

## Chapter 9

# Adaptive Exception Management in Uncertain Environments

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### **ABSTRACT**

*The ability to continuously revise business practices is limited when referring to traditional approaches in business process management systems. However, it is essential to organizations aiming at reducing their costs and increasing their revenues. In turbulent environments, the requirement for rapid and continuous changes to business processes, result in less control over the executed activities. As a consequence, process designers are limited in producing solid, well-validated workflow models. This chapter, reviews common approaches to exception handling, focusing especially on adaptive exception handling and introduces a mechanism that allows a flexible ad-hoc generated exception handling using backtracking and forward stepping at a process instance level. A dynamic approach in this domain is required, and can bolster the ability of a business process management system to deal with unexpected situations and to resolve, in runtime, scenarios in which such resolution both is called for and does not violate any business process constraints.*

### **INTRODUCTION**

Turbulent environments require organizations to continuously revise their business practices, seeking better business opportunities and continuously optimizing their processes. In the last decade, businesses have turned to technological solutions to assist them in this task. The use of electronic means to commerce, data mining, SLA's, and customer profiling are all recent technological developments that penetrate business activities. One of the most recent technological developments is the use of Web services, components with a well-defined interface that are embedded in cross-organizational business processes.

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Using Web services, the functional aspects of business applications are encapsulated (Aalst, 2003), with interfaces defined using standards such as BPEL4WS (BPEL4WS), and invocation controlled using approaches such as Service Oriented Architecture (SOA). Web services promise to deliver greater choice and flexibility to business processes.

Frequent and continuous changes to business processes carry with it risks, due to shorter (or even nonexistent) design time and less control over the executed activities. As a result, the ability of process designers to produce solid, well-validated workflow models is limited. Workflow management systems (WfMSs), serving as the main vehicle of business process execution, should recognize these risks and become more dynamic to allow the required business flexibility. To illustrate this point, two examples, involving Web services, will be used. First, an observation that the development of Web services is an ongoing task and new and improved services are continuously replacing existing ones. Currently, WfMSs provide little support to the re-execution of successfully processed tasks for running instances, even if the gains from such re-execution outweigh the costs. As another example, observe that Web services merely provide syntactic information regarding their input, output and processing logic, through standards such as WSDL. In most cases, such descriptions fail to convey all necessary constraints and restrictions. Modeling using Web services, therefore, is likely to make the validation of workflow models more difficult (Gaaloul, 2004), and more exceptions at run-time are to be expected. Efficient exception handling is a fundamental component of WfMSs and is critical to their successful implementation in real-world scenarios (Agostini, 2000).

The motivation for this work, lies in the need for flexible and dynamic WfMSs to support the growing number of exceptions that cannot be designed a priori, due to poor design or the lack of sufficient information regarding the internal logic of Web services. In particular, the introduction of a new and more beneficial Web service may trigger backtracking of a process for a re-execution to an activity in which the new Web service is performed, and then continue the regular execution while utilizing, to the extent possible, previously executed activities. In the case of an exception, the proposed algorithm identifies a feasible alternative that avoids the failing activity or communication channel. In this scenario, again, we backtrack to an activity from which it is considered safe to step forward. This is an elaboration of the work presented in (Golani 2005).

This chapter introduces the following:

- **Model:** An analysis of a workflow model, based on WSM nets, that generates a conceptual framework in which backtracking and forward stepping can be evaluated and implemented.
- **Algorithms:** algorithms for alternative route identification (at design time or run time) and forward stepping (at run time), to allow dynamic modifications to workflows.
- **The meta-process concept,** an efficient and a fully automatic mechanism (at the WfMS level) for activating the proposed algorithms. Four steps have to be completed when guiding the designer in the design of exception handlers:
  - **Functional block detection,** in which a workflow graph is analyzed and revised to fit certain properties that are needed for the next steps.
  - **Alternative paths detection,** in which a set of possible alternative execution is generated.
  - **Parameter modification analysis,** where the amount of change to earlier stages of the workflow is determined for each alternative path.
  - **Exception handler construction,** in which the designer is presented, in an iterative manner, with alternative paths from which it can choose.

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