Information Systems Integration through Message Transfer System: Planning Phase

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Abstract: *Huge and complex business systems are usually supported by previously developed or inherited information systems, which have been developed on the basis of business functions standard model. Such information systems cover a particular business fields, but, since they have been developed in an independent and uncoordinated way, there're modest possibilities of interacted automated data exchange because of heterogeneous data, first of all. Because of increasing data exchange needs, resulting from interconnectedness of business processes and permanent changes in internal and external circumstances, development and upgrading of programme procedures is an imperative. In this connection it is necessary to find ways and means to integrate all existing information systems in given circumstances and render possible exchange and usage of all needed data in a reliable and consistent way. The problem can be solved organizationally and technically in different ways and this paper, within information system planning phase, investigates the possibility to use message transfer system. This implies initiation of automated data exchange between existing information business systems providing for full scale control and management of mutually exchangeable data. Chapter 1 and 2 deal with the necessity to integrate information systems of a business system; the concept of solution model is given as well. Chapter 3 explains technical aspects of examined integration solution at logical level. Possibilities to enlarge the elaborated approach on future integration processes in relation to a business system external circumstances are examined in Chapter 4. Conclusive Chapter 5 reveals benefits which can be achieved by application of proposed concept of the information systems integration. The approach itself is open for enlargement, dynamic adjustements and extensions needed to fulfill business system needs.*

Keywords: *application, database, information system, integration, message transfer process*

1. INTRODUCTION

With complex business systems and their accompanying information systems which support the implementation of their business functions there is a need for constant mutual data exchange, where informatized processes of one information system produce data then used by another information system or several of them. Due to the constant need for data exchange, in the conditions of frequent changes in the inner and outer environment of a business system, the making, using and maintaining of procedures supporting the data exchange processes and operations presents an additional effort for information staff and an additional expense for the business system.
This kind of data exchange organization slows down other business processes in the system as well – those depend on data which needs exchange, because this procedure cannot be executed in real time. The dimension of this problem is much more organizational than it is technical; in solving it we must take into account the restriction which is obvious in the fact that within every information system, alongside the allowed (and desirable) business process reengineering in the business system, the data structure of the indexing system should be maintained.
In the case examined and elaborated by the authors, databases can physically be centralized or distributed, but from the point of view of business functions and processes they are logically separated

and the object-related communication is conducted through the existing and specifically created batch procedures. There are no common database tables, and the data, when transferred from one system into another, change their format and structure – they are being processed through a new group of specific procedures, according to the system they have entered, keeping their information content. Different information systems' programme solutions are also independant of each other and support the work of independent databases as parts of these systems. There is a networking infrastructure which enables the interconnection between information systems and work for users of all information systems, together with enabling safety and protection of information.
It is vital to create an integrated information system by integrating all existing information systems of business functions, because part of the data created by one system's processes (output values) is used for processing within one or more other systems (input values). The basic integration condition of the information system must be realisable: with information systems which are complex and distributive in organization, as well as in those which are organized centrally, managing the data of a business system must be centralized.

2. BUSINESS NEEDS, INFORMATION SYSTEMS AND INTEGRATION APPROACH

On the business and technological levels one needs to plan, analyze and shape data and processes through which the exchange is done, and to make a programme solution for linking and intercommunication of the information systems to be integrated. The programme system must have 3 main parts, functioning as follows:

- **Data mapping system**, which copies index entity data of the information systems exchanging data. For the automating of data transfer and linking two bases it is necessary to predict, model and shape all the data and procedures necessary for the data copying between systems to be consistent. This part of the system must ensure data dynamics (creating, viewing, editing and erasing data), because it is subject to change. It is the basis for logical linking and exchange, and for physical copying and storage of synonymous data, indexed differently within each of the existing transaction systems. This kind of data is the result of organizational procedures from the previous period, and the data values which their identifiers point are necessary for data exchange and the processing required.This part of the programming system must ensure simple data handling, and give the system administrator complete control and management of data and the programming solution.
- **Message (data) transfer system - middleware.** This system ensures data transfer between information systems, definition of data format and linking/transfer paths, use of the existing and development of missing data-extracting programme procedures, it insures monitoring of the message transfer system.
- **Systems (applications) for automatic interfacing of existing information systems** in the roles of sender/receiver in the message transfer system. It enables the sending/receiving, adjusting and processing of the messages (data) received.

Information systems exchanging data must have an in-built functionality of sending and receiving data, with the option of their transformation before exchange. They must (on the sending side) include procedures for data selection/classification in both directions, protected sending/transfer of data through the linking/transfer path, entry to the data mapping system and their transformation, continuation of safe transfer, receiving and distribution of data into appropriate application tables/ modules (on the receiving side).
The transformed data (adapted to the indexing system of the sender's or recipient's information system) must fill in the tables of the appropriate modules in the processing application. In case there aren't any, tables and modules of the processing application must be defined and built, and implemented in the existing information systems - in the databases and programme solutions part. All information system application modules (the newly-made and the existing) must in the end make an interconnected and consistent whole - an integrated programme and device system.

2.1. BENEFITS EXPECTED

Interface systems will be construed as subsystems to the existing information systems within which there is need for data exchange. It will enable sending data from the source information system, use of the message transfer system and their receiving on the part of the target information system, and the other way round. The received data will gain the shape adapted to the indexing system of the source/target information system, fill in the corresponding tables of the right processing modules. Tables and processing modules will be defined, built and implemented into the existing information systems - databases and programme solutions.
Information systems integration tasks will be executed through methodological development procedure stages and steps, by recognizing data and process groups - defining the object system business technology, and changing, expanding or cancellation of the existing business processes, with the opportunity to introduce new ones. This way we will get an integrated information system, by connecting the existing information systems which have the characteristic of data independence and the indexing systems.
The business system's integrated information system will be open - in the future it will enable data exchange with new information systems. Its openness should in the end lead to the possibility of constructing and realization of an integrated information system in a business system, by connecting the existing heterogeneous information systems and those emerging.

2.2.FUTURE DEVELOPMENT

In the process of implementing the integration procedure, which should be conducted by the regulations for the designing and building of information systems (through the stages of planning, analysis, defining, building, introduction and implementation) there will be experts of a diverse project team, composed of third-party experts and the business system information staff. It is ensured that the latter gain the knowledge of the existing business system functions, processes, activities (procedures) and data - business technology, system control and management through control and management of key data and processes.
Business systems require security functionality in five main areas [1]:

- Authentication: Are the users of an application who they say they are?
- Integrity: Is a received message identical to the one that was sent?
- Privacy and confidentiality: Can you ensure that only the intended recipient can read a message?
- Auditability and nonrepudiation: Can messages be audited, so that nobody can deny having sent or received a given message?
- Availability: Can a message be sent at any time, from anywhere?

Successful integration, in accord with the order of development priorities and corresponding to the required conditions for information protection and safety, will ensure the possibility of consequent integration of emerging information systems, both in inner and outer environments.

3. FUNCTIONAL ASPECT OF THE INTEGRATION SOLUTION

Business integration platform can be used to [6]:

- Create and deploy new business processes
- Synchronize business events in multiple systems
- Integrate applications on diverse platforms
- Transform information formats en-route between applications
- Link people into a new business approach.

Detailed performance management and activity monitoring is essential for managing an integrated business environment and ensuring efficient and effective operation. A real-time, continuous view of all activities enables immediate reaction to any changes in operating performance [8]. An integration subsystem is an open, modular, parameterized system of linking and integration of two or more independent systems into the so-called conjugated systems model. The integration subsystem has its

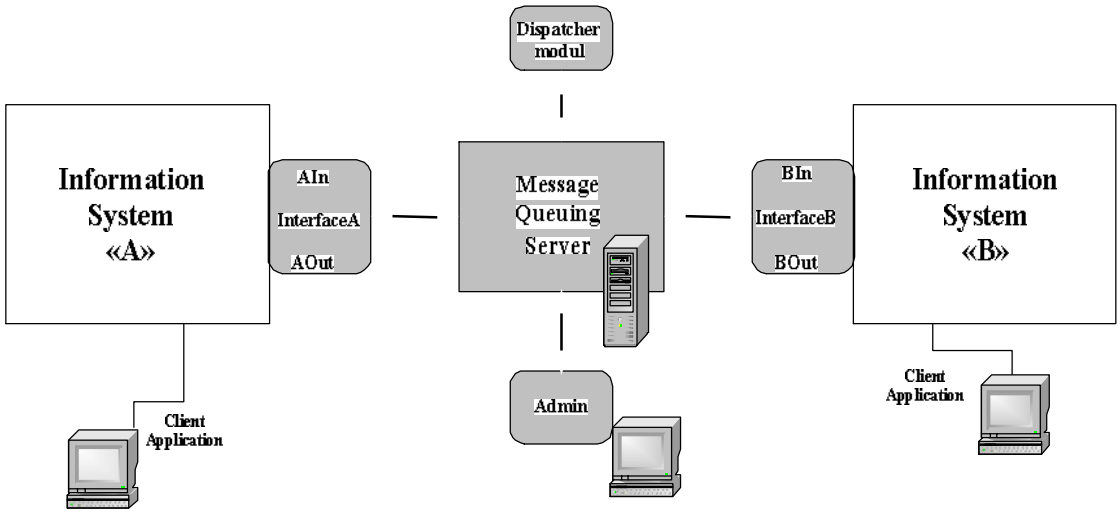
own database for the needs of parameterization and tracking of message exchange between linked systems. It is installed on an external server, because its work is autonomous, and the linked systems can be on the same or separate device system, with compatible or a different kind of operating systems.
The integration subsystem relies on middleware, which ensures quality communication and guarantees safe data transfer between the linked systems. Secondly, it directly supervises the interfaces to the linked systems, and thirdly its interface is exposed toward the user who controls and manages the integration subsystem.

3.1. INTEGRATION SUBSYSTEM FUNCTIONS

Integration capability enables integration of people, processes, information, and systems throughout the enterprise [4].
Integration subsystem functions are divided into 4 segments, as follows:

- **InterfaceA**, with two functionality subgroups:
  - **AIn** function set is in charge of retrieving the requested changes and applying, that is, propagating them in the information system "A". It also keeps track of exchange for the needs of control and analysis.
  - **AOut** function set is in charge of retrieving the requested changes from the information system "A", and their corresponding record and sending to the Dispatcher Module.
- **InterfaceB** with two analogous functionality subgroups:
  - **BIn** function group is in charge of retrieving the requested changes and applying, propagating them into the information system "B". At the same time, it keeps track of changes for the purpose of control.
  - **BOut** function group for retrieving changes initiated in the information system "B" and sending them on to the Dispatcher Module.
- **Dispatcher** Module, in charge of:
  - message manipulation, their distribution, forwarding, enrichment and control
  - data mapping
  - authorization of requested changes
  - keeping record of changes.
- **Admin** functions allow:
  - parameterization of the integration subsystem
  - administration of mapping charts
  - administration of exchange rules and conditions
  - analytical review of synchronized changes (who, when, what)
  - synthetic, statistical review of synchronized changes
  - control and management of the integration subsystem (audit, alert, manual synchronization…).

An integration solution model, with the above characteristics, is shown in Picture 1.



Picture 1: Logical Scheme of Integration Subsystem

3.2. INTEGRATION IMPLEMENTATION AND SYSTEM INTERCOMMUNICATION

The integration is implemented through message exchange between the linked systems. They are uniquely specified with a message type and operation direction. Every message type can have its own structure, or message types can be grouped into a uniform structure, and it is also possible to define a unique structure for all message types. The concept used depends primarily on the nature of the data exchanged. The number of different message types is limited and countable, but it is always possible to add new messages, if needed.

3.2.1. SYNCHRONIZATION OF CHANGE INITIATED WITHIN SYSTEM «A»

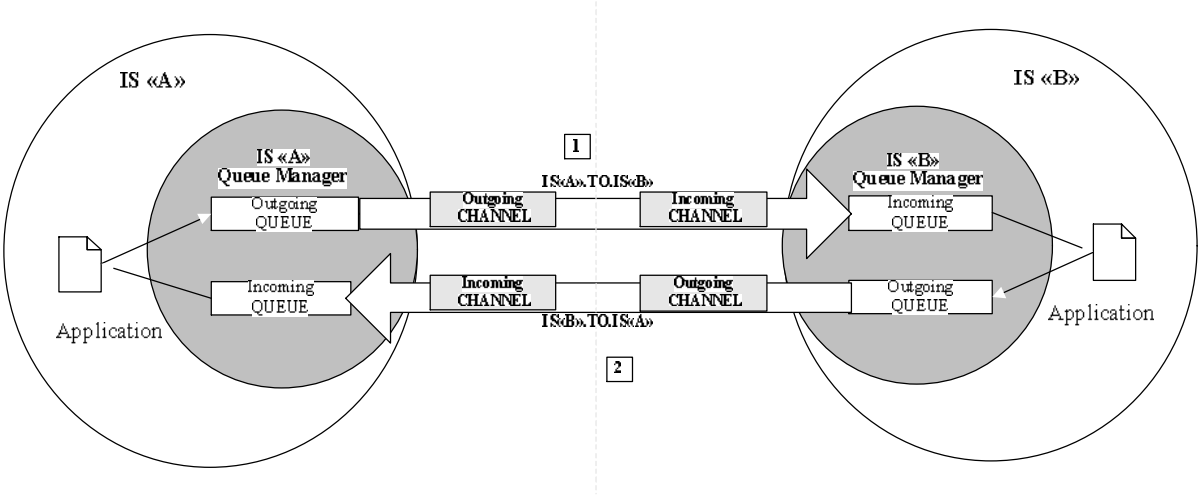
If the change (action) is not from the segment in which actions for data transfer are, nothing happens, the status remains the same.
If the change has come from the transfer request segment, the **AOut** module will recognize this information, prepare it for sending, and send to the **Dispatcher**. The Dispatcher will verify the message, authorize it, edit it, do some mapping if needed (depending on the parameters and rules of exchange, which are set through the **Admin** module), and route it to system "B". Automatically, the **BIn** module accepts the message and carries it through in system "B", by all the business rules of this system. All relevant information is recorded in the integration system's database for quality control, management and analysis.

3.2.2. SYNCHRONIZATION OF CHANGE INITIATED WITHIN SYSTEM «B»

If the change is not from the segment of required transfer changes, nothing happens, the status remains the same.
If the change is requested for transfer, the **BOut** module will recognize this information, prepare it for sending, and send to the **Dispatcher**. The Dispatcher will verify the message, authorize it, edit it, do some mapping if needed (depending on the parameters and rules of exchange), and direct it to system "A". Automatically, the **AIn** module receives the message and carries it through all the business rules of system "A" through this system. All relevant information are recorded in the integration system's database, for the purpose of quality control, management and analysis.
If the transfer actions have not been successful, the messages remain in the system, accessible through the **Admin** module, and can be manually processed at the target system.

3.2.3. BUSINESS PROCESS AND TYPES OF COMMUNICATION

A business process is conducted through two types of communication:
- real time transactions
- exchange of registers, reports, lists, recapitulations etc.



Picture 2: Information Systems Communication by Questions and Answers

Communication by questions and answers, shown in Picture 2, goes as follows:

1. Application generates message
2. Outgoing Queue
3. Outgoing Channel - Incoming Channel
4. Incoming Queue
5. Application generates reply message
6. Outgoing Queue
7. Outgoing Channel - Incoming Channel
8. Incoming Queue
9. Application records reply message.

- The Application generates a message containing business data, message transfer from one system into another is completely transparent when the content of the message and its meaning in the business system is concerned. Message content is only manipulated by Applications.
- The Application puts the generated message into the Outgoing QUEUE. The message is placed in the Outgoing QUEUE regardless whether the Outgoing CHANNEL is active or paused. The application continues its work. The message will stay in the Outgoing QUEUE if the Outgoing CHANNEL isn't active.
- Once the Outgoing CHANNEL is established, becomes active, the message will be transported to the target system. Every CHANNEL has two complementary ends. What is Incoming CHANNEL in system "B" is the Outgoing CHANNEL in system "A". The connection between them is evident in the name of the CHANNEL. The name of the Outgoing CHANNEL in system "A" is the same as the name of the Incoming CHANNEL in system "B", IS"A".TO.IS"B". The other way round is also true - IS"B".TO.IS"A".
- The message reaches the system through the Incoming CHANNEL and enters the Incoming QUEUE. The message stays in the Incoming QUEUE until the Application receives it.

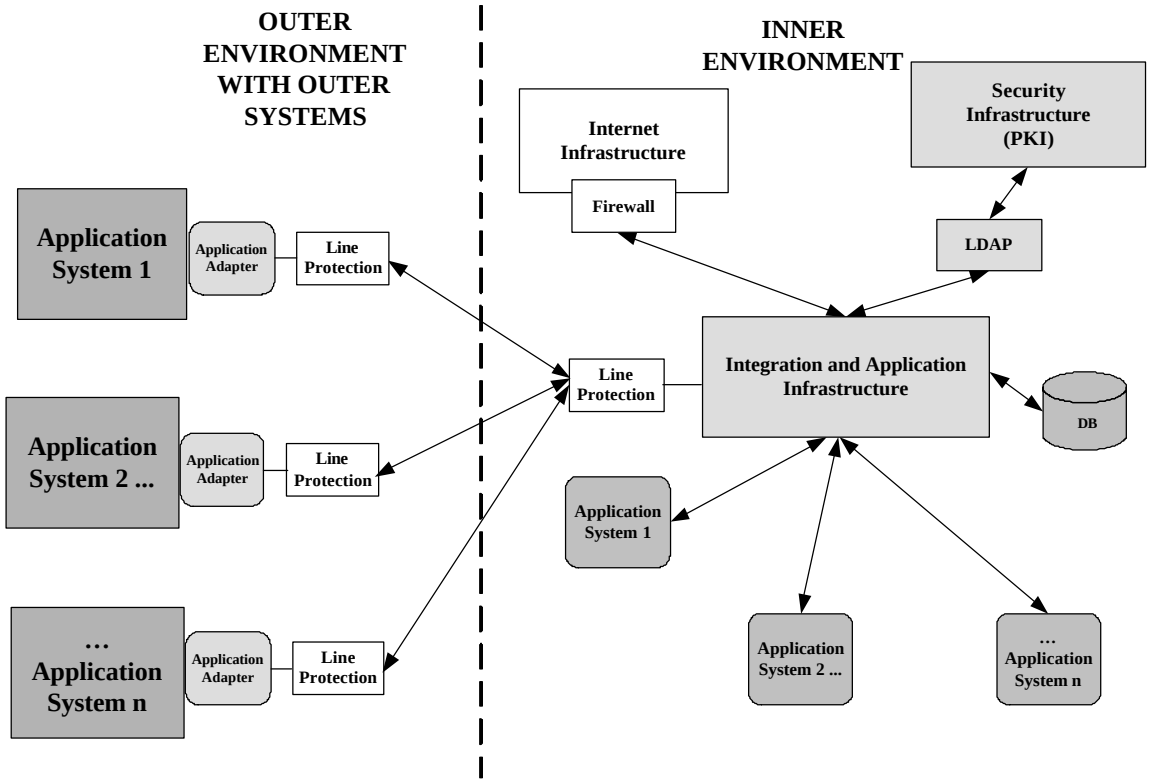
- The Application takes the message from the Incoming QUEUE, interprets its content, makes appropriate business action, gathers appropriate results, and finally forms the reply message. The formed message is placed in the Outgoing QUEUE. The application continues its work. The message will stay in the Outgoing QUEUE if the Outgoing CHANNEL isn't active.
- When the Outgoing CHANNEL is established, becomes active, the reply message will be transported into the target system. Again, it is important to note that every CHANNEL has two complementary ends. What is the Incoming CHANNEL in system "B" will be the Outgoing CHANNEL in system "A". The name of the Outgoing CHANNEL in system "A" is the same as the name of the Incoming CHANNEL in system "B", IS"A".TO.IS"B". The other way round is also true - IS"B".TO.IS"A".
- The reply message reaches the system through the Incoming CHANNEL and enters the Incoming QUEUE. The message stays in the Incoming QUEUE until the Application receives it.
- The Application takes the reply message from the Incoming QUEUE and records the message content as the answer to the original message.

4. INTEGRATION WITH OUTER ENVIRONMENT

All business systems must communicate reliably and seamlessly with the ERP backbone [7]. As for each business system there is constant need for data exchange not only between its corresponding information systems, but also with the elements from its environment, expanding this research gives the option of using the planned inner system processes integration solution for all the relevant outer system processes.
Considering that by using this concept we get further openness of the business system, it is necessary to pay extra attention to the appearance and content of the integration safety infrastructure, in order to fulfill the conditions required.

4.1. INTEGRATION INFRASTRUCTURE ENVIRONMENT

Complex ICT environment nowadays are heterogeneous; heterogeneity of hardware, operation systems, applications, development tools, communication channels, lots of computer paradigms (messaging, objects, transactions, data, processes, networking and communication - synchronous and asynchronous), an integrated business process passes fully through a system parts of which are heterogeneous, through islands within the system. This introduces the need for developing new methodologies to simplify and accelerate the development of new applications, as well as integration of the existing systems into a unified information flow, in a unified way, with flexibility concerning business processes. Prompted by these needs, the information-communication technology industry has developed solutions for information systems embodied in a strong integration and application infrastructure.
The representative of the application infrastructure is the application server, which represents a unified operative system for heterogeneous platforms, which integrates and standardizes the approach to system resources, meta-data and uses the safety infrastructure services. Also, it simplifies system maintenance and administration, and supports system openness through the openness of the technologies/standards used. Picture 3 shows the integration infrastructure for the interaction between information systems and its applications and the business system environment.



Picture 3. Integration Infrastructure Environment

In the authentication process the usage of safety infrastructure is fully standardized. If we look at the public key infrastructure (PKI) as the basic safety infrastructure, than by its standards it generates a unique identification of an individual (a certificate) which it stores dividedly to LDAP (public part) and to the real person's property, most often a smart card (private part). The LDAP server represents a repository which gets data from PKI, and is read by the application infrastructure for the need of authentication of registered users. The authenticated user is then authorized, given permissions and functions. Authentication and authorization processes take place in the background of the applications themselves. All applications use the same service for authentication and authorization of users through the application infrastructure.

Application servers also have messaging services so there is no more a clear line between integration and application infrastructure in the sense of commercial products. The most robust integrational infrastructure has its representatives in separate message servers. It is for critical integration processes, where great reliability of data exchange is required, that asynchronous messaging communication gains advantage over classical (RPC - remote procedure call) communication or the more recent technology of communication through web services.

The integration is conducted through message exchange between linked systems. They are uniquely specified with a message type and operation direction. Every message type can have its own structure, or message types can be grouped into a uniform structure, and it is also possible to define a unique structure for all message types. The concept used depends primarily on the nature of the data exchanged. It is always possible to add new messages, if needed. Message content is transparent for the integration infrastructure and presents a sequence of bytes, and the information content of the message is retrieved by using applications. Messaging does not technologically exclude XML either, XML messages can be tunneled through the messaging infrastructure.

Authentication and authorization processes take place transparently from the applications themselves; all applications use the same user authentication and authorization service through the integration infrastructure.
If the communication between two or more systems requires utmost secrecy of data, it can be additionally protected by hardware cryptographic devices, which execute linear protection of such communication by the highest safety standards.

4.2. GENERIC INTEGRATION ELEMENTS

The example of the integration of two information systems (application system "A" and application system "B") shows generic elements, which can be expanded to other information systems in a business system, but also to outside systems, which belong to the environment. Business system information systems present isolated islands where the processed information usually remains, without the option of its further distribution and use. Isolation is usually a consequence of a series of heterogeneities, heterogeneities of the hardware platform, operation systems, system software and development tools. That's why it is necessary to establish data flow, open the application systems, so they would become source and destination of information (IN i OUT processes) toward other application system.
This approach uses the integration structure as a lever for successful overcoming of the information systems heterogeneity, enabling the establishment of a unified integration methodology.
An application adapter (shown in Picture 3), is defined as a standardized adjustment hardware for the access point of the business system to the integration infrastructure, and as a group of functions it is construed and becomes a constituent part of an information system within a business system.
The administration module unites the transformation and processing rules in connecting two information systems within business subsystems.
The structure described represents horizontal integration of the existing systems and also implicates transparent construction of new horizontal systems, as a condition for establishing vertical integration processes. An example of accomplishing a vertical integration process is the information portal, which in a new way evaluates the existing information, and it is the example of establishing new services and system values.
To summarize, there are two kinds of systems. We recognize the first one by looking at the existing system (current status). It is closed, single-layered, unstandardized and needs upgrading with an application adapter. Characteristic for the other type of systems (status as it should be) is multi-layeredness; when approaching the system resources and data application infrastructure is used, with the transparency of authentication and authorization.

5. CONCLUSION

The processes within a business system which are to lead to the integration of the corresponding information systems, based on the standard business functions model independently of one another, are long-lasting and expensive (cost-intensive in both time and money). Such processes demand lots of organizational effort and adjustment, with the constant danger of possible conflicts between separate decision makers (representatives of the organizational sections whose information systems are being integrated within a business system) and of execution interruptions.
The classical way of integrating information systems, through the usage of database technology, cannot in this sense give satisfactory results because it is not fast of elastic enough and needs significant cuts into the model and database structure.
The integration procedure and the planned solution, as a result of the authors' work, eliminates this need for core changes in the databases and the integrating information systems data, introducing adjustment hardware and interfaces between systems instead.
With the implementing of a message transfer system the problem is solved on a higher level of organization and technology, without the need for direct changes in the data structure and organization. In this way the unchanged data model still, in a simplified way, through a set of entities, attributes and connections, shows the business system characteristics, while for the data copying a

new mechanism has been introduced, with full “inner” control by the business systems’ authorized expert staff.

Despite the need for additional modelling and programming in the project development stages in order to make an interface, and the need for educating the expert and user staff for the future use of the programme solution, after the system has reached a stable level one only needs to keep the data up-to-date and supervise the process (which is characteristic for all approaches).

Because the use of an integration solution is planned and prepared, on the level of planning and analysis of the business system the integration solution, using other tools, serves to accomplish phasal construction of the integration levels in the future integral information system. This way on the concept integration level the existence is enabled for independent information systems based on the business functions model, with the securing of their connection/access points. What is done on the content level of the information systems integration is the establishing of mutual business entities, and the data concerning different values (states) the entities can reach during the business cycle. The common content thus defined can be then (within one’s information system) changed, expanded or re-shaped according to need.

The planned integration solution gradually leads to integration in technology and methodology as well. This happens through gradual standardization of approach to organizational (structural and processing) problems, standardization of data sets structures which are transferred between systems by way of developed interfaces, and adjustment of index systems as a result.

The planned integration solution leads to consolidation of existing business system data. This way, through the application of the interfaces developed and the implementation of the accompanying procedures, centralized control and management of data within a distributively organized information system is accomplished.

The integration solution, concerning its characteristics, can be expanded to all system elements in the inner and outer environment which, in regard to business processes interconnection and data exchange, need integration. The planned integration solution will reduce the need, and accordingly the cost, of creating and maintenance of business system coordination mechanisms - creation, control and evaluation of the work of temporal organizational form for the needs of organization, planning, implementation and control of dynamic data adjustment between systems.

This approach also indirectly leads to the restructuring of business processes as a positive effect, because the introduction of interfaces between information systems reduces the number of participants and connections in data exchange, and increases the data flow speed.

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