Experience with business process orchestration and choreography using BORM methodology

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Abstract. Any system may be composed of several subsystems that communicate with each other. Similarly, each process may consist of several interrelated processes. Generally, systems and processes are not isolated from their surroundings. They often have to interact with external entities. The problem of setting up the proper and effective communication between subsystems or processes is known as choreography and orchestration. Choreography and orchestration of Web services is a well studied issue explored by many authors. A similar situation exists in the area of the modelling of process interaction. The most common approach to orchestration modelling is the BPMN notation. Our team uses different approach utilizing the BORM method as means of modelling of processes and their interactions. However this method is not as widespread and the issue of orchestration and choreography modelling using this method is not well known. This paper presents the advantages and shortcomings of this method and suggests possible solutions to enhance the method.

Keywords: BORM method, Orchestration, Choreography, Business process.

1. Introduction

The reason why more and more companies invest considerable resources in analysis, audit or re-engineering of their internal processes, is especially to increase the work efficiency and reduce operating costs. In the times of the current economic recession even public institutions like universities set out to optimize their internal processes. As important as process optimization is also setting up efficient and optimal communication within processes, i.e. process orchestration. Also no company or public institution is completely isolated from its surroundings. Therefore setting up an effective communication with partners outside the organization – creating the choreography – becomes important. Well designed and maintained processes are essential for the smooth running of a company (Knott et al., 2003). Optimal adjustment of the processes related to the company’s internal structure and their orchestration and choreography, can be painful and difficult but relatively easy to enforce. Another situation is the case of communication and synchronization of internal processes with external entities (i.e. the process choreography). The orchestration analysis should be preceded by an ontological analysis, i.e. proper identification of domain terms and their relations, as discussed by Pergl in (2011). Often we are not able to influence the structure of processes of external participants, either because of the mutual agreement or due to the position of the weaker partner in the relationship. In such case the only available possibility is a description of a process interface of the external participant, which is sufficient for business process modelling purposes.
2. Motivation

Orchestration and choreography of processes and web services is an area explored by many researchers. Nowadays the usual means of graphical description of processes is the BPMN (Barros et al., 2010) notation. Web services can be composed using the languages like BPEL4WS (Khalaf et al., 2003), WSIPL (Chafle et al., 2004), BPEL (Barros et al., 2010) and (Peltz, 2011) or using Petri nets (Decker and Weske, 2007). To the authors’ best knowledge there is no paper dealing with process orchestration or choreography using the BORM methodology. BORM is not widely used methodology, but from our experience it offers a great potential, especially in initial phases of the project, when it can be used for requirements modelling, process optimization and verification. Our research team uses this methodology in most of its projects and full support of process orchestration and choreography modelling seems to us as the opportunity for its future enhancement.

3. Objectives

The main aim of this paper is to show the ways and means of orchestrating processes and creating their choreography in process models of the BORM method. This method is used by the Department of Information Engineering in Czech University of Life Sciences Prague, mainly for information system requirements modelling and as a tool for capturing and optimizing business processes. Another aim of this paper is also to highlight the benefits of using this methodology, which despite it being informal, offers strong mathematical basis for process simulation and verification.

4. Business process choreography and orchestration

The terms orchestration and choreography are usually used in the context of coordination and combination of Web services. Generally, our approach to the business processes orchestration and choreography in BORM can be considered analogous to the web service approach. Each participant of the process then plays the role of a service provider.

Choreography describes the cooperation within the group of services (processes) in order to achieve a common goal. It captures the interaction, flow control, data flow and timing of activities. The choreography doesn’t describe the internal interactions within the participating service (Barros et al., 2005), in our case the particular participants. The choreography captures interactions from the global perspective, which means that all participants in the process are treated equally and are equally important.

Orchestration describes the activities within the process and the mutual communication among internal participants. Activities inside the process represent the transformation of its inputs to its outputs. Orchestration may also include defining responses to communications or declaring dependencies between inputs and outputs that are not implemented in the behavior of the process. Generally speaking, if the control process doesn’t receive a response from any of its associated processes, it can fill in a missing input based on some predefined logic (Barros et al., 2005) and (Busi et al., 2010).

The orchestrator (special kind of participant centrally controlling the process) can be perceived as a process responsible for coordinating all data and control flows between
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the other participants. All communications pass through this central communication node, which puts considerable demands on its reliability (Chafle et al., 2004) and (Busi et al., 2010).

We assume that the primary difference between orchestration and choreography from the perspective of process modelling is the presence of some central control element in the case of orchestration (Barros et al., 2005). The process can be perceived in a similar way as a group of web services. Most processes involve more than one participant. Each participant carries out some activity depending on a role assigned to him in the process. Individual participants communicate with each other, exchange messages and hand over process control. It cannot be exactly said which process will be managed centrally – using one of the participants to coordinate the activities of others – and when the control will be handed over between the participants. Orchestrations are also called executable processes as they are executed by a central control process – the orchestrator (Barros et al., 2005). To use an analogy to the web service coordination, we face a problem where the controlling process can’t compensate for a missing answer from one of the participants by filling in some predefined default value (Barros et al., 2006). Business processes within an organization are based on the interaction between the participants. For that reason the communication failures cannot be effectively compensated for and it is always necessary to wait for some response. Therefore in most cases we use combination of both orchestration and choreography for process control. It isn’t really that important if for some time the process is controlled centrally, then at some point the central controlling member hands over the control, which, from this time on, is handed over between the participants as needed.

5. External and internal participants

We assume that the purpose of each of the modelled processes is the transition from the initial to a required state. The sequence of activities leading to the desired outcome is dependent on specific process requirements. Typically, the process has more than one participant. Participants may be internal or external. Behaviour of internal participants can be relatively accurately modelled. If necessary one can also modify their behaviour so as to better meet the demands of process’ activities and required result. External participants of the process can be considered black or grey boxes. In most cases, we have a description of inputs and outputs of such external participant. Thus from the process modelling view we know all incoming and outgoing data flows and communications. Internal operations (i.e. the transformation of input to output inside a process) are hidden which makes it very difficult to define correct choreography. If we deal with modelling of processes of public institutions, the situation is much simpler because to a large extent the internal processes of such institutions are defined by publicly accessible laws, subordinate legislation or regulations. Generally, modelling any process requires the knowledge of the environment which the process is part of. Knowledge of processes of external participants may initially seem to be an advantage. However, if we are unable to influence the structure of such processes, whether by mutual agreement or from the position of a stronger partner, creating effective choreography may be impossible. In such situation we have to result from predefined relations and relationships. When taking into account the interdependence of orchestration and choreography as we
defined them, it is necessary to reckon with the fact that deficiencies in communication between external and internal participants of the process can considerably influence internal communications. In particular, previously unknown waiting time during the communication between internal and external participants of the process can negatively influence the process flow as whole.

Like UML, the BORM methodology graphically distinguishes between internal and external participants. Let's begin with two elementary assumptions:

- orchestration is the domain of internal participants, because only in the case of internal participants we can define a process that will manage all communications;
- choreography is used when it is not possible to define the control process. Especially while defining a sequence of communication flows between external and internal participants and also in situations where it is not appropriate to define a central element that will manage the communication.

6. About BORM methodology

BORM (Brozek et al., 2010) is a process-oriented method such as ARIS. The main advantages of using the BORM methodology for process modelling over UML are:

- BORM diagrams can be well understood by non-specialists;
- clarity of process models and a comprehensive view of process modelling;
- minimal limitations in the design process;
- comprehensible models even when modelling large-scale processes.

BORM has strong theoretical background. The method uses theory of finite-state machines and forms the modelled process as a composition of more Mealy-type automata. This strong theoretical background of BORM makes possible to do sophisticated verification and simulation of modelled problem (Merunk and Polák, 2001). The BORM way of representation of activities inside processes helps the developer to easily identify who is involved in each activity and their particular responsibility to that activity. Thus the modeller is constrained by the development method based on the theory of finite-state machines and can only add activities to some participant’s history and which are internally consistent with activities and stages already present in the process model. On the other side BPMN process diagram are like flow chart diagram.

In BORM the process is represented by a process diagram. Process diagram can be defined as a set of participants, states, activities, transitions, and data flows. Each diagram contains at least one participant. Each participant has at least one activity. In most cases the participant contains multiple states and activities. BORM defines rules for communication between elements of the process. An activity may be associated with a state only within one participant. In contrast, two activities are usually connected during a mutual communication between two participants in the process. Direct connection between two states is not possible.

As mentioned above, BORM process diagram is based on finite-state machine. This allows for easy process simulation and detection of potential deadlocks or communication inconsistencies, which greatly contributes to creating correct orchestration definition. In BORM all the individual participants communicate using
message (data) passing (Knott et al., 2003). Receiving and sending messages together with possible transfer of control are the cornerstones of process modelling in BORM. Petri nets, which are very close to the finite-state machines, employ a similar communication principle. Using Petri nets for choreography is described by (Decker and Weske, 2007), who defined Petri net extension for process interaction modelling.

The basic elements of the BORM process diagram are:

- Participant - represents participants of the process
- State - based on its actions each participant may change its state over time.
- Activity - an activity performed by participants. It is used for transition from one state to another.
- Communication - connects states and activities within one participant or expresses mutual communication among two or more participants. Communication may contain data.

Since the BORM methodology is backed by the finite-state machine theory, the rules of communication between participants are determined to a great extent. These restrictions represent a powerful tool for the verification of a process as a whole and also for elimination of incorrect or unwanted communications, as well as a tool for preventing unwanted process deadlocks or loops.

Although the BPMN offers more extensive graphical notation for process description, the BORM method allows us to model even large-scale processes. Because the effort to include means of support for process orchestration and choreography is relatively new, the method doesn’t contain complete apparatus for such purposes yet.

Due to the limitations of the graphical notation it is needed to propose such method that would if full allow to model behaviour and interactions of participants in such special cases.

Abandoning the BPMN in favour of the BORM method was considered and rejected, because the method was successfully tested and used in many projects in Deloitte & Touche’s Prague office (Knott et al., 2003). Our team also used this method for many projects e.g. Comparative analysis of processes on FIT and FEL on CTU, Regional management project concerning the analysis of the legislation and local officials’ knowledge (Brozek et al., 2010) etc. The advantages of process modelling, simulation and verification in BORM outweigh the necessity for method’s modification to fully support choreography and orchestration of processes.

7. Example

Process of orchestration and choreography using BORM methodology will be demonstrated on one of the process diagrams created for the project mapping the key processes of the Faculty of Information Technology at the Czech Technical University (CTU).

Based on the excellent mutual relations between universities, our team was asked to become the main solver on a project focused on mapping the key processes within the newly established Faculty of Information Technology. From the perspective of a state institution, it may not seem necessary to map internal processes as the prevailing view is that state institutions are on a principle inefficient and do not manage their resources effectively. However in times of economic recession and related
budget cuts, the public universities realise the growing need for effective operation, internal process optimization and operating cost reduction – similarly to the private sector. The output of the first phase of the mentioned project is an extensive report mapping the key processes of the Faculty of Information Technology (FIT). The following table quantifies the obtained outputs.

**Table 1. Outputs obtained from the project.**

<table>
<thead>
<tr>
<th>Output</th>
<th>Count</th>
</tr>
</thead>
<tbody>
<tr>
<td>Number of processes</td>
<td>63</td>
</tr>
<tr>
<td>Number of internal participants</td>
<td>46</td>
</tr>
<tr>
<td>Number of external participants</td>
<td>7</td>
</tr>
<tr>
<td>Number of unique data flows</td>
<td>72</td>
</tr>
</tbody>
</table>

As an example we will present the process of establishing a bilateral agreement between the FIT (or CTU as whole) and a foreign university or college. Following participants of the process were identified based on the information obtained from the faculty staff:

- FIT: Contact person – member of the educational staff, employee of the FIT
- FIT: Vice-dean for the foreign relations – vice-dean for the foreign relations of the FIT
- Rector’s office: Department of international relations – department of international relations of the CTU.
- Foreign university – any foreign university of college

The initiator of the process is the contact person. The baseline is the need to establish a bilateral agreement allowing the teachers or students to take study trips to foreign university. The target state is a signed bilateral agreement. Contact person fills in the "Request for a bilateral agreement" application form. The application must first be approved by the Department of International Relations of the CTU and then by the vice-dean for foreign relations of the FIT. After the application is approved the contact person fills in the "Bilateral Agreement" form, which again must first be approved by the Department of International Relations of the CTU and then by the vice-dean for foreign relations of the FIT. Contact person then sends the approved "Bilateral Agreement" document to the foreign university for approval. If the foreign university approves the document, new bilateral agreement is signed. The result of the process is a new bilateral agreement. As shown in Figure 1, the process may end any time during its course if one of the documents is rejected.
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Fig. 1. Process diagram of the “Establishing a bilateral agreement” process.
From the process control perspective is the FIT: Contact Person the coordinator of the whole process, and can be therefore classified as the orchestrator. Other participants, except Foreign University are internal participants. Therefore part of the process will be orchestrated while the communication with the foreign university will be choreographed. As the original process diagram is too large for the purposes of this paper, in the figure 2 we present a simplified view of the communications in the aforementioned process.

Fig. 2. Simplified view of the communications and data flows in process “Establishing a bilateral agreement”.

Although the sequence of communication between the participants of the process has been clearly visible from the process diagram, we used a tool which allowed us to generate a table of mutual communications. Unfortunately at this moment the BORM methodology doesn’t contain a graphical apparatus that would allow modelling the communication sequences alone.
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Table 2. Sequence of communication between participants.

<table>
<thead>
<tr>
<th>Sender</th>
<th>Recipient</th>
<th>Dataflow</th>
</tr>
</thead>
<tbody>
<tr>
<td>FIT: Contact person</td>
<td>Rector’s office: Department of international relations</td>
<td>Request for arrange agreement</td>
</tr>
<tr>
<td>Rector’s office: Department of international relations</td>
<td>FIT: Contact person</td>
<td>Information</td>
</tr>
<tr>
<td>FIT: Contact person</td>
<td>FIT: Vice-dean for the foreign relations</td>
<td>Request for arrange agreement</td>
</tr>
<tr>
<td>FIT: Vice-dean for the foreign relations</td>
<td>FIT: Contact person</td>
<td>Information</td>
</tr>
<tr>
<td>FIT: Contact person</td>
<td>Rector’s office: Department of international relations</td>
<td>Bilateral agreement</td>
</tr>
<tr>
<td>Rector’s office: Department of international relations</td>
<td>FIT: Contact person</td>
<td>Information / Bilateral agreement</td>
</tr>
<tr>
<td>FIT: Contact person</td>
<td>FIT: Vice-dean for the foreign relations</td>
<td>Bilateral agreement</td>
</tr>
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<td>Information / Bilateral agreement</td>
</tr>
<tr>
<td>FIT: Contact person</td>
<td>Foreign university</td>
<td>Bilateral agreement</td>
</tr>
<tr>
<td>Foreign university</td>
<td>FIT: Contact person</td>
<td>Information / Bilateral agreement</td>
</tr>
</tbody>
</table>

8. Conclusion

In this paper we have presented the possibility of using the BORM methodology for graphical representation of the orchestration and choreography of processes. Since the BORM methodology is based on the finite-state machine theory, we can eliminate incorrect or unwanted communication during the process design, as well as to identify critical areas that could lead to deadlocks or loops. To the best of our knowledge, this is the first attempt towards the description of modelling or creating graphical representation of orchestration and choreography using the BORM business process diagrams.

In future work we will focus on defining an algorithm for transfer of model interactions from BORM to WS-CDL or BPEL. Unlike BPMN, at this moment the BORM methodology doesn’t define any special graphic elements that could be used directly for the modelling of communication sequences between participants of a process.

Therefore, as another part of our future work, we also want to focus on extending the method to include such elements. Our team contributes to the development of our own CASE tool that implements the BORM methodology. Our goal is to create a tool that will be able to verify the mutual communication inside processes, to simulate the process and to be able to automatically generate BPEL's XML source from the BORM business process diagram. The results presented in this paper were the first step, in which we have verified that BORM process diagrams can be used for choreography and orchestration definition.
9. References


JEL Classification D80, L21, L86