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## Actor-oriented approach for business-process management of analytical system development

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**Abstract.** This paper aims at investigating the feasibility of an actor-oriented approach for modelling analytical systems development business processes. The study analyzes existing management challenges of analytical systems development processes, identifies key business process modeling approaches, and proposes a modeling approach based on actor-oriented approach with high flexibility and enhanced control over business artifacts. The article also describes examples of possible applications of this approach in a business process management tool.

**Keywords:** business process; business process management; actor; artifact; analytical system

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### Акторный подход к управлению бизнес-процессами разработки аналитических систем

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**Аннотация.** Целью данной работы является исследование возможности применения акторного подхода для моделирования бизнес-процессов разработки аналитических систем. В исследовании анализируются существующие проблемы управления процессами разработки аналитических систем, определяются основные подходы к моделированию бизнес-процессов и предлагается подход к моделированию на основе акторного подхода, обладающий высокой гибкостью и улучшенным контролем над бизнес-артефактами. В статье также описаны примеры возможного применения данного подхода в инструменте управления бизнес-процессами.

**Ключевые слова:** бизнес-процесс; управление бизнес-процессами; актор; артефакт; аналитическая система

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### 1. Introduction

**Background.** Business process modelling and management is one of the most important tools for analysts and project managers developing software systems [1], including analytical systems and machine learning models (ML models). The main notation for business process modelling over the last decade is BPMN [2, 3].

Problems of business process modelling arise in many projects; an overview of these problems is given in [1, 3]. Different software tools are used for further management of modelled business processes. There are many tools on the market with different functionalities, their analysis is conducted in [2] and it highlights a few problems of existing tools.

**Professional Significance.** This study is a follow-up to the study [7] which proof of concept of an actor-oriented approach to business process modelling. The present study intends to confirm the feasibility of using an actor-oriented approach to further business process management and to advance the field of analytical systems lifecycle management, including by combining the artifact- and actor-oriented approaches.

**Article structure.** The remainder of this article is organized as follows: Section 2 introduces the motivation of this study, Section 3 reviews the related work, Sections 4 describe the problem statement and research methods, Section 5 describes the problems of analytical systems development, Section 6 highlights the key features of main approaches to business process management, Section 7 discusses an addition to the actor-oriented approach and the actor model for business process management of analytical systems development. Conclusion and future work are given in Section 8.

### 2. Motivation

The BPMN methodology has a few limitations [1, 3, 4], including the lack of flexibility in business process management. This problem is especially relevant when building analytical systems, as this area is characterized by a high proportion of data manipulation and experimentation when developing and implementing analytical models and ML models [5, 6].

Many different approaches to business process design have been proposed to address the above-mentioned problems. This paper discusses actor-oriented approach and combines it with artifact-oriented approach [7].

Actor-oriented approach is based on describing business processes through the interaction of actors that have their own state and have the ability to asynchronously exchange messages, process received data and generate new actors [8]. The artifact-oriented approach is based on describing business processes through describing the flow of process business artifacts and organizing the execution of tasks based on this flow [9]. By a business artifact (simply artifact) in this case is meant data records relating to key business-relevant objects, their lifecycles, and their use in carrying out process tasks

The use of the actor-oriented approach is also required in the development of an enterprise product, and this study was conducted for the purpose of designing an element of the system being developed.

### 3. Related works

Business process modelling is a key task for businesses [1] because with process modelling, further analysis, and management the performance of a business system can be significantly improved. This

is particularly important in the development of analytical systems and ML models, as will be shown below. Furthermore, there are a few approaches in business process modelling whose applicability to the lifecycle management of ML models can be shown since the identified features of this cycle. The development of analytical systems and especially ML models stands out for the high complexity of data management business processes, experimentation in model development and implementation in the final systems. The complexities of data management processes are shown in [5]. This process involves data exploration, validation and cleaning, and the process can be repeated several times to introduce additional features into the dataset. This leads to many business process artifacts that need to be tracked.

The cyclicity of analytical systems development processes is related to the large number of experiments required to build an accurate model [6, 10]. During the development process, the data scientist may test the applicability of multiple data processing algorithms and must use many input features to produce a result. Because of this, the development process often returns to previous phases for additional research or data preparation. This leads to the need to model highly flexible business processes. Moreover, the large number of experiments generates even more artifacts and metadata of the business process.

Once an analytical system is built, it goes through verification and implementation phases [10], which can also lead to changes in business processes. Meanwhile, an important part of the life cycle of ML models is monitoring and modification of models in case deviations are identified [10], which leads the model to return to the previous phases within the business processes. Thus, the main challenges for business process modelling and management of analytical systems development are the high number of experiments in the domain, which requires high process flexibility, and the huge number of process related artifacts that need to be manipulated.

To solve the highlighted issues, existing approaches and tools for business process modelling need to be explored. Nowadays, there is much research in this field in different directions. Thus, the paper [11] provides a survey of 405 articles devoted to business process modeling and management research of the ML model life cycle, highlighting the main research topics. According to this study, "Model Management" is the topic of about one third of all research, but the "Experiment Management" aspect is only addressed in 4 articles. "Data Management" is investigated in the 19 articles used in this research. This shows a low degree of investigation of the business process management challenges of developing analytical systems.

Tools are needed to use any business process modelling approach. A survey of 83 tools [2] shows a similar situation to the research in this area. According to the study, functionality for "Process lifecycle management" is represented in 4 tools and functionality for "Configurable meta model" in 6 tools. Thus, the existing tools do not satisfy the identified requirements for business process modelling and management of analytical systems development.

To respond to the highlighted challenges, it is necessary to identify the main approaches to business process modelling. Currently, action-, artifact- and actor-oriented approaches are distinguished.

The action-oriented approach means modelling a business process as a flow of tasks performed by process actors. The main modelling language for this approach is BPMN. This approach is currently the most used in real-world projects [2]. However, the action-oriented approach has several critical issues. Source [3] lists disadvantages of BPMN and other action-oriented business process notations. Among other issues, it highlights difficulties with resource management, process control flexibility and process inter-relationships, which do not allow effective use of the action-oriented approach for business processes management of analytical systems development. The papers [4, 12] also highlight the shortcomings of the action-oriented approach and provides a brief survey of the artifact-oriented approach concept.

The artifact-oriented approach offers the business processes management through a set of artifacts used and generated in these processes. The advantage of this approach over the action-oriented approach is the high flexibility of the built processes and the possibility of micro-manage of the data

used in the business processes [4], which is extremely important for business processes management of developing analytical systems. The authors of this study also highlight disadvantages of this approach, including difficulties in maintaining the connection between business process and business strategy. The study [9] presents the developed framework for this approach and confirms the possibility of using this concept for business process modelling.

A third approach is also proposed for modelling business processes. According to the actor-oriented approach, a business process is supposed to be considered as an interaction of intelligent business objects (IBO) [8]. Each IBO must be able to exchange messages asynchronously with other IBOs, process received messages, change its state, and generate new IBOs. This approach allows asynchronous interaction of business process parts and significantly increases the flexibility of the business process. The challenge of this approach is the difficulty to visualize the business process. The paper [7] presents the proof of concept of the actor-oriented approach.

#### 4. Problem statement

The BPMN methodology has a few limitations [1, 3, 4], including the lack of flexibility in business process management. This problem is especially relevant when building analytical systems, as this area is characterized by a high proportion of data manipulation and experimentation when developing and implementing analytical models and ML models [5, 6].

This study intends to address the following research questions:

**RQ1:** What would be the benefits of an actor-oriented approach for business process modelling of analytical systems?

**RQ2:** How to develop an actor-oriented approach using elements of other approaches to business process management?

The outcome of the study is expected to be the answers to these research questions, as well as an actor model for the simple prototyping of business process management system for development of analytical systems.

#### 5. Development analytical systems challenges

Articles [5, 6, 10] show the main challenges of analytical systems development processes. The following are important for this article:

1. **The high experimental nature of the field.** When developing analytical systems, it is necessary to research the domain of the analytical model, prepare data for the model, test the applicability of several algorithms in the domain and on existing data, develop the model and implement it in the runtime environment, and conduct continuous validation of the model's performance quality on updated data. Each of the steps described can be repeated several times, since at any of them it may be necessary to return to the previous step. This causes significant difficulties in the design of continuous business processes and their further management.

2. **The need to track data flows.** The main resource of the model work is the data on which it is applied. For proper functioning of the model, it is necessary to correctly process the raw data, to choose the algorithm for its analysis and to track the changes of data during the model's operation. To do this, it is critical to retain information about the data that is used as part of the business process of developing the model.

3. **The creation of many business artifacts.** The development of analytical systems generates many artifacts as part of experiments as well as data processing for the model. To effectively manage the processes, it is necessary to retain information about the artifacts that appear.

Thus, the business process management approach to developing analytical systems should allow flexibility to change the built business process in accordance with the current work and track the flow of data and artifacts.

6. Features of other approaches

When highlighting the main features of each of the approaches to business process management, it is necessary to operate on the needs of the area under study.

To address the challenges identified in the previous section, this article points out the following features of the approaches:

- 1. Simple process visualization (necessary for any human process management).
- 2. High flexibility (covers the high experimental nature of the field).
- 3. Control of data flows.
- 4. Possibility of asynchronous operation of business process elements (also covers high experimental nature of the field).
- 5. The ability to control individual tasks (adds flexibility to the approach).
- 6. Possibilities to control artifacts.

This article discusses three basic approaches to business process management - action-, artifact- and actor-oriented approaches. Their comparison according to the selected features is given in Table I. The comparison shows that actor- and artifact-oriented approaches roughly equally cover the requirements of the study field. However, the most successful in terms of visualization remains the action-oriented approach.

Table 1. Approaches comparison

	Action-oriented	Artifact-oriented	Actor-oriented
Visualization	+	+/-	-
Flexibility	-	+	+
Asynchronous operation	+/-	+/-	+
Control of data-flow	-	+	+/-
Control of artifacts	-	+	-
Control of individual tasks	+	-	+

7. Actor-oriented approach

The actor-oriented approach fits well with the microservice architecture. A separate service can be created for each actor to handle the messages received by the actor. On this basis, this approach was chosen as the key approach of this paper.

The comparison of the approaches showed that the most promising development of the actor-oriented approach is to combine it with the artifact-oriented approach. For this purpose, the creation of a separate class of actors for artifacts is proposed. Thus, the actor model builds a system for supporting actors and processing their states.

The problem of business process visualization in this approach remains unresolved. When developing an enterprise product, it is possible to visualize using standard BPMN methods.

To build an actor model based on this combined approach, the following entities are also needed:

- 1) User controller.
- 2) Business process - for each business process an actor is created in the system.
- 3) Artifact controller.
- 4) Task controller.
- 5) Restriction controller – for working with user-defined restrictions on task execution.
- 6) Business process architect – for creating a business process according to the parameters entered by the user.

The actor model created based on the selected entities is shown in Fig. 1.

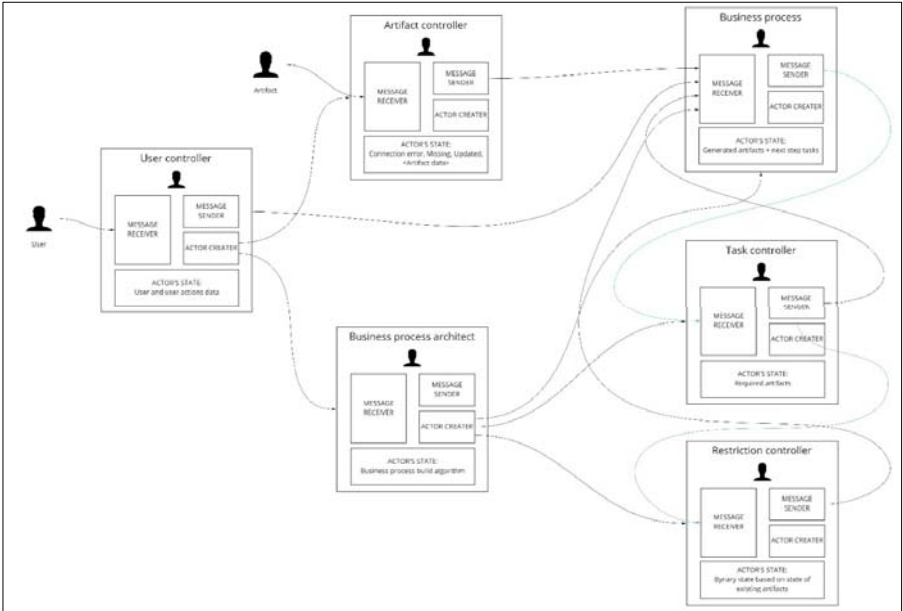


Fig. 1. Actor model

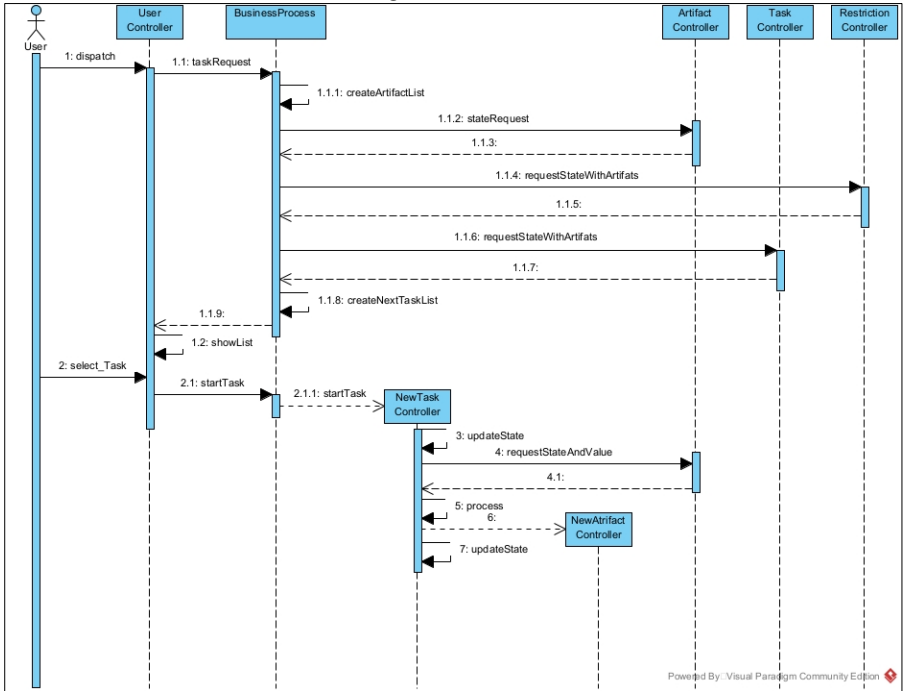


Fig. 2. Task selection and execution, UML sequence diagram

## 8. Performance examples

The proposed approach can create many different cases that meet the needs of a particular implementation. Two typical situations are designed for this article.

The first case is shown in Fig. 2. It represents the selection of a task by the user and its further execution. In the diagram, each of the objects is a previously described actor. Business process interrogates groups of actors of artifacts, tasks and constraints, on the basis of the responses it generates a list of available tasks to run. After selection by the user, the business process creates a new actor for the started task, and it performs the necessary actions for its execution.

The second case is presented in Fig. 3. This diagram simulates the situation of an artifact state change and the system response to this change. The artifact actor notifies the business processes and tasks actors subscribed to it. The end actors analyze these changes and update their state as needed. This process can be extended by a more complete description of the logic of each actor's actions, depending on the implementation context.

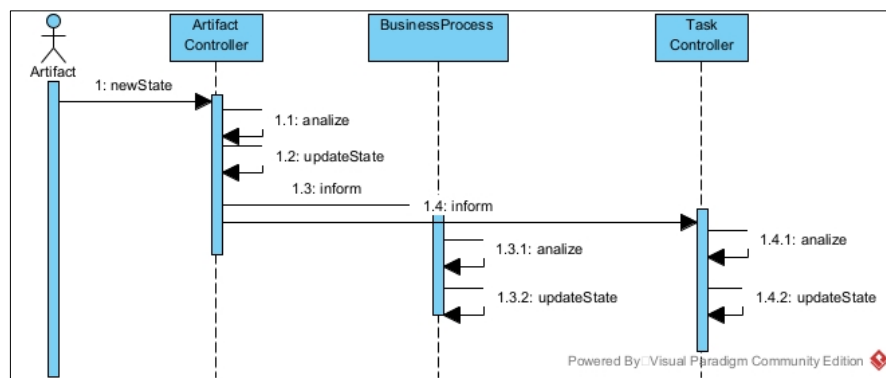


Fig. 3. Artifact update, UML sequence diagram

## 9. Conclusion

### 9.1 Answers to research questions

The following research questions were answered in this article:

**RQ1:** What would be the benefits of an actor-oriented approach for business process modelling of analytical systems?

**A:** The actor-oriented approach does not have decisive advantages over other business process management approaches to developing analytic systems, but it does make it easy to incorporate aspects of other approaches into its model. Moreover, the actor-oriented approach fits well with microservice architecture. These advantages make it possible to build business process management systems based on this approach.

**RQ2:** How to develop an actor-oriented approach using elements of other approaches to business process management?

**A:** The actor-oriented approach fits well with the artifact-oriented approach. This combination covers all the major challenges of business processes management of analytical systems development.

The article also provides an actor model for the system based on the developed approach.

## 9.2 Future work

The main area of further work will be to create a prototype system based on the developed approach to business process management. Another area of work could be the further combination of the created approach with others. For example, there are approaches based on Petri nets [13, 14], which were not considered in this article, but offers great functionality for process mining.

Finally, the study does not consider the problems of visualization of business processes built based on this approach. To create a visualization notation would require either combining the developed approach with BPMN diagrams or developing a new notation.

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