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Correctness criteria for dynamic changes in workflow systems—a survey ☆

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Abstract

The capability to dynamically adapt in-progress workflows (WF) is an essential requirement for any workflow management system (WfMS). This fact has been recognized by the WF community for a long time and different approaches in the area of adaptive workflows have been developed so far. This survey systematically classifies these approaches and discusses their strengths and limitations along typical problems related to dynamic WF change. Along this classification we present important criteria for the correct adaptation of running workflows and analyze how actual approaches satisfy them. Furthermore, we provide a detailed comparison of these approaches and sketch important further issues related to dynamic change.

Keywords: Workflow management; Adaptive systems; Dynamic workflow changes; Correctness criteria

1. Introduction

A rapidly changing environment and a turbulent market force any company to change their business processes ever more frequently [1]. Process changes become necessary, for example, when new laws come into effect, optimized or restructured business processes are to be implemented, exceptional situations occur, or reactions to a changed market are required. Therefore, a critical

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challenge for the competitiveness of any enterprise is its ability to quickly react to business process changes and to adequately deal with them [16,31].

As pointed out in [17,22,28,34], basically, WF changes can take place at two levels—the *WF type* and the *WF instance level*. *Instance-specific changes* are often applied in an ad-hoc manner and become necessary in conjunction with real-world exceptions. They usually affect only *single WF instances*. As opposed to this, in conjunction with *WF schema changes* at the WF type level, a collection of related instances may have to be adapted. There are many approaches supporting such *adaptive* workflows [1,5,9,18,21,26,28,34]. All of them present very interesting, but partially strongly differing ideas and solutions. Therefore, it is an important job to summarize central correctness criteria for adaptive workflows and to compare actual approaches along them. In this survey, we focus on three fundamental issues regarding dynamic WF changes:

(1) *Completeness*. Users must not be unnecessarily restricted, neither by the applied WF meta model nor the offered change operations. Therefore, expressive control/data flow constructs must be provided [7]. For practical purposes, at minimum, change operations for inserting and deleting activities as well as control/data dependencies between them are needed.
(2) *Correctness*. The ultimate ambition of any adaptive WF approach must be correctness of dynamic changes [1,5,9,18,21,26,28,34]. More precisely, we need adequate *correctness criteria* to check whether a WF instance I is *compliant* with a changed WF schema or not; i.e., whether the respective change can be correctly *propagated* to I without causing inconsistencies or errors (like deadlocks or improperly invoked activity programs). These criteria must not be too restrictive, i.e., no WF instance should be needlessly excluded from being adapted to a process change.
(3) *Change realization*. Assuming that a dynamic change can be correctly propagated to an instance I (along the stated correctness criteria), it should be possible to automatically *migrate* I to the new schema. In this context, one challenge is to correctly and efficiently adapt instance states.

In the following, we provide a classification of actual approaches based on the operational semantics of the underlying WF meta models and on the kind of correctness criteria applied for dynamic WF changes (Sections 2 and 3). Section 3 introduces a selection of typical *dynamic change problems* and discusses strengths and weaknesses of the approaches when dealing with these problems. A detailed comparison of the different approaches is presented in Section 4. We sketch important change scenarios and existing approaches in Section 5 and close with a summary in Section 6.

2. Workflow meta models of adaptive workflow approaches

Current approaches supporting adaptive workflows are based on different WF meta models. Very often, the solutions offered by them are dependent on the expressiveness as well as on the formal and operational semantics of the used formalism. Fig. 1 summarizes WF meta models for which adaptive WF solutions have been realized. According to [15] we classify those meta models with respect to their operational semantics and the evaluation strategies applied for executing WF instances during runtime. The first strategy uses only one type of (control flow) token passing