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CLASSICAL PROCESS DIAGRAMS AND SERVICE ORIENTED ARCHITECTURE

Milan Mišovič, Ivana Rábová

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Abstract

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SOA (Service Oriented Architecture) has played in the last two decades a very useful role in the design philosophy of the target software. The basic units of software for which the mentioned philosophy is valid are called services. Generally it is counted that the advance implementation of services is given by using so–called Web services that are on the platform of the Internet 2.0. Naturally, there has been counted also with the fact that the services will be used in software applications designed by professional programmers. Later, the concept of software services was supported by the enterprise concept of the SOE type (Service oriented Enterprise) and by the creation of the SOA paradigm.
Many computer scientists, including Thomas Erl – doyen of SOA, do not understand SOA either as an integrated technology or as a development methodology. Proofs of this statement are in the following definitions.
SOA is a form of technology architecture that adheres to the principles of service – orientation. When realized through the Web services technology platform, SOA establishes the potential to support and promote these principles throughout the business processes and automation domains of an enterprise (Erl, 2006).
Thomas Erl (Erl, 2007) has expressed the idea of SOA implementation using the following definition.
SOA establishes an architectural model that aides to enhance the efficiency, agility, and productivity of an enterprise by positioning services as the primary means through which solution logic is represented in support of the realization of strategic goals associated with service-oriented computing.
Nevertheless the key principles, on which SOA is constructed (Erl, 2006), are not significantly reflected in any of the previous definitions. Some of the mentioned principles are still included at least in the more free definitions of SOA, for example (Barry, 2003).
A service-oriented architecture is essentially a collection of services. These services communicate with each other. The communication can involve either simple data or it could two or more services coordinating some activity.
From the above mentioned we can pronounce a brief description of SOA. "SOA is an architectural style for consistency of business process logic and service architecture of the target software."
It is a complex of means for solution of special analysis, design, and integration of enterprise applications based on the use of enterprise services. The service solutions of the classic business process logic are, of course, based on the application of at least seven key principles of SOA (free relations, service contract, autonomy, abstraction, reusing, composition, no states). Key attributes of SOA are verbally described in (Erl, 2006). They are so important that a separate article should be devoted to their nature and formalization. On the other hand, there is also clear that each service solution of business logic should respect the principles published in SOA Manifesto, 2009, which are essentially derived from the key principles of SOA.
In many publications there are given the SOA reference models usually composed of several layers (presentation layer, business process layer, composite services layer, application layer) giving a meta idea of SOA implementation. Perfect knowledge of the business process logic is a necessary condition for the development of a proper service solution. The different types of business processes should be described in the necessary details and contexts.
Interestingly, the SOA paradigm does not provide its own method of finding and describing business processes by giving a layered transparent business process diagram. On the other hand, the

methodology provides deep understanding of not only the characteristics of services, but also their functionality and implementation of the key principles of SOA (Erl, 2006).
Let us assume that the required process diagrams can be achieved by using some of the advanced methods and descriptions. Among many other methods and description, we can introduce for example methods as Eriksson–Penker Business Extensions, ARIS, BORM (Business Object Relation Modeling) and description as BPMN (Business Process Modeling Notation).
This offers the idea of using these methods and descriptions for the SOA paradigm for the purposes of process models conversion into schemes of services with built-in orchestration. Conversion of transformations should be based on the knowledge of two artifacts. The first is the output artifact – everything what diagram process provides for the target service scheme and the second is the input artifact – all what service schemes need.
The issue of conversion transformations is the main topic of this contribution. Their implementation will allow software companies to move forward in the creation of service production and it gives a new view of the enterprise functionality in a service solution to company management.

process, process diagram, enterprise service, SOA (Service oriented Architecture), service orchestration, process diagram conversion

METHODS AND RESOURCES

1 Methods for process diagrams development

Already in the abstract we have mentioned our possible orientation as for three advanced development methods of process diagrams, i.e. Eriksson–Penker Business Extensions, ARIS by prof. Scheer and BPMN. The first two methods, although frequently used, are not accepted as a standard, while the third is the accepted norm under the OMG (Object Management Group) care. Because these methods are widely known we depict only some of their characteristics. We add other properties during the description of the transformation of process diagrams conversion into useful patterns in the SOA paradigm.

2 Eriksson – Penker business Extensions

It is an integrated method, detail explained in (Erik–Penk, 2000), providing four basic views of a business and a collection of graphical or verbal descriptions of diagrams:

Firstly:

The strategic view is focused on the description of the strategic objectives of the company in the production, trade, supply, customer activity and in customer care. The strategic view is flexibly changed to suit the requirements of a dynamic market. It comprises the company's vision (needed diagrams: Vision Statement diagram, Conceptual model, Goal model).

Secondly:

The process view presents business processes, their enterprise context, functionality for fulfillment of corporate vision and mutual respect. The view usually has its layered character and gives context of processes not only in individual layers but also between the layers (needed diagrams: Process Diagram, Assembly Line diagram, Use–Case diagram).

Thirdly:

The structural view describes enterprise resources of different nature, as organizational units, products, documents, information, knowledge, etc. (needed diagrams: Resource Model, Organization Model and Information Model).

Fourthly:

The view of the conduct of a company includes the interaction of individual elements of the enterprise (resources and processes) and responsibility for the corporate elements (needed diagrams: Statechart Diagram, Sequence Diagram and Collaboration Diagram, System Topology diagram).

Within these views, stereotypes and constraints are designed (processes, resources, procedural rules and objectives) and numerous graphic diagrams containing some unusual graphical notation (outside UML).

Process diagram is a unifying diagram for the whole collection of diagrams, because it binds elements of other diagrams (goals, inputs, outputs, resources, support objects, control objects).

The following example shows the strategic goal of a particular company and some fragment of its layered process diagram with two layers. We are going to use this diagram also for its conversion into the scheme of services in the SOA paradigm.

Example 1

The main objective of our company, we are interested in, are mediation group discounts for customer services and consultancy in the field of optimization of costs for various customer services for households. Among mediated customer services there are included mobile services operators, car insurance and energy.

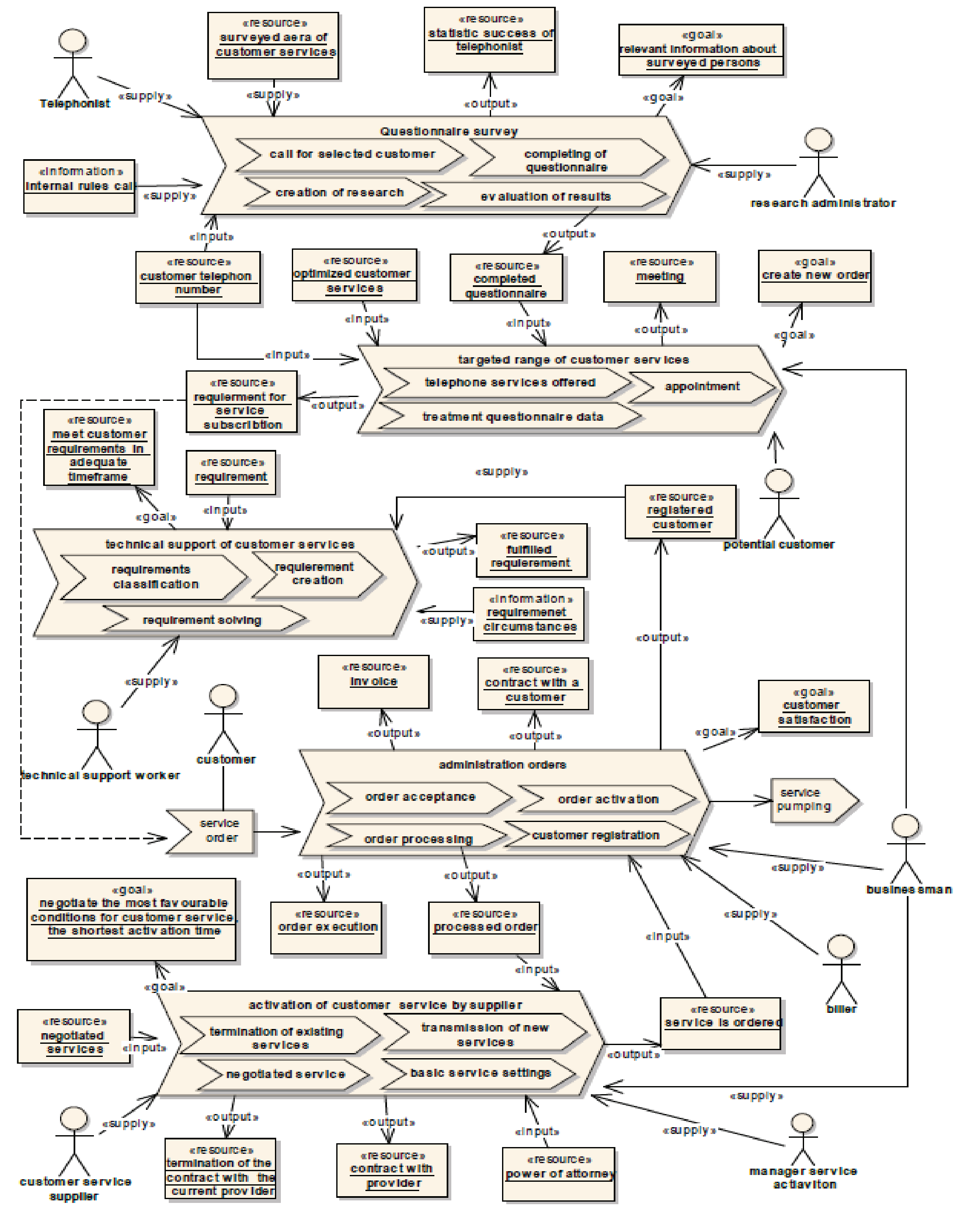
The company business has been identified by five fundamental processes that form the backbone of enterprise functionality as to the main objective of business, which is profit. They are:

- Questionnaire Survey

- Administration orders
- Targeted range of customer services
- Activation of customer service by supplier
- Technical support of customer services.

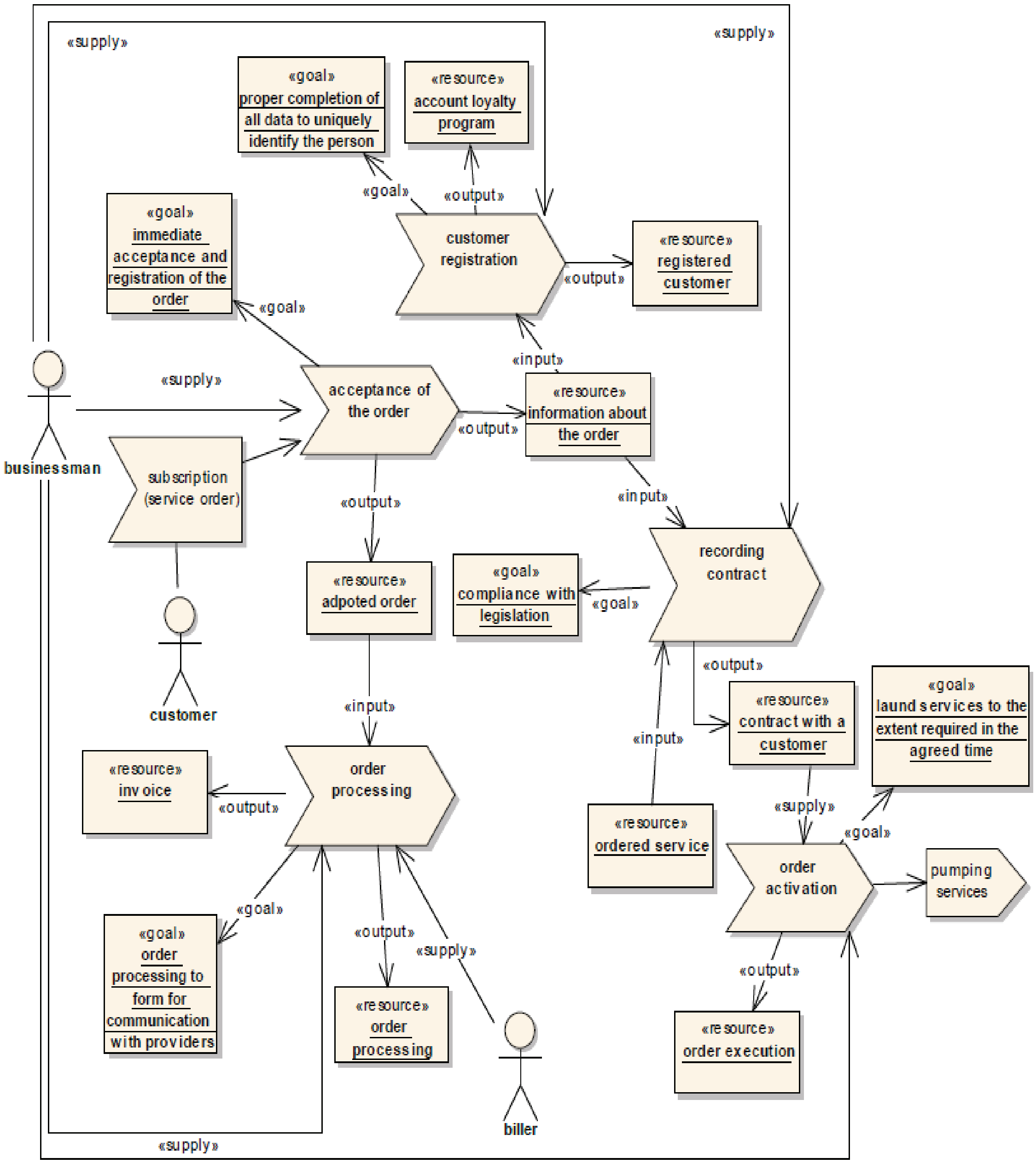
2.1 Process diagrams properties

Properties of the process diagram can be seen in multiple views. At first sight, we can focus on the properties of any process layer. In the second view, we can assume the existence of several layers of the process, from high starting abstraction with the highest layer and ending at the lowest layer. Processes of the higher layer are decomposed



1: *Process diagram. Scheme of the main enterprise processes, according to Eriksson–Penker process Extensions method. Taken from (Tom, 2012).*

Administration orders:



2: *Decomposition of Administration orders. Taken from (Tom, 2012).*

into processes in the lower layer on the basis of decomposition rules. The third view can consist of diagram properties that can affect the conversion of process diagram into a platform of enterprise services.

Assume that the process diagram is hierarchical in its nature and it will have a maximum of three layers. Be v_i marking one of the process diagram layers, $1 \leq i \leq 3$. Be $p_j^{(i)}$ the j-th process of the layer v_i. Furthermore, be r, s and, t numbers of processes of the first (top), the second and third layer.

On this basis, notations of all layers can be formalized into the following equations:

$$v_1 = (p_1^{(1)}, p_2^{(1)}, \dots, p_r^{(1)})$$

$$v_2 = (p_1^{(2)}, p_2^{(2)}, \dots, p_s^{(2)})$$

$$v_3 = (p_1^{(3)}, p_2^{(3)}, \dots, p_t^{(3)}).$$

Processes in the v_i layer have wide context and associations. Each process $p_j^{(i)}$ has input variables {inputs, process rules, events, supply, $source_{inp}$} and publishes output variables {outputs, goals, $source_{out}$}. These variables are not all the possible contextual variables. Based on these variables, there is organized the context to other processes of the given layer and enterprise environment. On the basis of the values of these variables, we can produce for $p_j^{(i)}$ the following collection of sets:

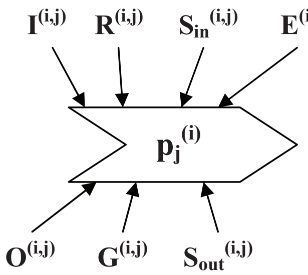
$$\{I^{(i,j)}, R^{(i,j)}, S_{in}^{(i,j)}, E^{(i,j)}\},$$

where
$I^{(i,j)}$ ....the set of inputs variables
$R^{(i,j)}$ ......the set of process rules
$S_{in}^{(i,j)}$ ....the set of $source_{in}$ variables
$E^{(i,j)}$ ......the set of events

$$\{O^{(i,j)}, G^{(i,j)}, S_{out}^{(i,j)}\},$$

where
$O^{(i,j)}$......the set of outputs variables
$G^{(i,j)}$ .....the set of goals
$S_{out}^{(i,j)}$...the set of $source_{out}$ variables.

The above mentioned sets' position is illustrated by the Fig. 3.



3: *Process $p_j^{(i)}$ and the list of sets*

Both sets of the input and output variables will be used for the conversion of the process $p_j^{(i)}$ to the service $s_j^{(i)}$ in the third view of the process diagram. Among other things, the sets $\{I^{(i,j)}, R^{(i,j)}, S_{in}^{(i,j)}, E^{(i,j)}\}$, $\{O^{(i,j)}, G^{(i,j)}, S_{out}^{(i,j)}\}$ can be used to define one of the factors for assessing the quality Q of the layer v_i. For example, such quality (mightiness) may be defined by the following regulations

$$Q = \Sigma|A|, A \in \{I^{(i,j)}, R^{(i,j)}, S_{in}^{(i,j)}, E^{(i,j)}\} \cup \{O^{(i,j)}, G^{(i,j)}, S_{out}^{(i,j)}\}.$$

The decompositions of processes of the higher layer v_i into finer processes in the lower layer v_{i+1} are part of the compositional point of view. There is necessary to draw up decomposition rules for the first and second layer. Both rules will be used for the introduction of new composite services. Decomposition rules are compiled primarily for specific process diagrams. For example, in the first layer in Example 1 the Order Management process is degraded according to the next rule:

Order management =
= Order acceptance, Order activation,
Order processing, Customer registration).

In the third point of view we are primarily interested in properties of the two previous views that affect the conversion processes into enterprise services. Let us choose process mapping into services of the type 1:1. Then we consider the set $\{I^{(i,j)}, R^{(i,j)}, S_{in}^{(i,j)}, E^{(i,j)}\}$ of the process $p_j^{(i)}$ as the basis for the desired interface of the resulting service $s_j^{(i)}$ and the set $\{O^{(i,j)}, G^{(i,j)}, S_{out}^{(i,j)}\}$ as an offered interface basis again. If the process $p_j^{(i)}$ is decomposed into finer processes at a lower level, the service $s_j^{(i)}$ will be of a composite type.

2.2 Conversion of Eriksson–Penker Process diagram to Enterprise service platform

Process modeling begins by the highest level of enterprise processes. In Example 1, it is the level composed of the processes Administration orders, Activation of customer services, Technical support, Questionnaire Survey, Targeted range of customer services.

Now we describe relevant conversion steps.

The first step:

a) Processes $p_j^{(1)}$ of the highest layer produce the highest composite service X. We carry out relevant mapping $\forall(j = 1, 2, \ldots, r)\ p_j^{(1)} \approx s_j^{(1)}$. We have just converted this highest layer process diagram to enterprise services and used process names for the names of the new defined service units.
b) We define two sets $\{I^{(i,j)}, R^{(i,j)}, S_{in}^{(i,j)}, E^{(i,j)}\}$, $\{O^{(i,j)}, G^{(i,j)}, S_{out}^{(i,j)}\}$ for each process $p_j^{(1)}$.
c) We define the required and provided interface for all new services $s_j^{(1)}$.
d) We will transfer links between processes $p_j^{(1)}$ to the links between business services and construct the resulting graphical orchestration scheme.
e) We replenish the service orchestration diagram in the topmost layer with a sequential diagram to express the functionality of components. We will use the previous results and analysis of the roles of individual actors in the first layer.

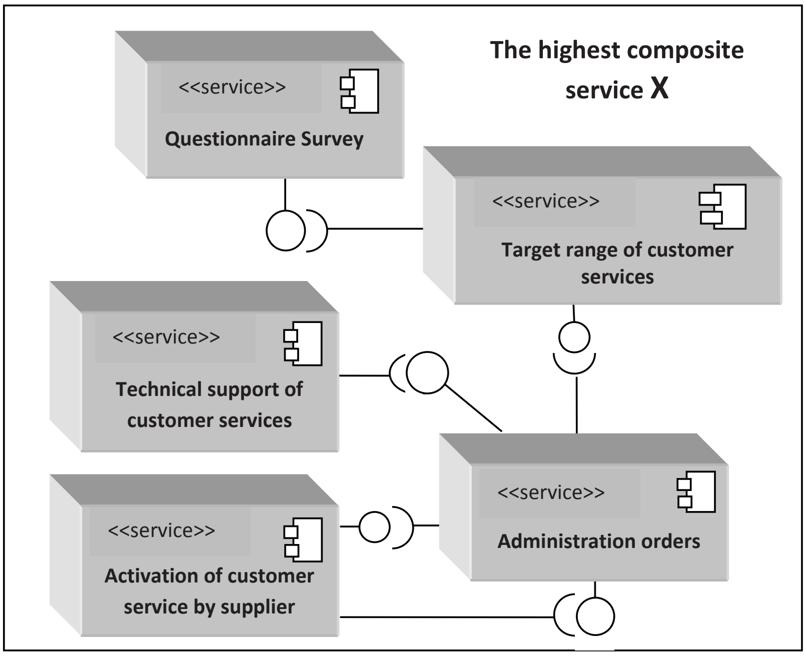
Example 2

We carry out the first step for all modules of enterprise services at the first layer. Furthermore, we find links between enterprise services. Based on information from the yet converted first level process model we can already draw a diagram of enterprise service collaboration on the first level with the offered and required interfaces.

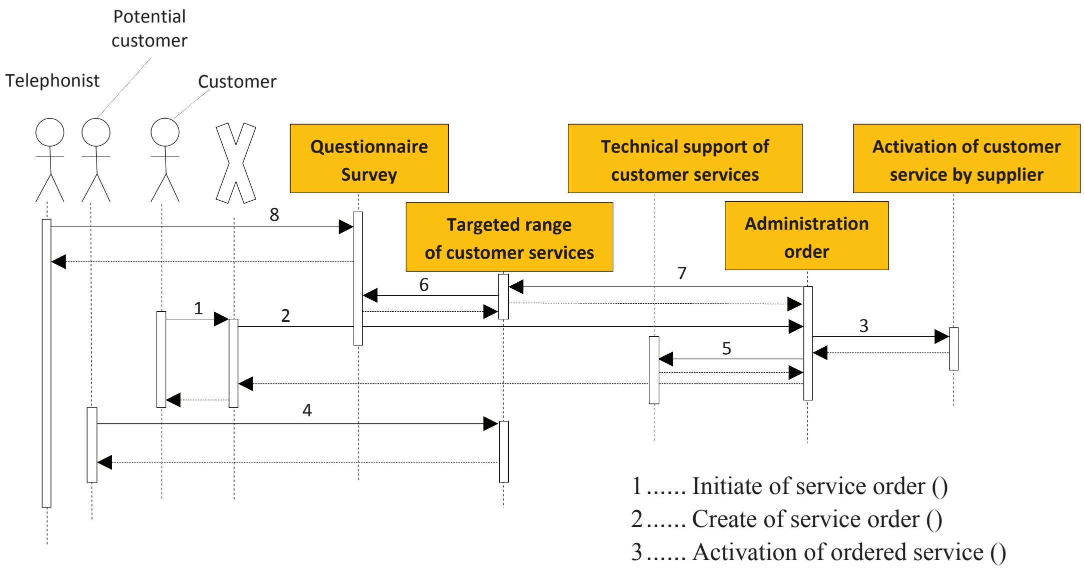
For example, the service Questionnaire survey has its interface as follows:

Required: *Surveyed area of customer services, Customer telephone number*
Internal rules call
Offered: *Statistics success of telephonists*
Relevant information about the surveyed persons
Completed questionnaire
Customer telephone number

Service orchestration of the first layer should be added by a transparent sequence diagram (see Fig. 4). The first layer of potential participants selects three actors Telephonist, Customer and Potential



4: *Orchestration scheme of business services at the first layer*



1 ...... Initiate of service order ()
2 ...... Create of service order ()
3 ...... Activation of ordered service ()
4 ...... Give result information about target range ()
5 ...... Technical support for ordered service ()
6 ...... Results of questionnaire research ()
7 ...... Give result information about target range ()
8 ...... Continue of questionnaire research ()

5: *Sequence diagram to the orchestration scheme of business services at the first layer*

Customer. We are going to build a strategy on these actors for managing communication services using messages and the interfaces between them.

The second step:

a) Further in the scheme of a service orchestration from the first layer we notice composite services only.

b) Be $s_j^{(1)}$ a composite service. This service is connected in the lower layer with a collection of daughter services. We identify an interface and relationships between these daughter services. On this basis we can construct for each mother service a service schema of the internal orchestration of its daughter services. In addition, we construct a sequence diagram to express the functionality of the mother composite services.

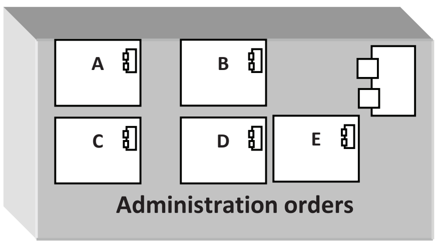
The third step:

a) We apply the procedure essence of the first and the second step between the first and second layer to the second and third layer. So we get service orchestration diagrams at the lowest layer.
b) We carry out check of the completed conversion of process diagram into orchestrations schemas with business services.

Example 3

We illustrate the essence of the second step on the case of one the first-level business service. For example the enterprise service Administration orders consists of the following daughter services: Order acceptance (A), Order activation (**B**), Order processing (**C**), Customer registration (**D**), Contract recording (E). Now we draw the working composition pattern of daughter component services at the second level.

For these five daughter services there is constructed at the second level a process diagram, to which we apply the steps very similar to the steps for the first level. The result is finding interfaces and bindings among services. We will add all this information to the working composition pattern and get a daughter service orchestration of the mentioned parent service.



6: *Working composition pattern of daughter component services*

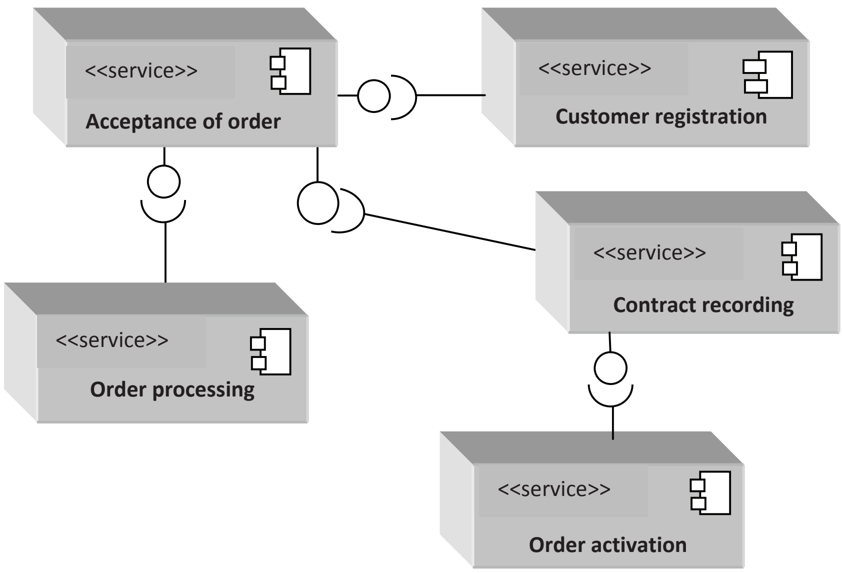
3 ARIS process diagrams

ARIS Method, designed by prof. A.W. Scheer is an integrated development methodology rather than a method. It is based on five different views (organization, data, functional, procedural, and power), similar to the method of Eriksson–Penker. Its view of the enterprise, however, is broader and the process diagram has stronger context, too. Using the system of diagrams the ARIS methodology provides an interdependent analysis and enterprise design. Due to similar processes in the context of business environment in the process diagram according to the method Eriksson–Penker, we do not get a new piece of significant knowledge in the conversion transformations. For this reason, we will not deal with the conversion transformations of the process diagram by ARIS.

4 BPMN process diagram and its conversion to SOA paradigm

BPMN (Business Process Modeling Notation) is a language standard of the type BPM (Business Process Modeling) of the organization OMG (Object Management Group) for graphical and formal description of business processes. Graphic language elements are divided into several categories (flow objects, connecting objects, tracks and artifacts), in which there are further diversifications. The semantics of BPMN graphical elements is very similar to semantics of suitable items in other known languages, especially in the UML.

The issue of conversion of the BPMN process diagram to the paradigm of SOA has been successfully addressed (Rychlý–Weiss, 2008). The authors used the conversion method of graphic

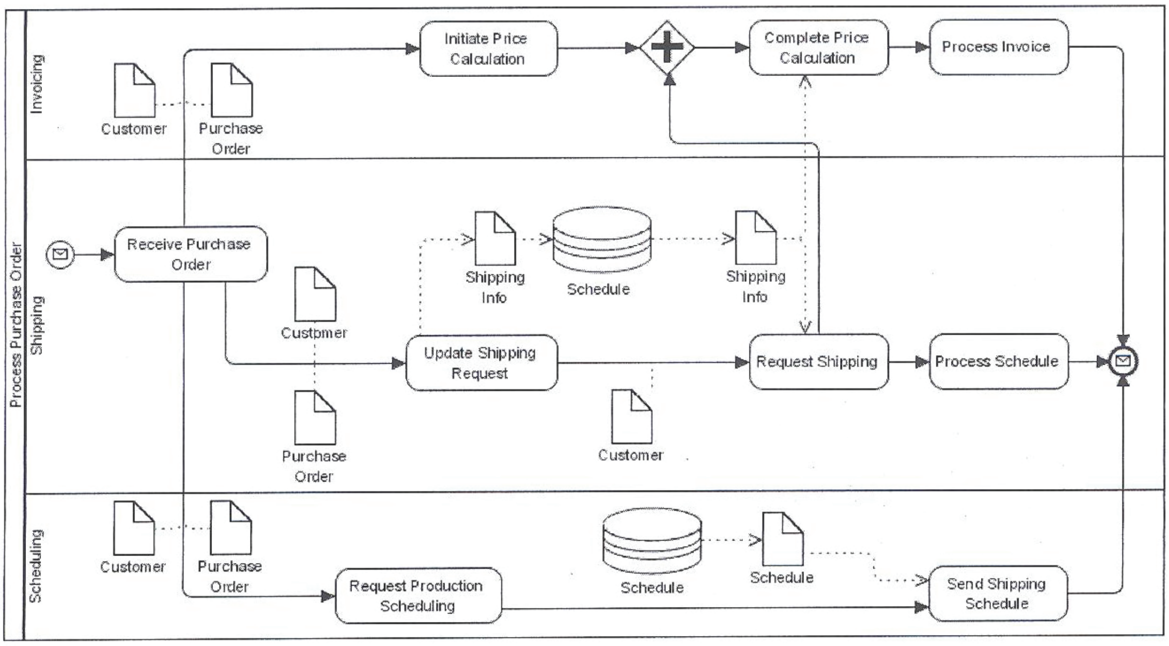


7: *Orchestration scheme of business services at the second layer* design constructions, of which the BPMN diagram consists, to the target graphic notations in the SOA paradigm. First conversion rules will focus on the basic elements of the BPMN diagram and then on the graphic design elements. Classical sequences, branching and looping (repeat, while) are considered as the graphic design elements.

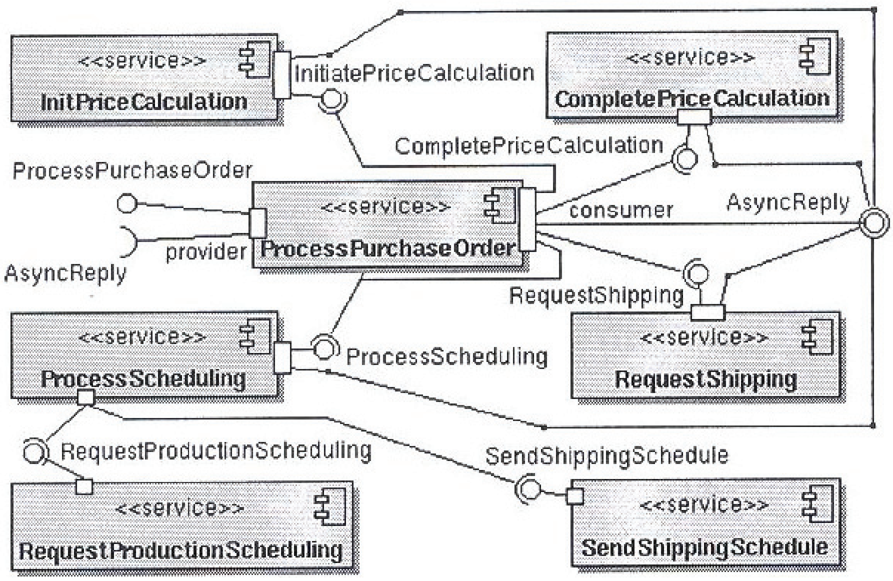
Identification of candidate services with a comprehensive view of the BPMN diagram is performed before conversion transformations. Tasks, processes and sub–processes are converted into primitive and composite services. Each service is described by a unique specification consisting of behavior and architecture. Behavior describes the action to be performed and architecture defines the communication protocol of services (interfaces and ports). The conversion method is complicated and we will not specify its details. The specific example of the BPMN diagram transfer in the SOA paradigm can illuminate many problems.

Example 4

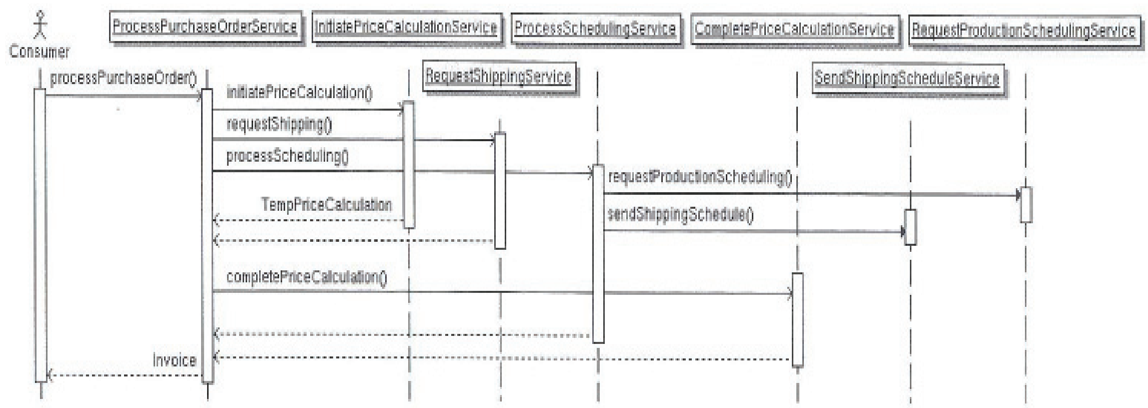
The following example of the BPMN diagram was by authors of the conversion method adapted from Object Management Group, 2006 b. According to the diagram, the process "Purchase Order" is composed of the processes Invoicing, Shipping, and Scheduling. The authors' conversion method



8: *BPMN diagram of the "Purchase Order" process. Taken from (Rychlý–Weiss, 2008).*



9: *Scheme of identified services with interfaces and connections. Taken from (Rychlý–Weiss, 2008).*



10: *Sequence diagram. Taken from (Rychlý–Weiss, 2008).*

converts the process diagram of BPMN type to a service orchestration diagram and a sequence diagram for communication between services.

Of course, both the above–mentioned diagrams are complemented by interface specifications and behavior of the highest composite service "Process Purchase Order".

RESULTS AND DISCUSSION

The result of the methods referred to in this paper are conversions of classical process diagrams created by the method Eriksson–Penker Business Extension and graphically described in the language of BPMN diagrams to basic business services schemes with orchestration and sequential diagrams. This procedure is very useful for communication with the company management that cares about business processes and utilizes conventional process diagrams in the process reengineering.

The importance of these conversion methods also lies in the fact that business processes are mapped to the business services that will be programmed by means of Web services. On the other hand, programmers can develop such applications of the target enterprise information system which are resistant to the modifications of their code. This means that the modification is performed only in the code of business services and not elsewhere in the target software.

Both proposed methods are original, but they are not the only existing. Both methods based on different types of source transformation process diagram. Therefore, there are substantial differences in transformation rules.

SUMMARY AND RECOMMENDADION

Problems of classic process diagrams conversion is characterized by the application of different sophisticated approaches. This is not due to the fact that we could find a company in another set of processes, or consider a different drive than the process. The point is in progressive – mind differences of modeling methods and differences in used processes notations which are very different by their nature. Such notational differences are easily noticeable in the methods Eriksson–Penker Business Extension, ARIS, BORM (Business Object Relation Modeling), BSP (Business System Planning) and in notations of different languages, especially in BPMN and UML.

The article presents two original sophisticated conversion transformations of process diagrams. The first is useable for process diagrams developed by Eriksson–Penker Business Extension and the second is usable for BPMN process diagrams. Both methods are illustrated by concrete examples of process diagrams. The development of new sophisticated conversion methods is certainly not finished. We certainly meet with them in next numerous software conferences.

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Address

prof. RNDr. Milan Mišovič, CSc., doc. Ing. Ivana Rábová, CSc., Department of Informatics, Mendel University in Brno, Zemědělská 1, 613 00 Brno, Czech Republic, e-mail: misovic@mendelu.cz, rabova@mendelu.cz