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EGOVERNMENT IN POLAND - RESEARCH ON POLISH POLICIES AND PRACTICES

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Abstract

In [1] some aspects of eGovernment: interoperability were discussed The aim of this paper is to summarize the national aspects and peculiarity in the field of interoperability in Poland (strategic frameworks, laws, regulations, implementation, specific requirements, organizational aspects, technical aspects, case studies, best practices, etc.). This information will be latter on used as a part of an e-course on eGgovernment interoperability course. The first part focuses on some of the organizational aspects and the effects they have on PA structures and on the performance of the services provided. In addition, the goal is also to analyze the changes that have produced some valuable innovations. The second section deals with the technological aspects, not only with the identification and exploitation of the best solutions in the field of innovation processes within the PA, but at the same time serves to detect unsuccessful attempts, analyzing the strengths and weaknesses of a given action taken in each case. The final section includes a detailed description of some success examples of a best practice and an in progress experiment of interoperability in Poland. The research was conducted within the LLP Leonardo da Vinci project „ELGI - eLearning for eGovernment" started in 2011. The project addresses its aims at the development of an innovative e-learning course for acquiring knowledge concerning interoperability.

Key words: egovernment, eadministration, IT systems, interoperability

1 Introduction

1.1 Reusing of existing IT infrastructures, services and their monitoring

In 1979 the system PESEL (General Electronic System of Population Records) was implemented in Poland. This system allows to record data about citizens of Poland. On 2 August 2006, the Steering Committee of the PESEL 2 Project was established, and from this moment on, the actual implementation of the project began. The PESEL 2 Project is implemented in compliance with the diagnosis and assumptions of the programme of the Law and Justice political party in the area of public administration computerization.[11]

The basis of the new methodology prepared by a team of experts from the Law and Justice Working Group for public administration computerization was to divide the project into several subprojects and to organize several calls for tender so as to prevent monopolization of such an important part of public administration by one IT company. Implementation of each large IT project in the 3rd Republic of Poland came down to one call for tender covering a huge amount of money and, consequently, a private company (Prokom, Computerland) brought a given part of public administration (e.g. the Social Insurance Institution) under control . This mechanism consisting in total dependence of the state's functioning on the interests of private companies was diagnosed during the previous term of the Sejm by the Law and Justice parliamentary group and Working Group experts cooperating with this group. Immediately after the first meeting of the Steering Committee, the Ministry of Interior and Administration took measures which led to the establishment of the PESEL 2 Project Office composed of such members as to make the content-related conducting of the project possible. The solution of the problem (locating it in an auxiliary unit of the Ministry of Interior and Administration) proved to be a great success. Nevertheless, it was necessary to undertake a range of activities, from the change of status of the auxiliary unit (handling establishment) of the Ministry of Interior and Administration, extending its activity with the tasks of the PESEL 2 Project Office, to the Regulation of the Minister of Labour and Social Policy allowing for employment of IT specialists on decent work and pay conditions (not in the positions of auxiliary staff). None of the central offices have decided to take such a step and applied just temporary measures with a view to „efficient expenditure of funds" without long-term collection of knowledge capital in the organization implementing the project. Free of charge IT courses delivered by the PESEL 2 Project Office for students in last years of IT studies was an integral part of the above mentioned process of building intellectual capital. At these courses, students were acquainted with the practical aspects of the functioning of large state IT systems (in particular PESEL). Some participants of the courses started work

in the PESEL 2 Project Office afterwards, and created the application of the Nationwide Registry of Issued and Lost ID Cards (OEWiUDO) – prototype of the future central database of the PESEL 2 system.

The PESEL 2 Project is the largest of all recent implementations of teleIT system in public administration in terms of the territory covered. Therefore, a working group was established, and it is composed inter alia of representatives of Offices of Voivodes and Voivodship IT Centres, which determine (together with experts from the Ministry of Interior and Administration) the so-called structure of „leading gminas", in whose territory preliminary pilot projects will be carried out. [4]

1.2 Homogeneity and compliance of online services' front-end provided by public organizations

The Polish Government has decided to make the main e-administration systems available from one page (http://epuap.gov.pl/). The Government named the project GATE OF Poland. The philosophy of this solution is to provide the platform to citizens, companies (portal) and administration (communication bus) to interact.[2]. Project Gate of Poland of online services e.g. tax paying, job placement, social insurance service, process of driving license and ID card service, process of document obtain from registry office, to arrange medical visit, service family and social allowance, economic activity registration.

1.3 Capability to provide and manage online payment services by online outlays

In September 2008, a new PaybyNet service set up by the National Chamber of Settlements, allowed Polish citizens to pay for public services via the Internet handling many official matters without leaving the comfort of their home. The Ministry of the Interior and Administration's Public Administration eServices Platform (e-PUAP) will allow users to pay online for public administration services.

PayByNet is a secure credit payment instrument based on the credit transfer mechanism, specifically modified for the purpose of supporting electronic trade. Information about the actual payment having been made transmitted online by KIR S.A. to the Internet store gives the store a guarantee of payment and constitutes grounds for delivering goods/performing a service. Introducing the PayByNet service means setting a new standard of online sale/purchase of products such as rail and airline tickets, software licences or access codes. The high standard and security of PayByNet has been recog-

nized by the National Bank of Poland which has included it in the group of authorization and clearing systems.

1.4 Customer satisfaction, feedback analysis to identify or define better services

From September 2011 to march 2012 The Chancellery of The Prime Minister realized a project named "Customer at the Center of Public Administration". One hundred government administration offices participated in the project. The main purpose of this project was to make office work effective on the basis of customer satisfaction. Within project conferences, training and analysis of customer satisfaction was organized. The final report consists of, among other, conclusions, that IT systems functionality on the client satisfaction aspect is very limited. It is necessary to implement new hardware and software in all offices, because it facilitates effective customer service and as a consequence customers satisfaction is increasing.

1.5 Citizens collaboration and e-participation

One particular purpose of the project "Customer at the Center of Public Administration" is to increase customer satisfaction by co-projecting, co-deciding, co-producing public services. One of the final report conclusions is: "more contact with customers". The offices have to often communicate with customers and encourage them to use modern IT tools.

1.6 Multi-channel PA services

Since 1 July 2011, it has been possible to register business activities in Poland through the Internet, provided that the entrepreneur has a trusted profile or electronic signature. The Central Register and Information on Business Activity (Centralna Ewidencja i Informacja o Działalności Gospodarczej - CEIDG, in Polish), which is run by the Ministry of Economy (Ministerstwo Gospodarki, in Polish), has introduced the CEIDG-1 form to replace the EDG-1 form. The new form is available through ceidg.gov.pl and firma.gov.pl websites. Other organizational advantages - E-administration allows to improve work efficiency thanks to time and cost savings. In consequence official matters are settled better for customers. Offices information and services are more available by using web-sites.

1.7 Organizational advantages of interoperability of online services

1.7.1 Improved circulation / exchange / delivery of data and information between PA organizations

On 12 October 2010, the IT Projects Centre (Centrum Projeków Informatycznych - CPI, in Polish) of the Ministry of the Interior and Administration reached an agreement with a private company to build and implemented a nationwide universal platform constituting the Police's eServices communication vehicle to ensure the efficient exchange of information within the Police. This eServices Platform will provide the following services, which will be available on e-PUAP:

eProcurement; eAuctions for properties; electronic applications for weapon permits; electronic applications for licenses; eRegistration of complaints and ePolice office.

On 1 October 2009, two websites (poszukiwani.policja.pl and zaginieni.policja.pl) were officially launched providing free access to databases containing information on wanted and missing persons.

These sites were introduced to the public at a briefing by Adam Rapacki, Undersecretary of State in the Ministry of the Interior and Administration and Inspector General Andrzej Matejuk, Chief of the Polish National Police. It was stressed that both portals will help improve the quality of investigations and assist in the identification of people escaping justice. The data, provided on the two websites, are taken from the National Police Information System (Krajowy System Informacyjny Policji: KSIP).

1.7.2 Responsibility

On the basis of Computerization of the activities of entities implementing public tasks Act the offices in Poland are obliged to accept a document sent by another office by electronic media, for example e-mail, electronic incoming box.

1.7.3 Validation / data processing

In June 2009, the pilot project called 'Simple Procedures Online for Cross-border Services' (SPOCS) was conducted by Poland, Austria, France, Germany, Greece, Italy and the Netherlands. It aims to develop new technical solutions for enhancing the quality of the electronic cross-border services provided by the Public Administrations. Under the EU Services Directive, by the end of 2009, each EU Member State has to establish "points of single contact", through which service providers can easily obtain all relevant information and complete all necessary procedures electronically, without having to contact several administrative or professional bodies.

1.7.4 Uniqueness of data processed

Geoportal

Poland's Geoportal is set to digitise and centralise all land-related data and information in Poland. Partly operational since the beginning of 2008, it became fully operational in 2009. The system is based on three different levels: local, provincial and central. It aims to enable users to access the systemised data that have been available only on different portals and in different institutions. The basic options of the system would include searching, exploring, downloading and converting. 'Searching' will employ geospatial solutions based on metadata. 'Exploring' means navigating, zooming and reading map legends. 'Downloading' will allow users to obtain full sets of maps, geospatial data or parts of these sets. 'Converting' will allow visitors to change spatial data sets. The nodes of National Spatial Data Infrastructure (KIIP) operate on the three levels: central, provincial (voivodeship) and district. The data bases of the register of lands and building (EGiB) are placed in the districts, while the warehouses of the topographical data are stored on the provincial level.

GEOPORTAL.GOV.PL enables access to geospatial information in the form of redirecting or indication to the outer data (any spatial data services registered in the system) and also be able to act as the data access point that indicates the source of the data (so called "one stop").

There is administrative load reduction in terms of time and cost savings. The example of such reduction has been obtained by introducing STAP

STAP, a Secure Network for Public Administration is a nationwide network linking Central Government departments, offices, agencies and Local Government. One of the projected advantages of implementing STAP is improvement of information exchange between offices and different organization register integration. It has influence on procedures`shortening and office workers` time savings. One of its primary goals are: to integrate existing public networks in order to minimize maintenance and service costs (phone, Internet access and data transmission); to increase security; to enable the interoperability of applications and to provide a communication infrastructure for the Electronic Platform of Public Administration Services (e-PUAP).

1.7.5 Documents' accessibility.

Many documents related to the topic are available in polish Internet. Most of them are freely published on Public Administration web services. The E-PUAP platform enables documents exchange between officers, in consequence these documents are accessible within short time. Often commercial organizations create web-systems and portals for offices, where there are necessary documents, e.g. legal documents, decision format.

1.7.6 Reusing of existing infrastructure and systems

Geoportal (first version) has been used as the starting point to creation of the next version of the service. As we can read on the official pages of the project: "Currently completed GEOPORTAL.GOV.PL project will be continued and further developed in the following phase called GEOPORTAL 2 focusing on extension of National Spatial Data Infrastructure. This infrastructure will be part of the wider European Spatial Data Infrastructure by meeting requirements of EC Directive INSPIRE and relying on fully digitalised documents, materials and data contained in the Polish National Geodetic and Cartographic Resource".

It is anticipated that the GEOPORTAL 2 (www.geoportal2.pl) project will extend the current functionality to include among other issues:

- sharing of data selling capabilities in the electronic or paper form in the transactional mode with theuse of the Electronic Charging System;
- support for spatial queries (e.g. query for the closest hospital);
- possibility to include in the systems spatial data files and services provided by third parties;
- geospatial address localization service;
- access to the geodetic network database.

The project provides for the future development of the network with interconnected diverse spatial

data infrastructure nodes that support a business process typical for the geodetic authority which

will be the owner of the node. [3]

1.7.7 Homogeneity / compliance of online services' front-end delivered between public organizations

An example of compliance of online services' front-end delivered between public organization is the Public Information Bulletin (BIP). Obligatory each office has implemented BIP. Structure of menu and kind of information in BIP are defined by law.

1.7.8 Definition and adoption of precise expertise

There are many projects on public administration, where definition and adoption of precise expertise have been realized. For example powiat Żnin project named "Professional personnel" [5]. One project purpose is the adoption of precise expertise between Żnin powiat offices. Another example is the project "Understanding and experience exchange platform" [6] realized by Regional Centre of Social Policy. Its assume exchange precise expertise between social assistance centres in Opole voivodeship.

2 Strategy for Poland in the fields of changes in organizational structure and logistics consequence of automatic processes

The strategy of Poland for 2013 introduces many changes which will influence organizational and logistic behaviors.

The use of information and communication technologies accelerates the implementation of administrative procedures, which results in reduced maintenance costs and reduces administration time that businesses and citizens must devote to formal legal action. Officials have at their disposal easy to use tools that streamline their work. This leads to the ease of access to data by using a consistent architecture solutions and adequately secured integrating ICT solutions to individual offices.

The use of ICT in administration allowed for the introduction of solutions enabling the efficient exchange of data between offices, reducing the time needed to process the documents.

Strategy for Poland 2013 also defines the tasks for re-engineering of existing systems. This includes:

- implementation of the full range, defined by the European Union, 20 interactive public eGovernment services for citizens and business will simplify the administration, administration-citizen and administration- business communication;
- introduction of public documents in electronic form and Services provided electronically, if the essence of the matter allows;
- development of new tools and channels for providing public services electronically using an electronic signature;
- develop a common vocabulary of terms used in the interpretation of computerization, standardization of data exchange and design of electronic documents;
- promote the use of advanced electronic signature;
- developing and Construction of new domain e-Services platforms for enterprises and citizens;
- simplify billing system based on VAT invoices and electronical sending.

3 Certification process for interoperability

There are many legislation laws which define the necessary standards for IT systems. The laws are provided above. One of interesting certification process initiatives was put forward with the project eadministracja.pl. Certificates issued by the Institute EITCI (European IT Certification Academy: EITC/EG/FAIS, EITC/EG/IEEGP, EITC/EG/PAIS) are a formal certification of acquired competencies to enable effective use of information technology components of eGovernment (under the IDABC program and ISA) . The cer-

tificate is obtained after completion of an e-course provided to local government staff. One of the aims of the course is the promotion of good practices and development of innovative IT solutions in public administrations. The course covers some technological, organizational aspects of e-administration. It contributes to the efforts of public administrations of Member States in terms of implementation, safety, efficiency and transparency of service.

4 Technological aspetcs

4.1 Analysis of administrative information systems that meet the interoperability requirements

E-PUAP (http://www.epuap.gov.pl)- The main concept of e-administration systems is to connect new systems to some central application (e.g. e-PUAP). This central application is a gateway to other services and applications. The services are provided as WEB applications (architecture). The applications that are connected do the gate are designed in different technologies of layer 2 and 3.

- Gate to Poland (Wrota Polski)
- Gate to Poland is built with the concepts of Service Oriented Architecture.
- Presentation Layer. This layer allows efficient adding of new communication channels. The main channels are RSS, NewsML, WWW, e- mail, WAP, SMS, PDA, IVR, call-centers
- Layer of services. Here, not only e-services are made available, but also a directory is connected. This allows the users to get information about the services themselves and how to use them. There are also electronic forms, search engines, personalization mechanism.
- Bridge Layer (BR). BR consists of Directory services, workflow software (which for example helps completing the registration processes, which assure the business/administration Process Management), event processors, IAAA, digital signature and e-payments features Below, there are so called adapters which connect administration departments, Certification Centre, etc.
- There are four roles within the system (logical architecture):
- Directory - in its most simple role, just presenting links to services and integrating of the content;
- Gateway - IAAA, initiating of the services (e.g. sending the form that has been filled by the user);
- Notifier - event manager;
- Coordinator - inter-department business process manager.

4.2 Some standards and technical rules for implementation of online eGovernment systems

Standard 1: SOA - 11 of 18 administration services are designed as SOA, web architecture. Service Oriented Architecture (SOA) is a business-centric IT architectural approach that supports integrating any business as linked, repeatable business tasks, or services. With the Smart SOA approach, the user can find value at every stage of the SOA continuum, from departmental projects to enterprise-wide initiatives. [7]

Standard 2:.NET 8 of 11 institutions use this technology and standards for their applications. .NET is an integral part of many applications running on Windows and provides common functionality for those applications to run. This download is for people who need .NET to run an application on their computer. For developers, the .NET Framework provides a comprehensive and consistent programming model for building applications that have visually stunning user experiences and seamless and secure communication. [8]

Standard 3:

J2EE - 3 of 11 institution use this technology and standards for their applications. Java Platform, Enterprise Edition (Java EE) 6 is the industry standard for enterprise Java computing. Utilize the new, lightweight Java EE 6 Web Profile to create next-generation web applications, and the full power of the Java EE 6 platform for enterprise applications. Developers will benefit from productivity improvements with more annotations, more POJOs, simplified packaging, and less XML configuration[9].

The main technological aspects are:

- demand for Webservices Architecture;
- built with the concepts of Simple Object Access Protocol;
- built with Universal Description, Discovery and Integration;
- built with Web Services Description Language.

It is expected that more web-oriented standards will be added as they are available and mature enough.

The systems should be built on the basis of

- .NET technology;
- Java Enterprise Edition;
- Linux/Apache/MySQL/PHP systems.

4.3 Existing methodologies in the management of IT services

Since the e-administration systems are designed and created by different companies (private and government owned) they use different methodologies of IT management. Often ITIL, Price2 and PMI standards are used in PA. ITIL is mainly focused on service delivery in the IT sector, whereas Prince2 and PMI cover all sectors.

Prince2 & PMI are focused on managing projects, pieces of work that have a beginning and end. The work could be large, like building a call centre, or small, like a social event. ITIL is focused on service delivery, the stuff that happens after you have built your "thing" in the project. For example, once you have built your call centre in your project, there will now be on-going work where the people in the call centre answer the phone. This service delivery goes on and on for as long as the call centre exists.

4.4 Authentication tools for electronic identification interoperability

The e-administration systems are typically equipped with smart card readers (administration users). The companies and private users can use smart cards and electronic signatures. E-PUAP also provides a so called Secured Profile. This method of authentication can be achieved in two steps.

The first one is issued electronically (the user fills the electronic form). Then the user has to go to the administration office and confirm his identity. From now on he is recognized by the e-administration systems. This method of authentication is free of charge, easy to deploy. There is another method described above, the so called Trusted Profile

4.5 Tools for unattended access to services and information in public places

Since the eAdministration systems are web-based they can be accessed from any place. Generally speaking. the administration offices do not provide equipment for users to access the services. Many local offices and cities provide internet access (Wireless access) which helps the users to connect to the systems using their own computers. Many offices make available multimedia kiosks for customers who can use e-services. For example Małopolskie voivodschip realizated a project named "E-administration systems extension in Małopolska". Under the project offices bought 150 multimedia kiosks.

4.6 Online services directory and serach engine platforms for PA online services

The created eGovernment systems contain the sophisticated search engines incorporated into the system features. This is a part of WEB-oriented platforms.

One of the direct purposes of the E-PUAP2 project realized by IT Project center is services directory referred to simplification using e-services by studies systematic of these services by using directory form. The service directory

has? ordering tools, it allows the use of uniform names of services by all offices.

E-PUAP implemented technologies such as:
- Service Oriented Architecture (SOA);
- Open standards xml, SAML;
- scalability hardware;
- reliability;
- IBM applications.

5 Best practices and systems on trial

In this part of the article some best practice examples are described

5.1 BIP and e-Deklaracje

Public Information Bulletin (BIP) is a web system used to grant the citizens access to public administration information. Access to information is possible via:
- newsletter home page located at www.bip.gov.pl, containing basic information on administration entities (name, contact details, information on the editor page), along with links to selected offices;
- links to public administration entities` web sites, with information about their activities.
- Addresses of these pages can be found in the main BIP.
- Public Information Bulletin is a step in the way to providing all coherent, complete and timely public information. System BIP implemented several often open source technologies, such as Linux operating system, Apache Server, MySql database, secure technologies (SSL, TLS, SSH). Content management systems (CMS) and frameworks are used to implement BIP, too. In this project all public offices are involved.
- Since 2009 the Ministry of Finance has introduced the system for taxpayers (www.edeklaracje. gov.pl). The system was developed in such a way that the taxpayer can use it virtually without any effort. It is intuitive, user-friendly, guides him through the steps required to prepare, and then send the declaration. There are many advantages of the system, it has many useful technologies, such as drop-down list of fields; mandatory fields are marked with brackets and further described. In addition input validation was programmed. Security of data transfer is ensured by requiring authentication of the declaration (qualified electronic signature, or as simple and costless: the taxpayer has to "sign" his declaration by providing information of amount shown of the previous income tax return). E-deklaracje implements Adobe AIR technology (http://www.adobe.com/products/

air.html). The Adobe AIR runtime enables developers to deploy standalone applications built with HTML, JavaScript, ActionScript®, Flex, Adobe Flash® Professional, and Adobe Flash Builder® across platforms and devices — including Android™, BlackBerry®, iOS devices, personal computers, and televisions.

- Ministry of Finance presents data about using the e-deklaracje system. 2,1 million declarations were sent in 2011. It is a 100% increase in comparison with 2010. 53% of persons aged 21-40, 17% of persons aged41-60 and 8% of persons aged 61 or more sent a declaration using internet. Ministry of finance and all tax offices are involved in this project.

5.2 System on trial

In Poland there are more and more systems that are made available to public.

SORBNET - billing system for large-value settlements, run by the Polish National Bank. SORBNET supports banks' current accounts held at the NBP for interbank settlements. It belongs to the class of RTGS systems (called Real Time Gross Settlement) or allowing wholesale accounts in real time. Now new version of the system (SORBNET2 is on the tests). The SORBNET was launched in March 1996, replacing the SORB that had been in operation since April 1993. Although SORB had fulfilled the basic requirements of an RTGS system, it had not been a fully efficient system since banks could present their payment instructions only on paper or a floppy disk. Since December 1998 all banks have been able to transfer their instructions electronically.

Operating rules for the SORBNET system are specified in the resolutions of the NBP Management Board and in the bank account agreement, concluded between the NBP and the bank, which has its settlement account maintained in the NBP Head Office in the SORBNET system. The resolutions cover access criteria, types of payments to be processed, general prerequisites concerning technical infrastructure and pricing, while the agreement provisions, which are identical for all banks, regulate time of operation and other operational details.

As of 31 December 2001, there were 62 banks participating in the SORBNET system. The requirements for banks wishing to become participants in the SORBNET are specified in the Resolution No 14/2000 of the NBP Management Board on terms for opening and maintaining accounts of banks with the National Bank of Poland of 31 March 2000, subsequently amended in December 2000 and in December 2001. Banks that wish to open a settlement account with the NBP have to meet the following requirements:

- the bank has to have been conducting operational activity for at least 6 months;
- financial standing of the bank has to be considered by the NBP as appropriate;

- the bank has to meet specified technical requirements enabling electronic exchange of payment orders messages and other information between the bank and the NBP;
- it has to receive a positive rating of the relevant tests from the NBP.

Additionally, in the SORBNET system there are banking accounts handled for two clearing agents, i.e. the KIR [10] and the KDPW.

The SORBNET settles banks' payment instructions related to the interbank money market, foreign exchange and securities market transactions, transactions between banks and the NBP. The SORBNET can be used for processing payment instructions sent by banks on their own behalf or on behalf of their customers (for large value and/or urgent payments). A large value customer's payment is equivalent to the amount above PLN 1,000,000 (EUR 272,480). The system is also used for settling banks' obligations arising from clearing systems: net positions arising from the KIR related to the retail payments and net positions arising from the KDPW related to the capital market.

In general, participants may access the system between 7.30 a.m. and 6 p.m., while customer payment orders may be sent till 4 p.m. However, between banks participating in the "Interbank Agreement on the Rules of Co-operation between Correspondent Banks" customer payment orders may be sent till 5 p.m. After 6 p.m. payment messages are no longer accepted.

Messages transferred between banks and the NBP are encrypted for confidentiality purposes and an electronic signature is used to ensure authenticity, integrity and non-repudiation.

The flow of information between banks and the SORBNET is V-shaped. Banks send the payment orders to the central bank, which informs the sending and receiving bank of the settlement.

Banks' instructions are transferred to the SORBNET system via electronic post. In the event of any disruption in the system, the instructions concerning banks' payments can be transferred on a floppy disk or on paper (including via fax). Instructions filed on paper have to be registered at the NBP. The customer payment instructions can be transferred on a floppy disk only.

E-administration systems are developed in the following architecture.

Citizen<=>Administration<=>Business

The cores system allows communication between the eGovernment departments. The business uses the eGovernment systems through the provided web services or can use plug-in or has to install software on local computers.

Another of the possibilities is to allow the full use of eGovernment systems (e.g. ePUAP) to integrate with external systems for both service providers and recipients. The integration enables combining different applications and thus to automate and simplify the exchange of data.

Such integration allows:

- sending, receiving, treatment of documents;
- payments;

- delivery of dictionaries - collection of data dictionaries, with the exception of their updates,
- collecting information about the subject;
- events Subscription (to be notified by the occurrence of certain events, such as modification of settings);
- document management within the storage;
- one point of authentication SSO (single sign-on) or the transmission of identity.

ABBREVIATIONS

BIP	- Public Information Bulletin
CEIDG	- Central Register and Information on Business Activity (Centralna Ewidencja i Informacja oDziałalności Gospodarczej)
CPI	- IT Projects Centre (Centrum Projeków Informatycznych)
DVC	- Data Validation and Certification
ePUAP	- Electronic Platform of Public Administration Services
ICC	- Circuit Cards
KDPW	- Krajowy Depozyt Papierów Wartościowych
KIIP	- National Spatial Data Infrastructure
KIR	- Krajowa Izba Rozliczeniowa
KSIP	- National Police Information System (Krajowy System Informacyjny Policji)
NBP	- Polish National Bank (Naridowy Bank Polski)
NIF	- National interoperability framework
PEPPOL	- Pan-European Public Procurement Online
PESEL	- General Electronic System of Population Records
PIT	- Personal Tax Declaration
PZ	- Trusted Profile (Profil Zaufany)
REGON	- Company Registration Certificate
RTGS	- Real Time Gross Settlement
SOA	- Service Oriented Architecture
TP	- Polish Telecommunication
ZUS	- Social Security Service/ Social Insurance Institution (Zakład Ubezpieczeń Socjalnych)

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THE CONCEPT OF FAIRNESS IN THE GROUP DECISION SUPPORT SYSTEMS – A SOCIO-PSYCHOLOGICAL APPROACH

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Abstract

In this paper we present ae general concept of the consensus reaching process supporting by the group decision support systems. We proposed the idea which combines the mathematical direction based on "soft" consensus developed by Kacprzyk and Zadrożny [6] and relevant socio-psychological factor concerning fairness component. Essentially, we divide fairness approach in consensus reaching process on two possible directions: a fair distribution (fair resource allocation) and a fair final decision. We stress the benefits resulting from the implementation of proposed concept in the group decision support systems and point the direction of further model formalization.

Key words: decision support systems, consensus reaching process, fairness, fair distribution, soft consensus, fair decision, fair resource allocation

1 Introduction

It is well-known that decision theory is an absolutely interdisciplinary domain which combines researches from many disciplines, i.e. psychology, sociology, economics, philosophy, political science, etc. The formal direction can not be the only course of decision making problems, since all the classical methods had a very limited capacity for explaining empirical choices.

Regardless of its origin, the essence is always the same: there are some options to choose between and only one has to be chosen. In fact, many different models of decision making process occurred, enriched at analysis of human behavior, social interactions and other socio-economic descriptions depending

on the respective purpose. All of these novel agent-based computational models appeared in order to make the process more human-consistent and believable. That is the reason, why we decided to apply psychological and sociological theories to investigating and designing systems in this research topic.

We agree with the statement that the group of individuals is known to be an effective organ in decision making process. In spite of several dysfunctions of groupwork, there are more crucial benefits (process gains). Namely, groups are better that individuals at understanding problems, at catching errors, so they provide learning. Moreover, a group has more information than any one member and can combine this knowledge to derive better solutions and stimulate the creativity of the participants and the process. Hence, the *group decision making process* will be the groundwork of our further consideration. Considering different natures of group decision making problem, we took into account *interpersonal orientation group*. It means, that where the final solution of the problem is only a minor goal. Here, the priority is to ensure a good relation within the group members during decision making process and to achieve consensus in the sense of some satisfactory agreement as to the chosen option.

We want to guarantee an equal participations of all decision members during the consensus reaching process. In most cases, there is also a small group of outsiders who are isolated in their opinions as to the rest of the group and omitted. Finally, outsiders do not sense the satisfaction of the discussion what affects on the effectiveness of entire group. Of course, it does not exclude the final decision achievement, but decreases the opportunity of many, further activities, i.e. practical implementation of the final decision, survival of the group in the long time period, etc. Therefore, all of these socio-psychological aspects forced us to seek for a novel approach of consensus degree which will consider the satisfaction of every individual throughout the consensus reaching process. Furthermore, we attend to reduce the complexity of proposed system with detailed description of only relevant aspects. According to the fact, that most human behaviors have not been formalized mathematically yet, our purpose is to get a better understanding of how social mechanism in group decision support systems works.

2 Group Decision Support Systems

Since the development of modern technology, computerized support in making decision have enormously progressed. Today's tools are flexible, efficient, easy in use and allow to create an interactive user-friendly interface to view data, configure models, etc. This class of computer-based information systems including knowledge based systems that support decision making activities has a common terminology *decision support systems.* They combine

the intellectual resources of individuals with the capabilities of the computer to improve the quality of final decision.

Similarly, *group decision support systems* mean interactive, computer-based systems that facilitate solution of unstructured problems by a set of decision-makers working together as a group. Unstructured problems are fuzzy, complex processes for which there are no cut-and-dried solution methods and where human intuition is often a basis for decision making. Software products provide collaborative support to groups, i.e. supply a mechanism for teams to share opinions, data, information, knowledge, and other resources. What matters here is that group decision support system is an adjunct to decision makers to facilitate their decision making process but not to replace their judgments. Moreover, it is a dynamic system which adaptive over time, therefore the decision makers should be reactive and able to change their opinions quickly. Group decision support systems attempt to improve the effectiveness of decision making (accuracy, quality) rather than its efficiency (the cost of making decisions)[7].

The key to success is to create more 'human consistent' and 'human centered' tools and techniques to grasp and deal with difficult (decision making type) problems. These systems should provide computational tools, cognitive aspects and social dimension. In the GDSS consideration it means that the computer asks a group to solve a problem, then collects, interprets and integrates the solutions obtained by the humans.

3 A schematic view of the proposed system

The general overview of the proposed system is presented in figure 1. The participants will be referred to as individuals, and the interaction of them takes place during the discussion of two or more agents. Its core is composed of preference structure (pairwise comparison) and consensus measurement modules, but the discussion and external information sources are also treated as significant part of the scheme.

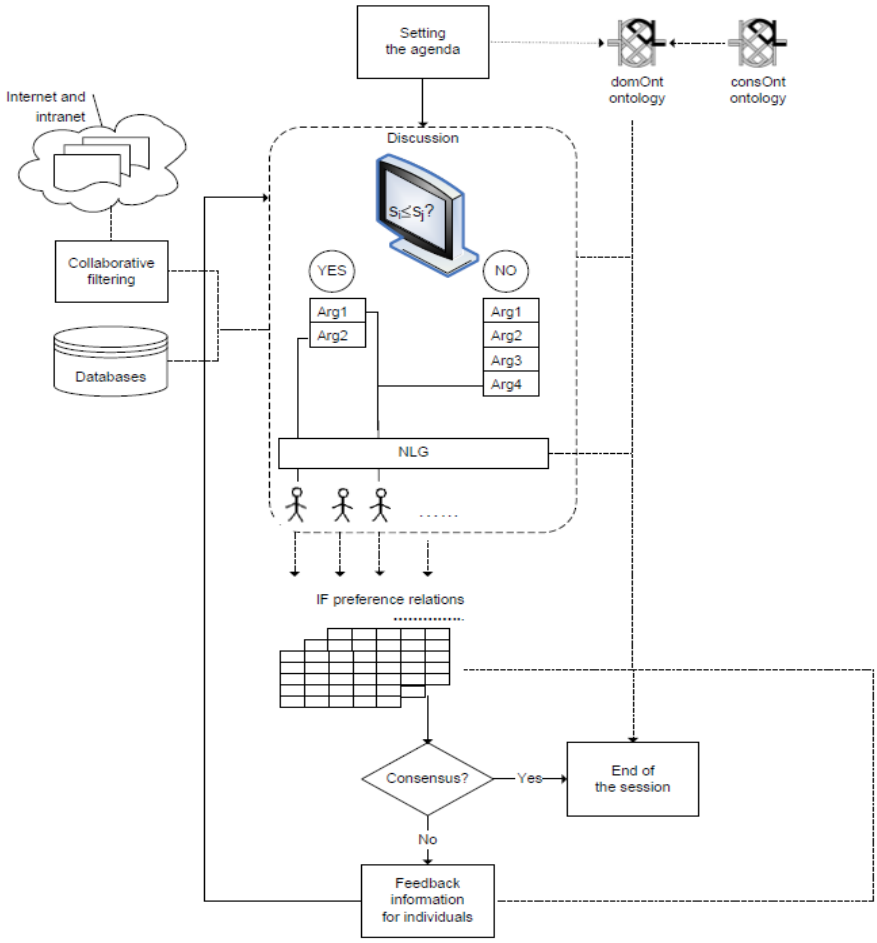

Figure 1. The structure of proposed system [5]

Setting the agenda is the first stage which concerns defining and planning the decision making problem. The representation of options is denoted as *domain ontology* (*dom-ont*) while the *consensus ontology* (*cons-ont*) defines main concepts of the consensus reaching process.

We discuss a consensus reaching process in a group of individuals. To simplify, we attempt to make preferences of the individuals more similar and, in fact, get the decision makers closer to the consensus in the sense of agreement. Basically, there is a finite set of $N \geq 2$ alternatives, $S = \{s_1, s_2, ..., s_N\}$, and a finite set of $M \geq 2$ individuals $E = \{e_1, e_2, ..., e_M\}$. Each individual $e_M \in E$ expresses his/her preferences as to the particular pairs of options in the form of individual *fuzzy preference relation* R_m in $S \times S$, and its member-

ship function $\mu_{R_m} : S \times S \to [0,1]$. Namely, $\mu_{R_m}(s_i, s_j) > 0.5$ indicates the preference degree of an alternative s_i over an alternative s_j, and $\mu_{R_m}(s_i, s_j) < 0.5$ indicates, properly, the preference degree of an alternative s_j over an alternative s_i. The third possible relation represented by $\mu_{R_m}(s_i, s_j) = 0.5$ is also acceptable and denotes the indifference between two considering alternatives s_i and s_j.

The *discussion* is meant as a way to clarify the preferences of the decision makers as to the every pairs of alternatives, exchange of the knowledge and advocate different opinions. During this part, moderator monitors the decision making process, identifies problems (opportunities), filters and tracks relevant data and information and provides suggestions and hints which helps to obtain a final decision. If the satisfactory consensus has been received the session ends, otherwise another round of discussion is set up and some other clues are made by the system in order to help guide the process to the final agreement.

By the *feedback information generation* we understand the fact that the system confronts the individual preferences relations and the list of options submitted by the decision makers during the discussion. Furthermore, *external information sources* and *collaborative filtering* support the discussion by any additional available information and make the flow of information more efficient [5].

It seems that such a combination of tools and modern knowledge will help to develop an innovative human-consistent systems for supporting consensus reaching process. In these systems human perception or valuation becomes essential, thus we can not ignore human characteristics like variability of opinions, imprecise preferences, etc [3].

4 Notion of fairness in group decision support systems

One of the definition of *fairness* says that "fairness means the satisfaction of justified expectations of agents that participate in the system, according to rules that apply in a specific context based on reason and precedent" [10]. Fairness is an intricate idea that depends on many factors, i.e. cultural values, context of the problem. It combines many different research areas such as mathematics, philosophy, economics and other social sciences, especially social psychology. The last research area is crucial because it gives a response to a question: how people understand fair behavior.

The explanations can be given by the definition of the *cooperative game theory* which virtually is a game where players can enforce fair behavior. Cooperative game theory is connected with the distribution of benefits that a group of agents achieves from cooperation. The model assumes that the group

of individuals wishes to solve a common problem and by cooperating they could solve the problem more efficiently [9]. In fact, several research in psychology has shown that in group situations, the decisions of individuals are influenced by motives such as group performance, sense of responsibility for others, or social concern.

Furthermore, many psychological studies have revealed that, in real life, decision makers are not as selfish as the solutions received using mechanisms of rational choice approaches, in the sense of maximization of some utility function. Experiments showed that individuals tend to cooperate and give priority to fairness over greedy behavior [3].

Trust game will transparently perform this activity. In the *trust game*, A has an initial amount of money he or she could either keep or transfer to B. If A transfers it, the sum is tripled. B could keep this amount, or transfer it (partially or totally) to A. Traditional game theory suggests that A should keep everything, or if A transfers any amount to B, then B should keep all. Experimental studies have revealed that agents tend to transfer about 50% of their money and this fairness and cooperation is related to all cultures, sexes, etc [1].

With reference to our assumption that fairness means the satisfaction of expectations of agents, group decision support system should provide the sense of satisfaction among the group members during the discussion and after process completion. According to the psychological research, satisfaction of decision makers has a direct influence on higher quality of final decision and several further activities, i.e. practical implementation of the final decision or survival of the group in the long time period.

5 Fair share of distributed resources

In our research we mainly reflected on one of fairness judgments identified by social psychology, namely *distributive fairness* [8]. It is usually related to the distribution of resources, goods or costs, thus to *fair resource allocation problems*. Resource allocation problems are concerned with the distribution of constrained resources within competing activities so as to achieve the best general implementation of the system with respect to fair management of all the participants. Briefly speaking, the aim is to take a *fair share* of the distributed goods, thus to find such a distribution that is perceived as fair by all individuals.

According to our background – decision support systems – we considered *system fairness*. It could be meant as the ability of a system to enforce the distributional fairness of all individuals participation in goods or costs [9].

The main goal of considering system is to take into account preferences of every individuals and get the entire group closer to the consensus with fair

treatment of all the participants. We neglect the situation when the moderator gets decision makers closer to the consensus by argumentation and persuasion as to the most promising directions, individuals which are isolated in their opinion are omitted. Moderator can not ignore the individuals who are isolated in their opinions as to the rest of the group members, quite the contrary it has to convince them to change their previous preferences. This attitude undoubtedly carries out one of our assumption, namely, active participation of every individual during the entire consensus reaching process.

As we assumed, our research should be done with respect to fair distribution. The theory of distributive fairness can be applied whenever it is possible to precisely define a fair distribution problem and to find a solution that is accepted by the participants (or proposed by the moderator). If we consider the distances of the individuals' opinion to the final opinion, naturally, the final opinion should be fair in the sense that the distances of the individuals' opinions to the final opinion should be fairly distributed.

6 Fair solution to decision making problem

The basic idea of fairness has been divided on two possible directions. The first one, presented in the previous section concerns a fair distribution of resources, while the second is directly connected with the outcome of decision making process, namely a *fair final decision*.

Fair solution to decision making problem has its origin in a voting process and concerns two main aspects: every vote counts and the majority rules. We simply define a *fair decision* as to reach a final consensus during a series of discussions. However, the majority here refers directly to the outcome and can be defined as the *soft consensus*, a conceptual human-consistent framework proposed by Kacprzyk and Fedrizzi [4,5], and Zadrożny [2]. The developed idea is meant basically as an agreement of a considerable majority of individuals with regards to a considerable majority of alternatives. This operational definition of consensus can be, for instance, expressed by a linguistically quantified preposition: *„most of the individuals agree in their preferences to almost all of the options"*, and the consensus degree (in the range [0,1]) is computed. It means that, except none or total agreement between agents as to the chosen solution, this approach allows to some partial, acceptable consistency.

Notice, that to define a fuzzy majority for measuring a degree of consensus the application of *fuzzy linguistic quantifiers* (most, almost all etc.) has been performed. The computations of this relative type of linguistic quantity can be also handled via, i.e. Zadeh's classic calculus. Regardless of the way of implementation, the main condition of this novel approach is that it definitely overcomes the conventional concept in which full consensus occurs only

when „all the individuals agree as to the all the alternatives", what is unrealistic in practice.

What matters here, is that we neglect the majority related to the discussion when it was defined by the opinion holding by more agents in a encounter. Hence, the situation when minority must obey majority and change their opinions accordingly is in a proposed system ignored.

7 Conclusions

In this article we proposed a new concept of supporting group consensus reaching process. We considered the approach of soft consensus model proposed and successfully implemented by Kacprzyk an Zadrożny [6] enriched by the novel fairness component. This notion is strongly connected with psychology, economics, game theory, etc. and, as a result, takes into account more socio-psychological aspects of group behavior. In fact, it helps us to understand typical human behavior within a group of individuals and to extend more intelligent, human-centric and human-consistent systems for supporting consensus reaching in the future development.

Our research determined us to formulate conclusion that degree of consensus obtained by including aspect of fairness would be higher than the previous approach based solely on soft consensus with the use of fuzzy logic. Hence, we take liberty of defining a hypothesis that the concept of novel approach affects directly on effectiveness of decision making process and the quality of the final decision, which becomes highly justified. The ultimate goal of our further research is the mathematical formalization of the fair group consensus reaching process (building a model with regard to the real events and psychological facts) in order to confirm or to reject our assumptions.

Acknowledgements

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DETERMINATION OF PID CONTROL PARAMETERS OF PLASMATRON PLASMA REACTOR

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Abstract

The paper presents determination of PID controller parameters for application of plasmatron powered plasma reactor designed and build in Industrial Research Institute for Automation and Measurements. Plasma reactor is the key element of the test setup, designed to research, processing and recovery of metals from waste of electric and electronic equipment, focusing on electronic printed circuit boards. Experiment was carried out with power of 36 kW. In experiment two temperatures were measured in two points of the reactor chamber, allowing verification of thermal response. Basing on identification of thermal parameters of the plasma reactor carried out in previous paper [7], the PID controller was chosen, as suitable to control second order inertia object. Parameters of used PID controlled were determined using MATLAB-Simulink toolbox. Calculated PID model was utilized for plasma reactor parameters control, allowing examination of energy saving by reducing of plasmatrons power, and stabilization of process parameters.

Key words: PID, recycling, electronic waste utilization, plasma technology

1 Introduction

Increasing digitalization of appliances, and machines equip them with electronic circuit boards. Those electronic circuit boards after end of life of appliance, becomes hazardous waste, that needs to be treated property. Mass production of electric and electronic equipment, requires huge amounts of nonrenewable resources, like metals including precious, and rare earth. It is important to develop new effective ways of treating waste of electronic printed circuit boards (PCB), because they are also new „renewable" resource that can supply recycled metals for new production. By processing the waste of electronic circuit boards, it is possible to recover metals, energy, and decrease its hazardous effect on environment.

Waste of electrical and electronic equipment (WEEE) is a global concern. In the 27 EU countries it is estimated that the weight of produced waste WEEE in 2005 was 8.3 - 9.1 million Mg (tones), 25% of which is collected and processed, while remaining 75% is not registered and does not occur in collection points [1,2]. Such state of waste management system can be caused by lack of processing capacities and suitable technologies which can utilize WEEE effectively. The amount of WEEE rises continuously [3,4] in 2008 Sweden collects 16.7 kg/capita of WEEE, Britain 8.2 kg/capita, Austria 6,5 kg/capita [5]. Moreover European Commission proposes rising collection targets from 4 kg/capita to 65% of average mass of electrical and electronic equipment placed on market (WEEE directive 2002/96/EC) [6]. WEEE has to be utilized, but it also can become a source of valuable resources. Need for technology allowing recovery and neutralization of this waste is strong in Poland, due to huge technological and organizational gap between Poland and west European countries..

Traditional simple WEEE processing technologies i.e. manual dismantling, milling, allow recovery of most of the waste mass. Also new robotic technologies offers new approach to WEEE dismantling decreasing human labor and energy consumption [7]. However every waste processing technology also generate waste, and does not allow full neutralization and recovery. One of such fraction that require specialist processes is the waste of printed circuit boards, and the second one is the "under sieve" fraction from milling of WEEE waste. Currently in Europe only few plants process electronic printed circuit boards, and they use pyrometalurgical processes. There is no such installations in Poland. Important is also that the waste of electronic printed circuit boards, is only a part of the total input in those technologies. Moreover there is no complete processes for neutralization of waste of printed circuit boards and recovery of metals form them. That is why research project was undertaken, financed by Polish National Centre for Research and Development, to investigate and design plasma process allowing processing of waste of printed circuit boards and recovery of metals they contain.

In Industrial Research Institute for Automation and Measurements the test setup was designed and constructed to investigate plasma processing of waste of electronic and electric equipment for recovering of metals and its neutralization. The stand is presented on Figure 1. The key component of the test setup is the plasma reactor, equipped with three plasmatrons - plasma sources, each located 120^{o} around the reactor chamber. The test position is equipped with peripheral systems, measurement and control apparatus for data acquisition and control of the process, during research.

Figure 1. Overview of laboratory setup: 1) Plasma reactor, 2) Plasmatron, 3) Molten product collection, 4) Fumes Exhaust – chimney, 5) Waste package transporter, 6) Plasmatron power supply, 7) PLC – automation and data collection apparatus cabinet, 8) Automatic waste package feeder

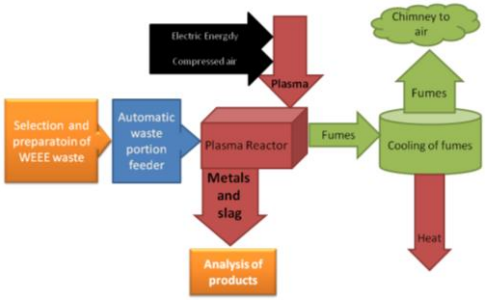

Figure 2. Block diagram of the designed process for research over high temperature plasma technology for metals recovery and electronic waste utilization

The high temperature plasmatron plasma reactor is the key component of laboratory setup for research over high temperature utilization of waste of printed circuit boards, for metals recovery. Block diagram of laboratory setup is presented on Figure 2. Designed test setup allows wide range of possible experiments and data acquisition during research over waste processing and metals recovery. Designed plasma process is being carried out by the fallowing steps presented on Figure 2. Prepared waste portion is transported through automatic feeder to the plasma reactor chamber. In the reactor chamber waste is being incinerated and molten by three plasma streams, next the incineration fumes are being transported to the scrubber where they are neutralized, cooled and then released to the atmosphere. As to the metals and slag, in molten form metals and slag flows out form the reactor and sets in casts, from which it can be recovered and recycled. Figure 3 presents cross section of the reactor, ar-

rows marks the waste and metals route (orange arrow), plasma stream (black arrow), and the fumes exhaust direction (red arrow).

2 Reactor chamber construction

Reactor chamber construction consist three layers: first from inside is fire proof concrete, next is the thermal insulation, and last is the external metal construction shell. Reactor chamber is hexagonal and its construction is presented on the figures 3 and 4. Such construction allows containing in its volume temperatures ranging for 1500 up to 1650 ^{o}C. However, in the area where the plasma streams has direct effect on waste, the temperatures exceeds the temperature measured above, however due to difficulties of measurement of temperatures above 2000 ^{o}C, this temperature currently is not measured.

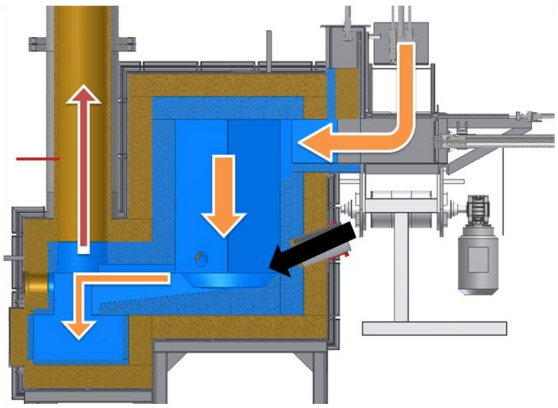

Figure 3. Cross section through plasma reactor with presented material flow. Waste, and molten product – orange arrows, plasma stream – black arrow, fumes – red arrow

The plasmatron plasma reactor have three sources of heat, which are 20 kW arc plasmatrons. Plasmatrons efficiency reaches 80% of energy to plasma heat efficiency. However calculating the plasmatron efficiency including efficiency of the power source, overall efficiency decreases to 70%.

Each plasmatron generates stream of plasma, that flows out at the bottom of the reactor chamber. Plasma is produced from compressed air, that is used as plasmatron working gas. Three plasmatrons consume 11 Nm^3/h of air during normal operation.

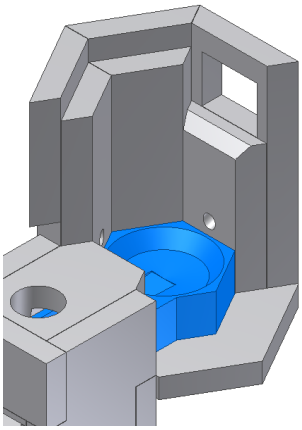

Figure 4. Internal construction of plasma reactor – CAM model

3 Measurement of tempearture in the reactor

Temperature inside the reactor chamber is measured in two points located 30 mm away from reactor wall, and placed in theirs centre. Temperature probe A is located 350 mm above reactors surface, and probe B is located 30 mm above reactor surface. Both sensors are thermocouples type B in ceramic cover. Sensors placement is shown on Figure 5.

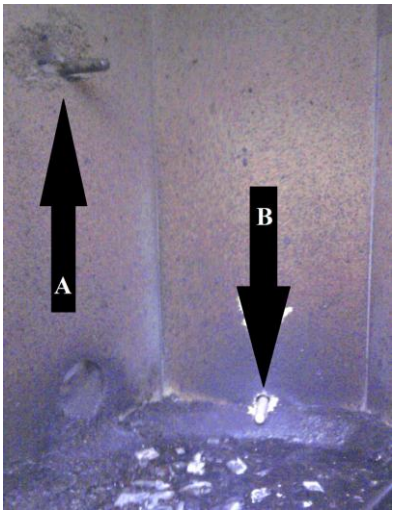

Figure 5. Placement of the temperature measurement probes: A – 350 mm above reactor surface, B – 30 mm above reactor surface

4 Determination of of control alghoritm and its parameters

For determination of control method, mathematical, linear model of the developed reactor has to be determined. We consider, that input variable is power P (kW) provided to the plasma reactor and output variable T (^{o}C) is temperature in the reactor.

Analyse of the physical background of the changes of temperature in the reactor shows, that the time constant of heating up of the reactor chamber, is about 3 minutes, whereas the time constant of heating of the concrete walls of the reactor is to over 22 hours. For this reason transfer function *G(s)* of the plasma reactor was determined as inertial second order given by equation (1).

$$G(s) = \frac{K_p}{(1+T_{p1}\,s)(1+T_{p2}\,s)}, \tag{1}$$

where K_p is gain of the object, T_{p1} and T_{p2} are time constants of inertial elements.

Identification was based on step response of the reactor, with given step input power of the plasmatrons [7]. Results of identification of parameters of transfer function G(s) are presented in the table 1. Identification was carried out for two points of plasma reactor

Table 1. Results of identification of parameters of transfer function *G(s)* [7]

Step response for power P=36 kW	
Measurement point A	Measurement point B
$K_p = 94,8 \pm 0,7$	$K_p = 47,45 \pm 0,09$
$T_{p1} = 84235 \pm 934$	$T_{p1} = 21455 \pm 105,14$
$T_{p2} = 201,8 \pm 1,6$	$T_{p2} = 224,55 \pm 5,13$

Basing on identification of thermal parameters of the plasma reactor, the PID controller was chosen, as suitable to control second order inertia object. This controller was operating in control loop using temperature signal from point A.

Point A was chosen for control loop due to the fact, that temperature in this point is higher, that temperature in point B [7]. As a result, using temperature in point B as an input parameter for control, may lead to malfunction of plasma reactor, due to exceeding its maximal temperature. Maximal temperature of reactor operation was estimated as 1900^{o}C. It is determined by temperature durability of elements of plasma reactor.

Schematic diagram of control system is presented in figure 6. Control loop is oriented on temperature in point A, whereas temperature in point B is only observed.

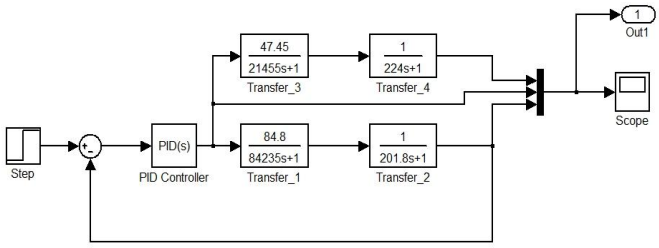

Figure 6. Mathematical model of plasmotron reactor system

Parameters of used PID controlled were determined using MATLAB-Simulink toolbox. There were applied following criteria for PID controller:

- stability of the system,
- minimal time of temperature stabilization,
- output power limited to 40 kW for full range of operation of controller.

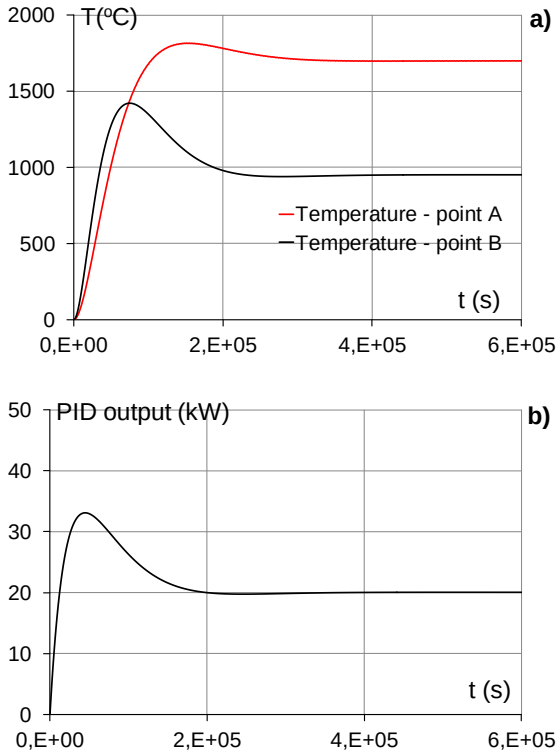

Figure 6. Time plots of: a) temperature T in points A and B in controlled system, b) PID controller effort

As a results of tuning parameters of PID controller, it was determined, that:

- linear element gain should be: $1.413e^{-2}$,
- integrating element gain should be: $3.092e^{-7}$,
- derivative element gain should be: $-1.934e^{2}$.

Time plots for temperature in points A and B, using control system presented in figure 6, for T=1700 ^{o}C in point A are presented in figure 7a. Controller effort is presented in Figure 6b. Limited controller effort should be indicated.

5 Summary

Basing on carried out identification of thermal parameters of the plasma reactor and identified transmittance, presented in previous paper [7], the PID parameters tuning for control of temperature was carried out.

Such automatic control is very important in undergoing research, allowing examination of energy saving by reducing of plasmatrons power, and stabilization of process parameters. Presented identification will be also used in mathematical modeling of plasmatron plasma reactor equipped with three plasma sources.

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FRACTAL FORMAT FOR BITMAP IMAGES

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Abstract

The conception of proposed recording format is the example of the theoretical and practical application of the FBS method, which was precisely described in thesis [18,19,20]. The foundation of the presented recording format is the use of a new method of fractal basis splines (FB-splines), which allows the reconstruction of complex geometric structures with the properties of fractals. Fractral basis splines method is based on the use of non-local characteristics to describe the interpolation nodes. With that the one-parameter family of fractal curves is used as the basic approximating elements.

Keywords: fractal interpolation method, image recording formats, fractal dimension, multifractal analysis, non-local characteristics.

1 Introduction

The mode of saving the image in the computer's memory essentially distinguishes between bitmapped graphic and vector graphics. Taking into account the criterion of recording the image still fractal graphic needs to be included in the above distribution, due to the fact that fractals can be recorded as system of iterated mapping IFS (Iterated Function System).

In vector graphics primitive components (objects) are stored using mathematical equations, which causes that they can be freely scaled without loosing the quality. This vector graphics formats are software formats, in which vector graphics is generated: AI (Illustrator) and SWF (Flash), CDR (CorelDraw program), SVG (Scalable Vector Graphics) – format created by the consorti-

um World Wide Web Consortium (W3C) - the format based on XML language, promoted as the standard for vector graphics. Vector graphics is ideal for creating graphic designs and technical documentation. Files that store the content of the drawing have small size.

Coding bitmapped graphics formats can be divided into:

- using lossless compression - moderately reducing the file size without losing any information: RLE (run-length encoding) - sequence length encoding and LZW (Lemple-Ziv-Welch);
- using lossy compression significantly reducing the file size (up to 1/100) at the expense of loss of information, with strong compression a significant deterioration in the quality of the image can be seen (jpeg);
- not using compression.

The most popular bitmapped graphics formats: GIF (Graphics Interchange Format), PNG (Portable Network Graphics), TIFF (Tagged Image File Format), JPEG (Joint Photographic Expert Group), JPEG (JPEG Interchange Format), BMP (Bitmap Format).

The format, which describes the fractal image is the FIF (Fractal Interchange Format)format, which is based on the local image self-similarity and using fractal compression. It was introduced and patented by Interated Systems Inc. in 1987. FIF is something in between bitmapped and vector graphic, has many raster features , but it can also be scaled without loss of quality - such as in vector graphics. The file format created by Iterated Systems, Inc. is based on the mathematical thesis on fractal geometry from 1984. According to the princeples the images can be enlarged indefinitely without loss of detail, in practice, selecting the appropriate system of functions is difficult and can deliver extreme results from very good to quite average.

As an alternative to the FIF format, the authors suggest a different way of encoding a bitmap into a fractal form. Presented later in this article the algorithm encodes a bitmap into a fractal form, exactly using the FSB method (fractal splines Base) [18,19,20] wherein the chrominance chart of subsequent pixels of the raster image serves as the interpolated curve. The fractal record of the interpolation curve makes the encoded image form. The image is saved in the form of fractal interpolation curve decsribed in the interpolation nodes by fractal splines base scaling multipliers and non-local characteristics including the fractal dimension.

2 Theoretical basics of the method

The suggested method assumes that brightness values of consecutive pixels in the image line constitute a sequence which is a result of sampling of a sophisticated structure acting as a multi-fractal and being a reflection of the real image. Such a sequence may be analyzed by means of well-known meth-

ods based on multi-fractal spectrum analysis [18,19]. The sequence is a set of numerical values, each out of which automobile can be treated as a result of a Certain stochastic Process realization $P(x)$. The values in our expression (T_1, T_2,..., T_N) are established for the equal ranges Δx, where:

$$T_i = P(x = i\Delta x) \tag{1}$$

To make things easier, the sequence has been standardized:

$$\frac{1}{N}\sum_{k=1}^{N} T_k = 1 \tag{2}$$

A coarse function is defined:

$$T(x) = \sum_{k=1}^{N} T_k I_{[(k-1)\Delta x, k\Delta x]}(x) \tag{3}$$

where $I_A(x)$ is a specific function of set A in the form of:

$$I_A(x) = \begin{cases} 1, & for \quad x \in A \\ 0, & for \quad x \notin A \end{cases} \tag{4}$$

where the ensemble A in the presented method is the sum of intervals Δx.

The multi-fractal analysis is aimed at finding a new sequence *S(x)* composed of whole numbers σ_i and chosen from the range *1,2, ..., Q << N*, where each of these numbers corresponds to the value of the coarse Holder exponent from the range $[(k\text{-}1)\Delta x, k\Delta x]$ — a form of the Holder exponent α digitization:

$$S(x) = \sum_{k=1}^{N} \sigma_k I_{[(k-1)\Delta x, k\Delta x]}(x) \tag{5}$$

The purpose of these proceedings is to select subsets composed of ranges with the same σ_i value (discreet value of the Holder exponent).

In practice, we deal with discreet structures presented with a given resolution, for example in computer algorithms conditioned by the pixel size. In such a case, the coarse Holder exponent is used. Using a dependency, $\alpha(x,\delta x)$ is defined for the rane δx around the point x:

$$G_{\alpha(x,\delta x)}(x) = \mu\left(B_{\delta x}(x)\right)(\delta x)^{-\alpha(x,\delta x)} \tag{6}$$

where μ(Bδx (x)) is a certain measure indicating the probability that a randomly selected point is in the area of $B_{\delta x}(x)$ defined by the interval δx around the point x. In generality, the $G_{\alpha(x,\delta x)}(x)$ for any value of $\alpha(x,\delta x)$ takes the value of zero or infinity, there is only one value, for which the above measure is finite. This value determines the Holder exponent at the point x. $\alpha(x,\delta x)$ may be calculated by logarithming the above dependency:

$$\ln \mu\left(B_{\delta x}\left(x\right)\right) = \alpha\left(x,\delta x\right)\ln \delta x + \ln G_{\alpha(x,\delta x)}\left(x\right) \tag{7}$$

and by using a well-known procedure designates points in the coordinates ($ln\mu(B_{\delta x}(x))$, $ln(\delta x)$) for the ranges of various sizes. The coarse Holder exponent determines the inclination of a straight line adjusted with the least squares method. The procedure should be used for each point (pixel).

The notion of an interpolation node plays an important role in fractal interpolation methods. In case of reconstructing complex fractal structures, however, the classic notion of an interpolation node is no longer sufficient as it can not be attributed to one, clear-cut value. What follows is a necessity to introduce a new quantity defining a place of data gathering and being able to reconstruct the structure in the future. The Local Interpolation Window (LIW) [18.21] can be treated as such a new term. LIW is absolutely crucial with regards to gathering data needed for a local reconstruction of the interpolated shape. Numerical data from the LIW area, for example a local fractal dimension, create a data set on the basis of which a curve, representing a dependency of brightness on the pixel position, is reconstructed.

Using a similar approach, the coarse Holder exponent $\alpha(x,\delta x)$ can be averaged with the ranges representing the LIW width:

$$\alpha\left(x\right) = \sum_{i=1}^{N} \left\langle \alpha\left(x,\delta x\right)\right\rangle_{\Delta x_i} I_{\Delta x_i}\left(x\right) \tag{8}$$

Where $I_{\Delta x_i}\left(x\right)$ is a characteristic function (4) $\left\langle \alpha\left(x,\delta x\right)\right\rangle_{\Delta x_i}$ — medium value $\alpha(x,\delta x)$ in the range of Δx_i.

As a result, the multi-fractal curve breaks up, with a certain approximation dependent on the LIW width, into local (within the ranges of Δx_i) monofractal sets characterized by one, unique value of the fractal dimension $D(\Delta x_i)=D_i$ and in each range. The original curve may then be locally reconstructed by means of set fractal curves with the right dimensions. Practically, this is a case where a dimension may be calculated for every window as a box dimension, which greatly facilitates the calculations.

For the interpolated structure to be reconstructed, it is necessary to have a set of base curves fractals defined in the standard Δx range, for example: Δx

=[0,1]. For our practical proceedings, we have chosen a family of curves based on the well-known Koch's curve, and we shall call them Generalized von Koch Curves (GKC) [18]. One advantage of our choice is a simple dependency defining the GKC fractal dimension:

$$D = \frac{\ln 4}{\ln\left[2\left(1+\cos\varphi\right)\right]} \tag{9}$$

in the above parameter $\varphi \in [0, \frac{\pi}{2})$, is the opening angle of breaking in the curve.

Interpolated curve may be marked by dependency means:

$$L \approx \sum_{i=0}^{N} s_i K_i(x - i\Delta x, y, D_i) \tag{10}$$

where: s_i – interpolation coefficients, and fractal curves $K_i(x,y)$ are placed centrally (with the highest possible value) he interpolation points.

Let us assume that we know the values of the curves y_1, y_2, …, y_n in the set interpolation nodes x_1, x_2,…, x_n (they represent the brightness of the marked pixels) as well as the fractal dimensions D_1, D_2,…, D_n of the interpolated curve L defined in the respective LIW interpolation windows corresponding to the given nodes The s_i coefficients are calculated iterationally on the basis of the expression:

$$y_i = \sum_{j=0}^{N} s_j^{n+1} y_j \left(\frac{(i-j)\Delta x}{s_j^n}, D_j \right)^* \tag{11}$$

where: s^0_j=1, y_i - set values of interpolated nodes, $y_j(x,D_j)$ is a set of y values of the curve $K_j(x,y,D_j)$ numbered j for the set value of x, and $K_j(x,y,D_j)$ - starting FB-splines are centrally located on each interpolation point. The basic curves' span equal to $6\Delta x$ has been assumed for our calculations. In expression (11), a possibility of occurrence of many FB-splines values with a set x has been taken into account. Therefore:

$$y_j^n(x, D_j)^* = \frac{1}{2}\left[\sup y_j^n(x, D_j) + \inf y_j^n(x, D_j)\right] \tag{12}$$

The mean square error of iteration is an accuracy measure of the calculations:

$$\delta^n = \sum_{i=0}^{N} \left(y_i - \sum_{j=0}^{N} y_j \left((i-j)\Delta x, D_j \right)^* \right)^2 \tag{13}$$

While conducting the interpolation, we have to remember about the notorious problem of lack of data at the ending points of the interpolated curve. These values have to be defined separately.

3 The description of the raster image processing into a fractal form with record algorithm

The concept of processing the raster image to the record in the fractal form is based on the method of fractal splines basis to store the level of chrominance or exertion of individual components RGB following image pixels. Therefore the chrominance pixel of the bitmap graph can be restored by using the method of fractal splines basis. We encode the image data into a data form needed to calculate the interpolation function by using the FSB (fractal splines base) method, instead of direct record of chrominance level values or intensity of the individual components of the following image pixels. The whole image is treated as a single sequence of pixels, without considering the division into the lines. In order to increase the probability of implying the close pixels position on the interpolated curve by their close position on the image, the encoding of the odd-numbered lines of the image in order from left to right was used, while with the even-numbered lines - from right to left. The existence of the above relation facilitates the application of fractal dimension read from a local interpolation window as an additional parameter describing the image, since it is closely related then to the specific consistent area.

Image can be encoded in the mode of three additive components - then it is treated as three separate monochromatic images representing each component. In order to encode the image based on all its pixels a chrominance chart is being created. In the case of using the RGB model the component G has the highest bit depth of the parameters, the most severe error criterion and the largest width of the local interpolating window , setting out the analysis range of non-local parameters of the curve. Due to the fact that the final outcome it is difficult to be predicted, that is the number of iterations and the total error of the using the fractal splines base algorithm, it is necessary to submit the image data to many attempts to recover.

The aim of the proposed method presupposes the attempt to recover the initially given segment of the generated graph so that in the case of failure of its reconstruction by using the method of fractal splines basis with the result,

which easy to describe with the smaller amount of data, be similarly examined, but in truncated form.

Therefore, the number of blocks into which the entire chrominance graph is going to be divided as well as the length of each block can not be determined in advance. In relation to that, the authors propose to base the image recording process on parameters, such as: the number interpolation nodes; permissible number of iterations the fractal splines basis method; permissible error of the curve projection using fractal spline basis method; the initial length of encoded in the block graph segment; shortening multiplier of the graph block.

The first parameter, called the number of interpolation nodes is the value required to start, here treated as the service, fractal splines basis method. The number of interpolation nodes used to encode of each of the analyzed segments of the graph is imposed on by the user prior to the encoding process. It has a significant impact on the reconstruction of the image - the greater number of interpolation nodes helps to obtain a better mapping, however it may turn out that achieving such conditions entails the consequence of carrying out many more operations.

The process of converting an image into a curve treated later in the process as the fractal shape has a remarkable influence on the further course of the algorithm. The conducted tests showed, that the result obtained, in particular the file size and accuracy of mapping is extremely sensitive to the values such as: length of initially being tested to be reconstructed segment of the particular graph in the *initial length of the interpolated curve* parameter; the expected maximum value of the deviation of interpolated curve which is the medium encoding the part of the graph from the relevant graph, acting as the interpolated function here; permissible number of iterative repetitions of the fractal splines basis algorithm

On the serialization speed, apart from *maximum number of iterations in the interpolation* impacts primarily reduction mulitiplier of the encoded segment of the graph *(interpolated curve reducing).* Reducing occurs when after performing a specified number of repetitions during any of the iterations it failed to get the error below the value specified in the *the maximum permissible error on the pixel* parameter. The authors aim is such a match of detailed algorithm solutions and also other parameters values that the remaining values, that is *the ratio of the number of pixels to the length of the curve,*and *the value for the white color*, which are the multipliers of the horizontal and vertical fractal curve graduation did not affect the time and the result of image serialization.

In the process of image encoding the fractal dimension plays a significant role. However, its use is possible only in the case of a large size images. It results from the fact that used in the Fractal Splines Basis method method of researching the box-counting dimension based on the Kolmogorov algorithm

requires high resolution. For the treated as a fractal curve chrominance graph to meet this requirement, the image should consist at least of one-fourth, and preferably of half of other megapixel. The authors suggest the use of the wide, approximately 2048 pixels, Local Interpolation Windows, since only similar values provide the opportunity to detect the fractal structure of the image. Due to construction of the FBS method, elementary approximating shapes will be in the selected nodes having a fractal structure similar to the value read from the image. It should be taken into consideration that both the impact of the dimension value on the image and the method of its reading do not apply to a single pixel, or a designated spot in the image. They are connected with the widely understood environment. With this use of fractal dimension as a non-local characteristics it will be able to get a chance of a single isolation of part of common image fragment features with simultaneus, taking into account differences saved by graduation basic splines multipliers of automatically placed interpolation nodes.

5 The results of research on the sample images

Tests were carried out on a wide range of images, gained both from imaging devices and generated algorithmically. Among many tests on the images examples were selected, which in the best way are showing issues that have yet to be solved, and the possibilities of the proposed method. The main weakness of the method is most often showed as a deviation of color saturation or brightness value occurring for all the horizontal lines of the image. Is most common where there are step changes in the values of these parameters.

In the case of algorithmically generated image in shades of gray, the horizontal lines in the color that differs from the color of their equivalents in the source image are existing in the areas of the color similar to black. This situation reflects serious problems in obtaining, with the fractal basic splines method, unified smooth curve with the value close to zero. As part of further work on improving the method, the authors plan inter alia to expand it with a mechanism enabling the elimination of smooth or linear graph fragments from the curve undergoing fractal reconstruction. The fragments of the classic curves will be saved in a way that better reviewers their character.

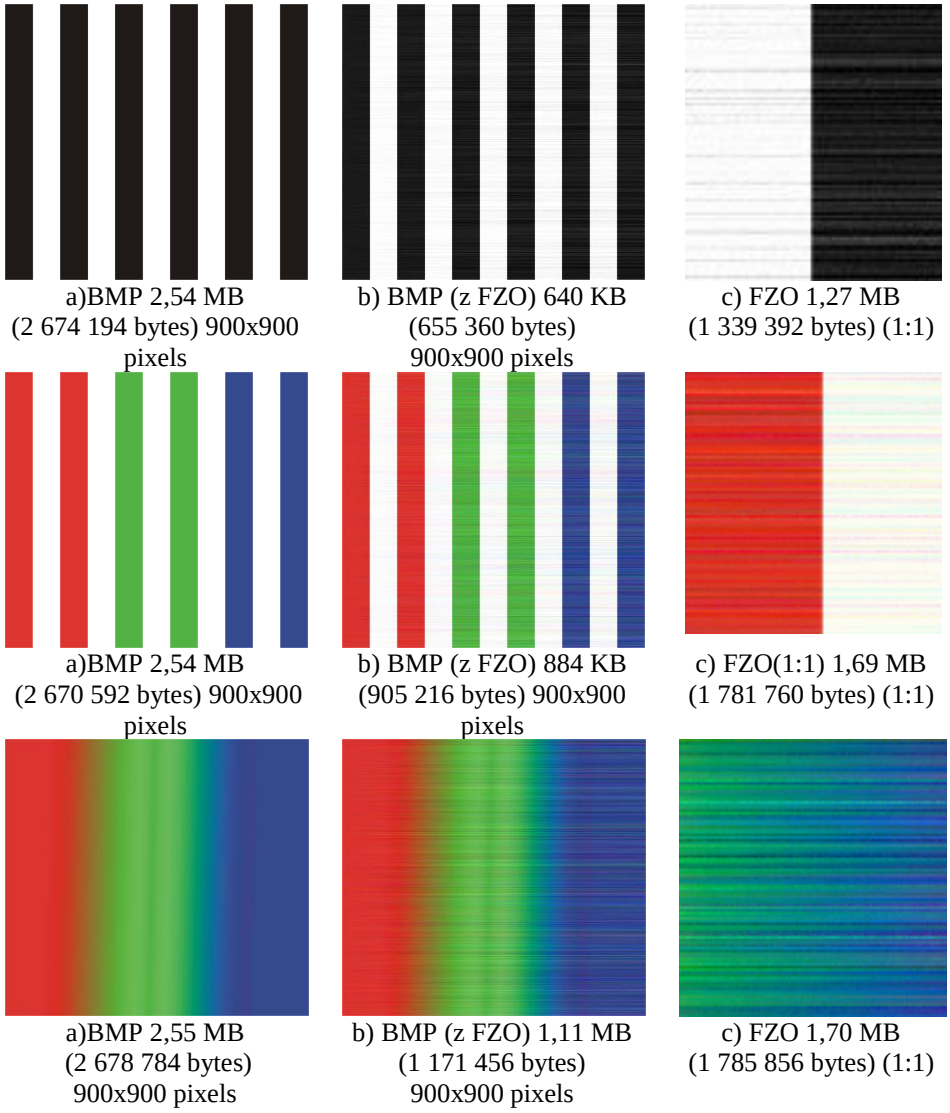


Figure 1. a) original image – BMP format - a computer-generated image; b) fractal image encoded using fractal basic splines method (FB-splines) - save in the bmp format ; c) Image encoded using fractal base splines method (FB-splines) saved in the proposed FZO format, decoded in the file browser FZO

The applied above example proves that the method can handle sharp edges very well. In addition, good results are guaranted iteratively invoking the fractal splines basis method for graph fragments of different length. The above result was clearly much improved by implemented mechanism of searching and a separately encoding, different from the surrounding points of the graph, so-called high and low peaks. Because these elements were present in the above examples exceptionally often, resulting in the repetition of a particular sequence of bytes in the file that stores the encrypted form of the image, the algorithm using compression zip, could additionally reduce the size of that file.

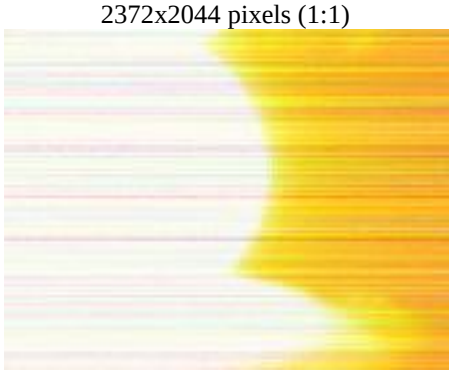
In case of application work on the image in gray scales the fractal image recording algorithm does not encode three separate components RGB, only one chrominance graph. Therefore there is no danger of values being inconsistent for any part of the image, where one or two from the components were extremely overestimated, and the other - in this particular part underestimated. Such situations very strongly spoil visually the end result. The described example shows how exactly the fractal image recording method is able to extract from the image the fractal structures and with how high accuracy will it later be able to restore them. At this point, the authors are convinced, that from every image it can be extracted smaller or bigger group of data, having such chaotic, irregular or jagged runs, just in order to subject them to the encoding with the suggested method.

Analogical used of the suggested method for the color image creates a threat of the previously mentioned components being inconsistent. Situations, in which there unexpectedly appear significant differences between pixels of the subsequent lines of image on the smooth areas is mainly caused by the fact that the use of the fractal methods do not work for processing of smooth shapes. The above problem can be fixed by averaging the subsequent pixels with neighbors lying below and above. Unfortunately, the unavoidable consequence of such operation must be the loss of data, and consequently a blured image. Homogeneous smooth large areas detected by the algorithm results in greater reproducibility of data in the binary file containing the encoded image, which was visible in the stronger compression of the file using zip compression.

a) JPG 1,81 MB (1 905 711 bytes)
2372x2044 pixels

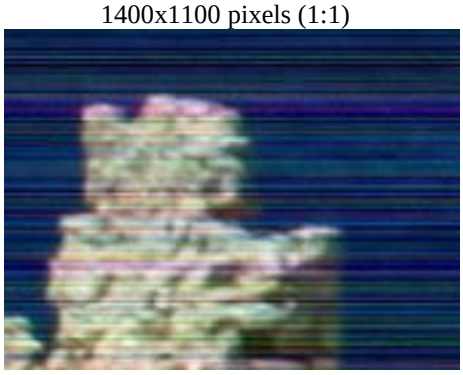
b) FZO 9,24 MB (9 696 742 bytes),
ZIP 6,63 MB (6 955 008 bytes)
2372x2044 pixels (1:1)

a) JPG 850 KB (870 977 bytes)
1400x1100 pixels



b) FZO 3,09 MB (3 250 182 bytes),
ZIP 1,83 MB (1 925 120 bytes)
1400x1100 pixels (1:1)

a) JPG 980 KB (1 003 520 bytes)
1452x984



b) FZO 2,72 MB (2 857 542 bytes)
ZIP 2,04 MB (2 142 184 bytes)
1400x1100 pixels (1:1)

Figure 1. a) original image – JPG format; b) Image encoded using fractal base splines method (FB-splines) saved in the proposed FZO format, decoded in the file browser FZO

The above example specifically illustrates the restrictions of the use of the suggested method to images with contain information of visibly low frequency. In large parts of the image large step changes appear only in the dominant red component. Also a small green element can bo spotted. In addition, the image looks exactly like the result of the applying of a strong low-pass filter. According to the authors realizing described earlier in this thesis mechanism of separately encoding fragments of classical curves will significantly improve the algorithm performance of the algorithm in such applications as described above.

5 Summary and conclusions

The presented above juxtaposition of bitmap is selected in such a way, to present the perceived advantages of the proposed recording method, but also in order to illustrate the particularly troubling drawbacks and deficiencies, with particular emphasis on those, with which the authors are planning to face in the near future. To the already mentioned advantages of the suggested method belongs, first of all the ability to match the encoding media into the irregular structures having chaotic and rough course. Much better result were achieved trying to save images with high frequency, than images partially averaged with a low-pass filter. As shown by the above examples, the majority of the work awaits the authors in areas for service in such situations, where the graph of color intensity or chrominancy takes the form of the classical curve, in particular linear function. Selecting such areas and their encoding using different algorithms is the major authors hope to improve the quality of decoded data achieved and the size of the files that contain their encoded form.

There are also no doubt that a lot of focus in the future will need to be given to the selection of the points separating the chrominancy graph on individual fragments treated as fractal curves undergoing reconstruction. The proper dividing of the graph to the relevant parts will provide a better fit of the interpolating curve to the interpolated one due to a better separation of certain different local characters of the examined runs. As a result, it will be possible to obtain improved image quality and reduced size of the file with the encoded data. It also seems necessary to return to the subject of the sequence of processing the source image into chrominancy curve or intensity of the component color. An attempt was made to apply to this purpose the Peano curve, however it did not bring the expected results. The revised order of reading the pixels, increased the probability of grouping similar pixels close to each other, but unfortunately it did not provide continuity of the most important characteristics of fractal structures.

It will also be necessary focus future research on the linking the image transformation algorithm into a graph with the detection of edges, surface, or other initial image analysis. The ideal solution seems to be the concept that is being able to connect the two recently discussed issues, that is, the enrichement of the algorithm with the ability to initialy divide the image into areas with similar fractal structure and connecting with them relevant, consistent in terms of the many features fragment of the analyzed later graph.

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FEDERATED DATABASE SYSTEMS IN SUPPLY CHAIN MANAGEMENT

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Abstract

The article shows the possible ways of use of federated database technologies in data management in the logistic chains of companies. The architectures and components of software for creating the federated systems and some suggestions for the architecture of data management information systems for companies are presented in the text. The mentioned solution stands a proposal to resolve the difficult problem of cooperation between the computer information systems in companies, which refers to making the data of company available to the external users and managing data in the logistic chain. The authors included an overall review of commercial software, which can be used to build the software of data managing in the chains of cooperating companies.

Key words: soft computing, supply chain management, data bases, federated database systems, middle software

1 Introduction

Contemporary competitive global market economy demands a lot from companies. Particularly, it concerns the spheres of activity where speed and reliability of action are the most important factors and where transfer of information and decision-making support are decisive.Despite the rapid progress of software and computerization of the most important information processes in the companies, no effective means of managing a business has been created. Simultaneously, the wider range of functionality of information systems there is introduced, the more complicated it is to operate them. New problems arose, having an effect on exploitation and making a good use of systems. the complex, integrated data management and the safety of computer systems are of vital importance. While watching the very rapid growth of streams documents being processed and information technologies, it is easily noticeable that the formula of systems of MRP/ERP class, that has been do-

minant so far, is not able to meet the expectations of flexible process management. Undertaken modernization activities of the software in companies consist in implementation of subsequent modules and supported functions to former architecture of integrated computing system in a particular company. Even the high-tech solutions, which have been used in the ERP II - class systems, such as Electronic Data Interchange (EDI), Workflow or Business Intelligence modules, stand only a partial solution to the general problem of business management [Paszkowski, 2006].

Increasing competition makes the companies to ceaselessly improve the performance effectiveness, which is usually achieved by increasing the cooperation between the producers and the suppliers and informatization of processes. It is striven to reduce the cost per unit or optimize the economic results. The very basic method is the division of production tasks between the cooperators. For the sake of realization of such enterprises, some suitably effective structures of logistic chains of cooperating companies and computers systems that support cooperation are indispensable.

The traditional SCM (Supply Chain Management) systems that have been used so far do not solve all the problems fully. Especially, it concerns the provision of flexibility or making closer cooperation easier, directly on the level of integration of that computing systems [Paszkowski and others, 2012].

On account of that, it is inevitable to look for software solutions which would provide effective ways of making data available and exchanging it, as well as employing new effective methods of optimization and business decision making.

The main problem that appears when it comes to discuss designing enterprise computing which is to manage the logistic chains is the data exchange in the whole chain of companies.

The needed solution, besides providing suitable and reliable data to a specific place in specific time, is to provide necessary level of information systems safety, including respect of confidentiality and integrity of data [Lockhart, 2004]. The prerequisite of that system feasibility is the provision of needed protection of each company businesses and strong protection from the possibilities of likely abuse of direct access to date while downloading it or later on. On the one hand, the system is to provide a direct and rapid access to the data needed to manage business tasks but on the other hand, it is to ration the data we need to process, in order to reduce not authorized access and criminal use to minimum. It seems that the safest solution is use certificated software which task is to download data essential for computational procedures, along with access monitoring and review of conformity to the employed processes of management. By design, it would eliminate human direct access to the source data, especially those belonging to the other subjects (companies, departments and processes), monitoring the authority of each user in terms of access to the resources. In the article below, there is a review of se-

lected notions and problems concerning the technology of data management in computer systems in cooperating companies presented.

2 Characteristics of the actual state of informatization of cooperation between companies in chains of supplies and distribution

2.1 Assessment of the state of information technology of supply chains

At present, the basic architecture of systems of supplies relies on the basis of network that links companies, connected in terms of supplier - customer relations. In literature, there exist such terms as Supply Chain Management or Demand and Supply Chain Management System. Different ways and rules of creating the chains [Pacana, Perłowski, 2010] and traditionally they rely on the existent relations between the business partners or their information systems. So far, in the systems managing chains of supplies - SCM (Supply Chain Management), the exchange of information between suppliers, producers and distributors has been carried by means of teleinformatics technologies. In the very beginning, the EDI system were the only ones in use [Zieliński, 2007], and after that the communication services of the Internet started to be used wider and wider [Paszkowski, 2009, p. 93-97].

Supply Chain Management in the very basic architecture consists of two management sub-systems: SCP - Supply Chain Panning and SCE - Supply Chain Execution. Supply Chain Planning stands a set of information technology tools which offer, on the basis of historical transaction data of the company, creating the forecast of the demand for products and making production plans [Paszkowski, 2006]. The system might be used for the purposes of operational management (current activities) or for working out the long-term strategies (expansion of the manufacturing forces, investments, working out quarter annual business plans).

Supply Chain Execution uses the information generated in SCP for the purposes of production and operations management, storing goods, transport, assembly of components and delivery completion.

The mentioned sub-system communicates with SCP and the order management systems of each company in order to set the scale of production, taking into consideration time and financal restrictions as well as updating the final production plan. When analyzing the detailed architectural solutions in communication systems of business chains [Paszkowski, 2009], it might be stated that the key factor in flexible and effective information exchange system building between companies is the system integrating their data bases. The complexity and multidimensionality of the problem of connecting data bases issue many challenges to the designers of the system.

The biggest problem is the heterogeneity of computer information systems and software environments of data bases that support individual companies. In the process of connecting different systems, federated database technology systems come in handy [Sheth, Larson, 1990], [Subieta, 2000], [Rutledge, Medicke, 2001]. There is a very big chance of using the above-mentioned technology in logistic chains of companies [Paszkowski, 2012, p.1].

2.2 Techniques of Database Integration and Federated Database

The most frequent and the easiest method of integrating many databases is creating double connections between all the databases which are to communicate with one another. Such connections allow one database an enquiry to another database, formulated with the use of notations of the language that is supported by the target database. While integrating the access to databases their heterogeneity stands a problem. It is so due to the fact that the bases may differ in their functionality, form of data representation (form of metadata) and very often they use different dialects of SQL language. Because of that, the access from one database to the other is to be created by means of the software assigned to these databases. That software is called "a gateway". Its tasks include [Wrangler 2005]:

- transforming the structures and types of data used in a particular database into the structures of the target base,
- providing the mechanism for running transactions comprising the databases taking part in them,
- transforming the dialects of SQL used in the input database into the version used by the output database.

In software used for the gates special standards are employed which define the methods of access to the databases. In the employed systems of databases standards are implemented in the forms of drivers, which stand the Application Programming Interface (API) - the collection of procedures and functions that carry out data support. In the databases two types of drivers developed by Microsoft are used, namely:

- ODBC1 (Open Database Connectivity) - for accessing database management systems using SQL,
- OLE DB (Object Linking and Embedding Data Base) [http://en.wikipedia.org/wiki/OLE_DB]

API enables access to any data source. The producers of database software provide the needed drivers in installation packages or distribute them on their web portals.

Federated database system is able to link systems of databases inside and outside the corporations, and other federation systems that due to their gate-

[1] DBC was originally developed by Microsoft during the early 1990s, source: wikipedia.

ways are seen just as a database of a virtual company. When it comes to the logistic chain of companies, its federated database would consist of gateways which are bridges connected to the systems of databases of particular companies and, hypothetically, to the system of federated database of cooperating supplies of suppliers or consumers chain.

The picture below depicts an example of the architecture of federated database for the chain of companies.

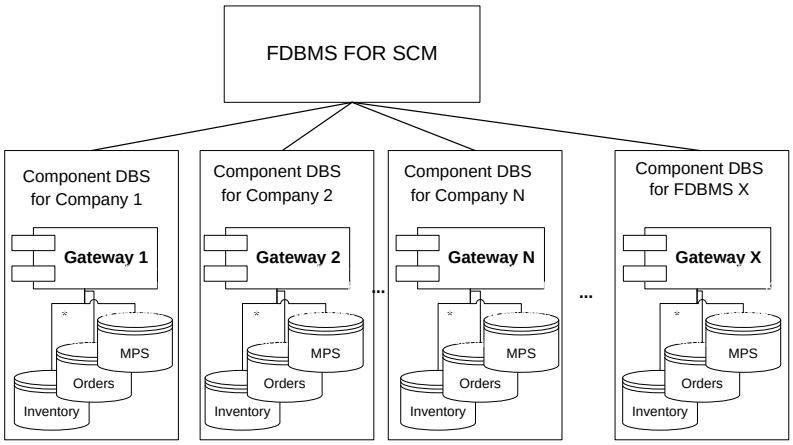

Figure 1. Federated Database Systems and its components

Own version according to [Sheth, Larson, 1990, p.185] and [Subieta, 2000]

The role of the System of Managing the Federated Database Systems may be fulfilled by a particular system of a database which has adequate technologies that enable to build and service of gateways and adequate resources and efficiency. In each case it is inevitable to design the information system that runs federated databases system of the chain. Such a system is to include a library of gateways software supporting particular types of database systems, used in individual companies, including databases used for Planning, Supplies, Sales, Distribution, Means of production and Investment Projects. That system would consist of two levels: the central level of Supply Chain Management System and the level of companies. That level would comprise autonomically working computer information systems of each individual companies linked by the processes of data exchange and coordination of logistic processes [Paszkowski, 2012, p. 2].

The examples of rules of data exchange in the two-level federal architecture of database of the system of Supplies Chain Management is shown in the picture 2.

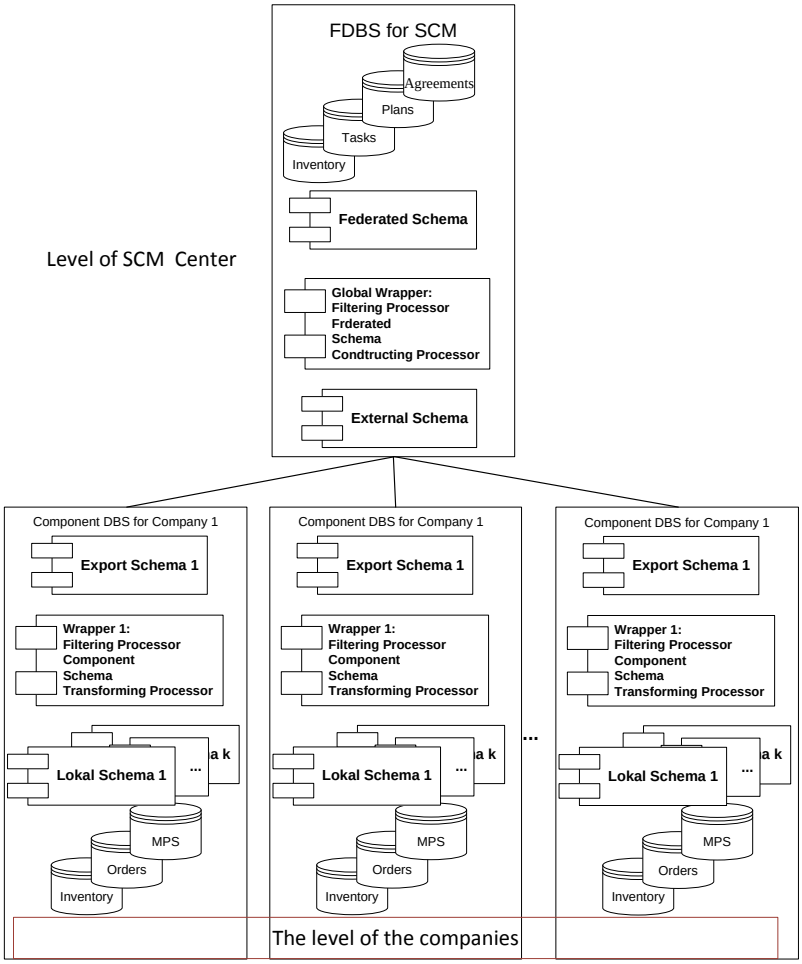

Figure 2. The architecture of Federated Database Systems in Supplies Chain Management

Own version according to [Sheth, Larson, 1990, p, 210]

In order to build the federated Database it is inevitable to design and implement a software that provides data exchange between individual applications and databases federated with them. That software, because of the need for flexibility of Supply Chain construction, should have a component structure that responds to elements of each process in the system of data management in the Supply Chain.

3 Components of the Federated Database

Picture number 3 shows an example of Federated Database architecture with the implementation of the Middle Software.

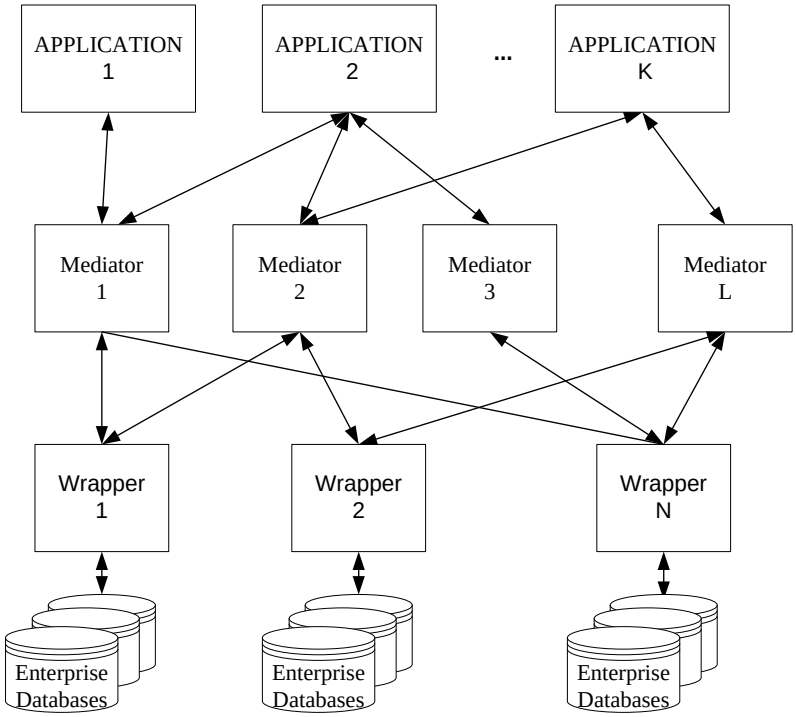

Figure 3. A diagram of architecture of the computer information system of companies chain with the use of the Federated Database.

Own version according to [Rutkowski, 2007, p.50]

In the literature there are a lot of terms for that type of software. Two of them are employed the most frequently. These are: Mediators and Translators (Wrappers) [Subieta, 2000], [Wrembel, 2005].

Mediators

Mediator is a software which depending on the needs of applications provides making a choice between the information sources and transformation of the obtained information in order to make it possible to process. Mediators

often transforms data to one model, changing notations or even terms, for example, they introduce the same units of mass, measurement or they fill in the missing data.[Subieta 2000]. In wholesale software companies mediators, thanks to the implantation in logic some elements of the Artificial Intelligence (AI), provide processing of various sources of information.

Wrappers (Translators)

Wrappers adjusts the local API of a given server to the canonical model and common enquiry language. In this way the heterogeneous data that are placed on different servers are adjusted to the processing with use of the enquiry language. The wrapper makes a simple copy of the data structures without changing their notional scheme. The module of enquiries processing installed on the server makes it possible to difine the perspective. used by the translators. In the simplest case, the translator in the relational database might take the form of perspective, especially, when there is an accordance between data schemata and dialects of databases language.

The perspective on a particular database server enables to search for necessary data and adjusts local databases structures to the scheme f federated database. It does not cause any perturbations in the local applications of the company. At most, the conditions of data integrity must be preserved. In literature, there can be often found some differences in definitions of Translator (Wrapper), Mediator and "a perspective", which are often blurred. In the work by [Subieta, 2004], specific standards for defining those notions are suggested.

For building the computer information system of Supply Chain, it is necessary to create a library of Mediators and Translators [Wrappers] for all applications and used databases in Federated Database SCM.

Each enterprise which joins the Supply Chain could be given a dedicated package of Mediators and Translators, within the supply actions, which are parametrized according to the owned architecture of systems of databases and structure of applications of data reprezentations chain which are predicted to be used. The problem with the software for that components often depends on the use of tools for the creation of Federated Database.With respect to the rules of supply chain building [Paszkowski, 2012, p.2] the software must use the software available on the market, mainly of COTS[1] type, which after parametrization can be used for systems of supply chain management.

[1] Commercial Off-The-Shelf

4 Tools for Building a Federated Database

The most advanced tools for creating Federated Database can be found in commercial packages of the biggest producers of databases systems. There can be mentioned [Wrembel, 2005]:

- Transparent Gateways by Oracle. It provides access and exchange of data among most of the commercial systems of relational databases, for example IBM, Sybase, Microsoft.
- EnterpriseConnect Data Access by Sybase. It provides access to the Microsoft SQL Server and IBM DB2 databases.
- Enterprise Access by Ingress. It gives Ingness applications the access to the data of other relation systems of databases, for example Sybase, Microsofr SQL Server, CA-Datacom, Oracle, Informix, CA-IDMS, DB2, Rdb, Allbase SQL and to the non-relational databases, such as IMS, VSAM, CICS/VSAM, RMS.
- IBM DataJoiner by IBM. It provides reading and transforming of data into the format of DB2 base from the ralational and non-relational sources. The package called Data Propagator Relational in cooperation with Data Joiner makes it possible to reply either synchronically or asynchronically between databases by such producers as Oracle, Sybase. Microsoft, Informix.
- InfoSphere Federation Server (previously WebSphere Federation Server). Within the standard licence DB2 one can federate data with other DB2 and Informix databases [Drzymała, Welfle, 2011].

The tools enumerated above help to implement software by providing standard components for creation of federated database.To create the computer information system of supply chain different components, related to the data processing, are used. The software supporting the creation of data access and managing systems is very useful.

Sap NetWeaver is a tool that helps to build the platform for multiprofile data management, access to applications and personalization of the users authority. One of the possible tools is the central authorisation management. The other one that helps to build the system of safe access to data is Coreid Federation software by Oracle.

Oracle COREid Federation is the autonomous federation server.It provides a safe connection between the users cooperating in the supply chain or on the platform of company portal or extranet. The platform that has built with use of the COREid Federation software gives safe common use of the data that is made available by individual company.

5 Conclusions

The crucial problem of cooperation between computer information systems of different companies, because of making some business data accessible outside the company and managing data in the supply chain, can be resolved by means of Federated Database System. That technology can provide a very high level of flexibility of joining and separating the companies and their databases, irrespective of their architecture and database systems which are in use. Simultaneously, thanks to the easy to implement and precise methods of downloading and gaining access to data, the unauthorized access to data can be eliminated or reduced to minimum. The system helps to automatize the processes of making available, sending and processing data. It also enables to post the rules of access to data, the level of authority to use data directly in the software of local bases and Federated Database System software.The necessary linking software such as gateways, in the form of individual components - wrappers, mediators and perspectives, can be provided with the software for basic, most common database systems and processes of supply chain and, what is next, it may be made available in the form of a library of parametrized standards (such as COTS). They would be installed in the system when the company was separated from the chain. For the computer information systems which relay on the dedicated software (written to order), non-compatible with the existing systems of the supply chain, the necessary integration components used for the creation of databases would be created on demand and they would stand the extension of the database software for a given system. The use of the Federated Database stands the extension of architecture in terms of one additional level of database (Middle Software type for databases). The used solution provides access to data at the level of application with the option of automatizing those processes and eliminating the direct access to data by the user. The use of federated database architecture is a great simplification to designing the computer information systems of supply chains and logistic chains functioning in companies in times of competition and constant changes [Paszkowski and others, 2012].

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