Workflow Modelling Based on Process Graph

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Abstract: Workflow modelling has been successfully introduced and implemented in several application fields. Therefore, its significance has increased dramatically. Several work flow modelling techniques have been published so far, out of which quite a number are widespread applications. For instance the Petri-Net-based modelling has become popular partly due to its graphical design and partly due to its correct mathematical background. The workflow modelling based on Unified Modelling Language is important because of its practical usage. This paper introduces and examines the workflow modelling technique based on the Process-graph as a possible new solution next to the already existing modelling techniques.

Keywords: workflow management, workflow modelling, process-graphs

1 Introduction

Workflow management was originally a tool for the organisation, analysis and rearrangement of business processes. Information technology has gone through one of the most significant changes in the last decades while having proliferated and penetrated into business processes in each and every business field and has become a determining component. In parallel the application of workflow has improved as well. By nowadays the number of application fields has increased a lot and after successes in the production and administrative processes, workflow management gained ground in almost each professional field. Further application fields include a wide range of sectors ranging from technical design [4] via solving of various computing problems [3] to several application of the processing of information data [11].

The drastic development in workflow applications has meant the computerisation of the existing processes and later, with the appearance of the Business Process Management (BPM), the total restructuring of these business processes. BPM examines and models the processes from various aspects, which meant the information based restructuring and reorganisation of this field.

1.1 Key Definitions of Workflow and the Elements

The concept of workflow is widely interpreted, and it might mean simple activity steps but can be interpreted as a synonym of the total Business Process. The Workflow Management Coalition (WfMC) as the acknowledged professional association strives to reach standardisation and also conducts widespread marketing to spread the concepts and methodologies linked to Workflow technology. Consequently, this paper takes the WfMC [1] definitions and interpretations for granted when reviewing the definitions.

Workflow: 'The automation of a business process, in whole or part, during which documents, information or tasks are passed from one participant to another for action, according to a set of procedural rules.' [1]

Activity: 'A description of a piece of work that forms one logical step within a process. An activity may be a manual activity, which does not support computer automation, or a workflow (automated) activity. A workflow activity requires human and/or machine resources(s) to support process execution; where human resource is required an activity is allocated to a workflow participant.' [1]

Process: 'The representation of a business process in a form which supports automated manipulation, such as modelling, or enactment by a workflow management system. The process definition consists of a network of activities and their relationships, criteria to indicate the start and termination of the process, and information about the individual activities, such as participants, associated IT applications and data, etc.' [1]

Instance: 'The representation of a single enactment of a process, or activity within a process, including its associated data. Each instance represents a separate thread of execution1 of the process or activity, which may be controlled independently and will have its own internal state and externally visible identity, which may be used as a handle, for example, to record or retrieve audit data relating to the individual enactment.' [1] Instances are process instances, which are representations of a single enactment of a process, or activity instances, which are representations of an activity within a single enactment of a process (within a process instance). Process instances are often called cases.

The following Figure 1 presents a simple example using the above definition and given the notation system provided by WfMC.

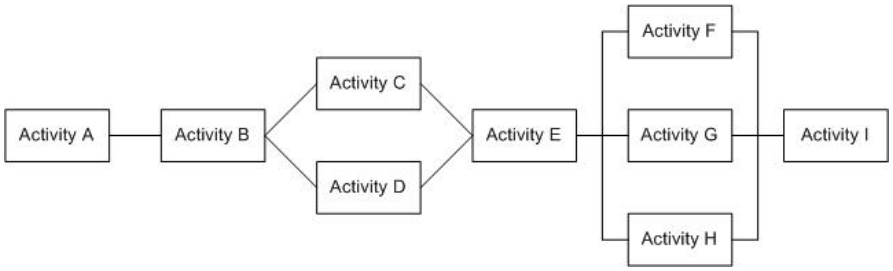

Figure 1
Example of a Workflow using WfMC's Notation

2 The Existing Workflow Modelling Methodologies

Taking workflow modelling into account five relevant workflow model perspectives can be differentiated based on the above [2], [5] and [8]. The **Control flow or process perspective** presents the workflow elements, their relationships, that is the static structure and organisation of the workflow. The control flow includes the time dependency between the elements, and the entire routing description valid for the workflow model. The **Resource or organization perspective** determines the types, the quantity and/or the availability and accessibility of the resources necessary for the execution of the tasks. It describes the roles from the perspective of functionality, and the groups from the aspect of the organisation as well as their labelled responsibility, authorisation and availability. The **Data or information perspective** includes the description of the control data needed for the operation of the workflow and the execution of the routine, and in the framework of production information the data, tables and documents containing the significant characteristics of production. The **Task or function perspective** defines the elementary operations carried out by the resources while performing a task. The **Operation or application perspective** specifies the elementary actions using specified applications. These applications could be general applications such as text editor, spreadsheet editor, or special applications developed for the given task. Traditional modelling focuses mainly on the first perspective.

This paper highlights two modelling techniques out of the several existing ones: the modelling technique based on the UML activity diagram and the modelling based on the Petri-Net.

Unified Modelling Language (UML) is a widespread modelling language in software engineering that is highly standardised and is rich in tool system. The control perspective of the Workflow model consists of a description process activities and its routing in cases [7]. This is the reason why UML's sequence

diagram and activity diagram is useful to model the discussed aspects of workflow models. The research work done by W. van der Aalst et all resulted 21 several patterns which describe the behaviour of business processes. [7] S. A. White mapped this patterns from business process model to UML activity diagram. The usage of UML reflects a rather practice-oriented view, which is closely linked to the everyday work of software developers.

Petri-Net is one of the most important mathematical and graphical representation possibilities of distributed systems [12], networks and workflows. It has been a popular workflow modelling tool for a long time [13]. Introducing Petri-Nets to the field of workflow modelling Aalst and Hee [5] specified a process using Petri-Net as the basic element of workflow. Van der Aalst with his more than three hundred publications worked out the whole theory and methodology of the Petri-Net based workflow management. He describes [14] how to map workflow management concepts onto Petri-Nets, defines the processes, the control flow possibilities, routing constructs, triggering, tasks, work items and activities. He focuses also on the analysis of workflow using Petri-nets.

3 Process Graph-based Workflow Modelling

A workflow model can be considered as a network structure. As it was presented in the previous chapter, the so far described solutions have been based on graph modelling. A simple graph, however, does not contain enough information so as to give the model precisely. The Petri-Net is also a directed bigraph which, with a token supplement, enables modelling of demand of resources crucial for workflow management and/or of eventual information or of raw material.

The Process-graph or P-Graph has been implemented in the fields dealing with the network-oriented synthesis of process networks (PNS) [15, 16, 17, 18, 19]. The P-graph is also a directed bigraph, the vertices of which are of two types. One vertex type is operation unit type vertex, while the other one is the material type vertex. The two vertex types form two disjunctive sets. Material type vertex points to material type vertex while operation type vertex points to operation type vertex. Restrictions are much more strict since the edges of the graph link the material ad operation units in a way, that an edge from an O operation type vertex can point to an M material type vertex only if M is element of the output set of O or vice versa, an edge from an M material type edge can lead to an O operation type edge only if M is element of the input set of O. At the same time the criteria of bigraph is also met. The graphical representation elements are shown in Figure 2.

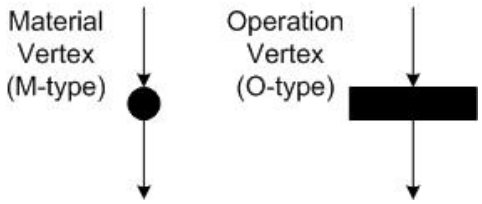

Figure 2
Representation of Material and Operation vertices in P-Graphs

The operation type vertex has been used for modelling Activity applied in workflow. The Material type vertex of the P-graph might present the document, data or information in the workflow. By substituting these vertices in the workflow and following the design patterns and rules of a P-graph the structure of the workflow can be easily and simply presented by a P-graph. The above workflow shown in Figure 1 is modelled by P-graph notations in Figure 3.

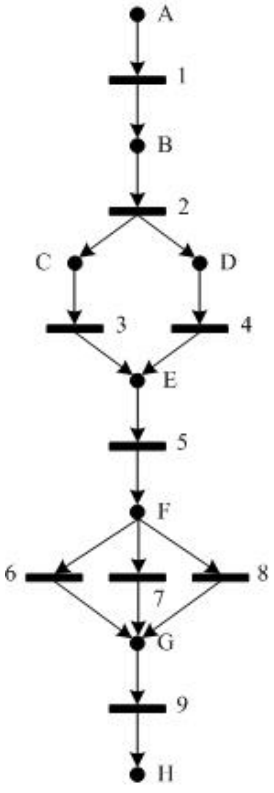

Figure 3
The workflow shown on Figure 1 modelling by P-graph

Obviously, the model above is a simple one and is given in order to present the network structure of the workflow. A lot of problems are already solved with Petri-Net modelling. Model controlling problems have not been mentioned at all, and routing has not been dealt with at all. The advantage of the P-graph is that there is a sound Mathematical background, the P-graph can be presented by set theory tools, a well elaborated methodology for the optimal synthesis of the network structure can be found in the [15], [16], [17] literature, which apparently have similar advantages in case of workflow modelling as in several other applications [18], [19].

Conclusions

Next to the already existing workflow modelling solutions, it is justified to search new solution methods. In parallel to the Petri-Net based workflow modelling that has an extensive literature and is widely used in the profession, P-graph based workflow modelling can take ground and prove to be a useful way of workflow modelling. As a future step, the task is to provide a sound mathematical base for P-graph workflow modelling and to investigate its further application.

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