data Pool Updating. The data pool is a centralized place in which a clearinghouse stores information about partners, their products, or services. It can be arranged in one or more catalogues. 3 messages are available for updating the data pool: partner information, price catalog, and product data. There is a message intended for a request of specific information about products and catalogues. A message confirming the validity of a received message is also available.

Partner Information. Providing basic information on the locations of operational, administrative, commercial, and financial data that are intended for the use of partner or the clearinghouse's catalogue.

Price Catalog. Providing information including descriptive, logistic, and pricing data on each individual product to a partner or the clearinghouse's master catalogue. Providing the possibility for changing, adding, deleting, or confirming product information.

Product Data. Providing information which includes identification and descriptions of products, as are product characteristics, technical data, handling information etc. for a partner or a clearinghouse's master catalogue.

Product Inquiry. The goal is to provide the possibility to ask a variety of questions regarding products or services. Participant can start investigation about some other partners, products or catalogues using clearing house data pool making queries with product inquiry message. Received answer is an adequate message about partner/s,

products or catalogues (PARTIN, PRODAT or PRICAT respectively). After making queries, through clearing house, participant can start other supply chain process.

Online Data Investigation. The goal is to provide the possibility for an online information survey and an online request for a message with product, catalogue or partner information. Data presentation for online investigation can be made with web resources and technologies, enabling of use those data by wide users group.

Syntax and Service Report. The goal is to provide a confirmation for a received message or a denial of a message with an error acknowledgment. Hence, the pattern provides a feedback necessary for system management. Participant who is sending messages can be sure that the other side has received correct message and is taking responsibility for its execution with receiving positive control message, or, by negative control message sender has indication that sent message is not correct, and other side cannot understand it and is not able to take responsibility.

Resulting Context. After applying the clearinghouse pattern, document exchanging processes are minimized at the least possible level and for participants it is not the primary interest data exchanging, but their main business.

Clearinghouse reduces expenses for its participants since it requires from each partner to sign only one contract and agree on the way of information exchange only once when connecting to the clearinghouse. In this manner, a clearinghouse prescribes to all participants equal message standards and equal rules for information exchange.

Systems for data exchange between participants, and participants and clearing house demands investments in building adequate infrastructure, which is sometimes significant. If business processes are based on these modern technologies, the old-fashioned alternate ways of data exchange will be hard to restart again. It has to be investing in standards innovation, developing communication possibilities in innovated manner.

Implementation Example. In most cases, participants who wish to exchange information are connected in a clearinghouse's network with a star topology. In this manner, a clearinghouse provides necessary network resources, including software modules for sending and receiving standard messages and for other purposes. In our example, messages for a supply chain are prescribed by the EANCOM 2002 Syntax 4 message standard [3].

The EANCOM standard is a subset of the EDIFACT (electronic data interchange for administration commerce and transport) standard. The EANCOM message consists of segments named UNB, UNG, UNH, UNT, UNE, UNZ that are fully described by GS1 [2] (Global Standard One) standard. In the EANCOM message, both sender and receiver are represented by addresses with specific values, an individual Global Location Number (GLN), which is assigned to every organization, and is registered in GS1 organization available for global use. GLN number identifies on a global level the location of each organization (including subaddresses in its structure), thus, making it globally available. Addressing is highly important, as according to the terms of the contract signed by all the participants of the clearinghouse, a message is transferred to a destination determined by GLN. Receiver processes messages by applying conventional business procedures, prescribed for the type of a received message. The EANCOM 2002 standard enlists 49 different message types: master

data messages (4 messages), transaction messages (26 messages), report and planning messages (14 messages), and other messages (5 messages).

Addressing. To send a message to a partner. Each company receives from GS1 an individual Global Location Number (GLN), which represents its individual global address. The message header includes sender and receiver's addresses, both defined with their individual GLN. A partner can be another company or a clearing house.

The clearinghouse receives messages with 2 types of instructions: instructions addressed to the clearinghouse which is a service provider, and instructions addressed to a partner. Standardized messages are regulated by ISO20022 [5], SWIFT [7] MT and other standards that possess equal characteristics.

The first communication type, presented in Figure 3, is between a subject, which is a person or an organization, and the clearinghouse. A subject is able to send and receive messages from the clearinghouse, i.e. a subject is able to address messages to the clearinghouse, and the clearinghouse is able to address the subjects which are clearinghouse's participants only.
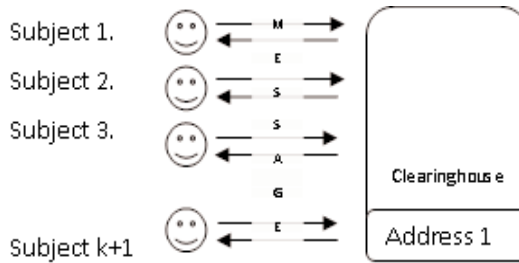

Figure 3. **First communication type**

The second communication type, presented in Figure 4, is between clearing houses. Clearinghouses are able to send and receive messages from each other; each of them is also able to send and receive messages from the addresses which belong to all other clearinghouses' participants. In that manner, a clearinghouse and its all participants are in the same address domain, and clearinghouses can address other clearinghouse's participants.
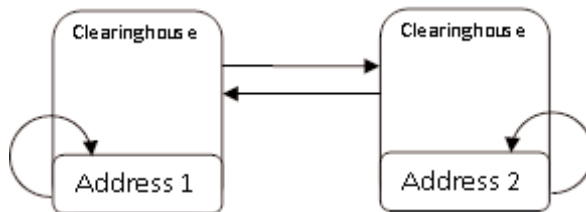

Figure 4. **Second communication type**

The communication, presented in Figure 5 is a combination between the first and the second communication types. Partners from different clearinghouses are able to address each other in spite of their participation in separate clearinghouse's systems. In this case, clearinghouses are required to exchange the data on their participants, and have to synchronize them in real time. Thus, the addressing enables an easy way for addressing clearinghouse or clearinghouse's participants. Every clearing-

house can establish predefined forwarding default delivery address, in case it receives a message that is not addressed to a destination from its address pool.

This manner of addressing, relying on the information included in the headers of messages, is used in the messaging system of the Bank Clearing Institution of the Bank Association of Serbia, and also by the SWIFT organization in its system for the exchange of financial messages. The same addressing system is used by the National bank of Serbia in its RTGS system for real time settlement and clearing.
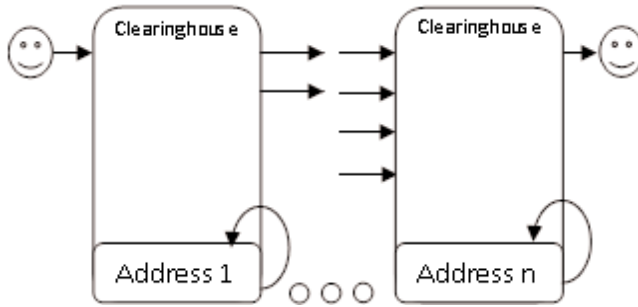

Figure 5. **Addressing: combined communication type**

Data Pool Updating — Partner Information, Price Catalog, and Product Data. We can create a data pool (Figure 6). from the standardized components with assistance of a globally available tool, Stylus Studio [6]. Stylus Studio's Document Wizard is able to create the EANCOM XLM scheme for all message types in EANCOM 2002 standard. Stylus Studio's Document Wizard also offers a choice between the standard version and a specific message type. Document Wizard produces XSD scheme file necessary for generating a database.

Using tool xsd2db.exe [10] we can generate a database scheme on MS SQL server [9] from the acquired XSD scheme.

Altova's [1] xml tool Map Force can be used for creating dynamic link libraries, intended for updating the generated database, by inserting the EDI components from standard EDI collection (for PARTIN messages) and their mapping with generated database components. Thereafter, we are able to update a database with message instances. The same sequence of procedures can be perform for all desired message types necessary for business processes both on clearinghouse's and partner's sides.

Partner Information — PARTIN[4]. Providing basic self-information, as an essential prerequisite for mutual communication, is required from all the partners in the supply chain. Partners' information is also stored into the central location, i.e. into the master data pool, available to all communication participants. This provides an equal treatment of information at all locations, by involved partners and the data pool. It allows for updating of information both in the data pool and, in case they decide so, in the companies, which have obtained the updated information from their partners.
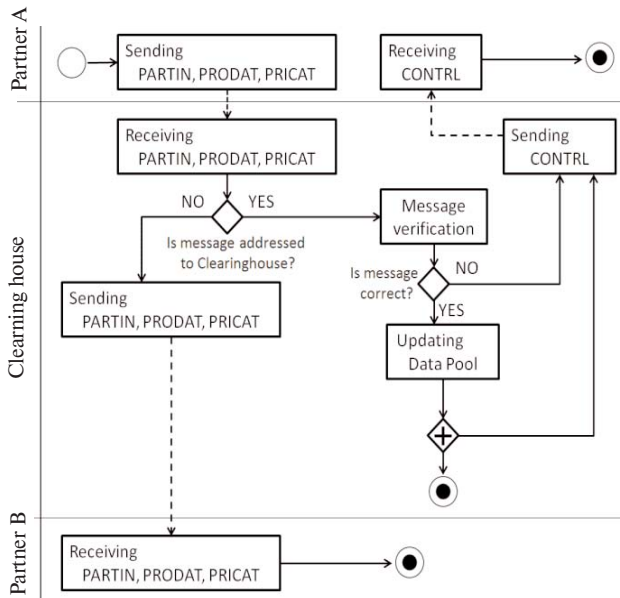
---

[4] Table 1, row.

Figure 6. **The data flow and the process of updating the data pool**

Price Catalog — PRICAT[5]. Partners in the supply chain interested in their partners' products and services collect basic catalogue information for their needs. For that purpose they store the catalogue information on their own or use the master data pool available to all participants.

Product Data — PRODAT[6]. Partners in the supply chain interested in their partners' products and services collect basic product and service information for their needs.

Product Inquiry — from a Partner or from the Clearinghouse's Master Catalogue. As presented in Figure 7, inquiry formulated in the message PROINQ is addressed to the partner or to the clearinghouse's master catalogue. In case the inquiry is addressed to the clearinghouse's master catalogue, the syntax and semantic control, as well as the control of business rules are performed. In case of any evidenced message error, the inquiry is denied. Otherwise, a response containing product information or catalogue details is created.

By using standardized inquiry messages, information regarding products and services stored with producers/service providers or in the clearinghouse's master catalogue are available to all communication participants.

Implementation consists of the use of addressing, syntax and semantic validation, inquiry creation, and standard message creation. These are standard procedures that should be supported by the clearinghouse's and individual participant's systems.

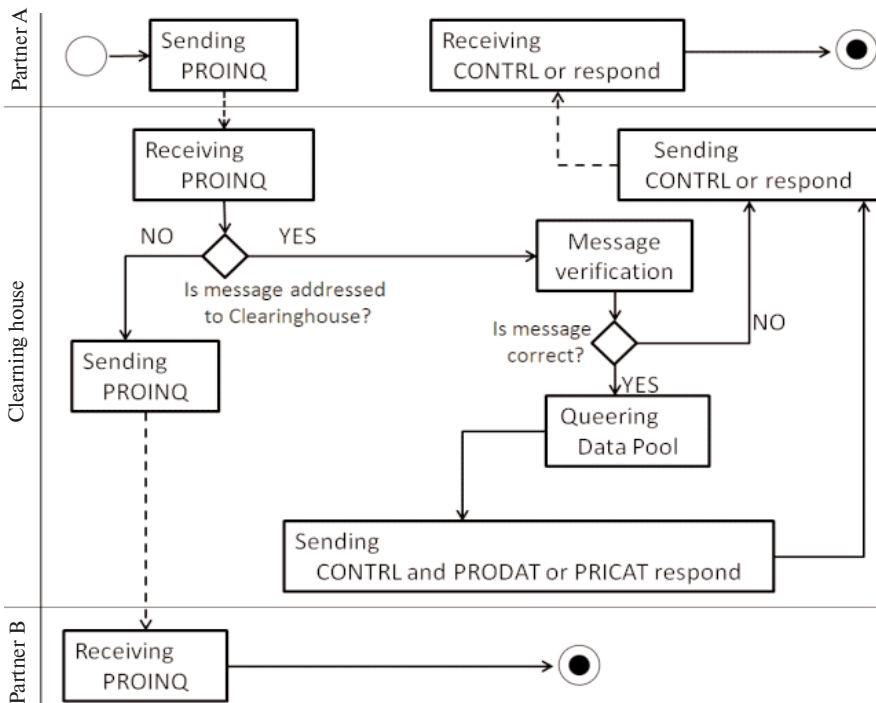[2] Table 1, row
[3] Table 1, row

Figure 7. **The data flow and the process of sending inquiry and response messages to the data pool**

Online Data Investigation — regarding Partner, Product or Product Catalogue. By the use of web applications a company can access the online data, which are then available for, copying etc. By selecting a group of information, a company can request an adequate PARTIN, PRODAT, or PRICAT message, which includes the discovered necessary information.

The acquired information can have further importance for a company's other business activities. Therefore, it is necessary to provide the possibility of receiving the information in a form of a standardized message, available for import and usage in the company's own information system.

By using web application systems, the information regarding products and services stored with producers/service providers or in the clearinghouse's master catalogue are available to all communication participants. Web application system allows for a survey of information regarding partners, their products and catalogues. Web forms provide a possibility to select partners, products, and catalogues, and to request adequate messages, which includes information pertinent to the selection.

Syntax and Service Report — regarding Partner, Product or Product Catalogue. This provides a consistent treatment of messages and a uniform segregation of responsibilities in message processing. A system, which sends a message, knows for sure whether the message is accepted by another system or not.

In case the message has not been received, the sender is provided with the reason for denial. This provides the opportunity to repeat the message upon the inclu-

sion of necessary corrections. The domains of responsibility are defined by the confirmation of acceptance or the denial of message receiving. In case a message is valid and further processing is possible, the confirmation of message acceptance is generated. In that manner a receiver takes responsibility for a received message. Otherwise, a sender of an invalid message takes responsibility for a sent message. In accordance with the validity of a received message, a receiver accepts or denies responsibility for the received document by sending a confirmation or a denial CONRL message.

For the segregation of responsibilities for a message in transport, SWIFT uses ACK (acknowledgement) and NAK (no acknowledgement) messages. For the same purpose, other systems also use similar messages. It is customary that besides the segregation of responsibilities on the level of physical message exchange, the systems may perform the same procedure on the level of business transactions. EANCOM 2002 uses CONTRL message for the segregation of responsibilities on the level of business transactions.

References

1. *Altova Map Force* (2012). MapForce — Graphical Data Mapping, Conversion, and Integration Tool, Retrived 23.09.2012. from http://www.altova.com/mapforce.html.
2. *GS1* (2012). The Global Language of Business, Retrived 23.09.2012. from www.gs1.org.
3. *EANCOM 2002 Syntax 4* (2012). EDI Standards Manual, Retrived 23.09.2012. from www.gs1.se/EANCOM_2002/ean02s4/index.htm.
4. *EDIFACT* (2012). Introducing UN/EDIFACT, Retrived 23.09.2012. from http://www.unece.org/trade/untdid/welcome.html.
5. *ISO20022* (2012), ISO 20022. Universal financial industry message scheme, Retrived 23.09.2012. fromhttp://www.iso20022.org.
6. *Stylus Studio* (2012). XML Productivity through Innovation, Retrived 23.09.2012. from http://www.stylusstudio.com/.
7. *SWIFT* (2012). Messaging, Retrived 23.09.2012. from http://www.swift.com/solutions/messaging/index.page?lang=en.
8. *Merriam-Webster Dictionary* (2012). Clearinghouse, Retrived 23.09.2012. from http://www.merriam-webster.com/dictionary/clearinghouse.
9. *MS SQL Server* (2012). Retrived 23.09.2012. from http://www.microsoft.com/sqlserver/.
10. *XSD2DB* (2012). Retrived 23.09.2012. from http://xsd2db.sourceforge.net/.

Стаття надійшла до редакції 28.09.2012.