Business Process Modeling Using Petri Nets

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Abstract. Business process modeling has become a standard activity in many organizations. We start with going back into the history and explain why this activity appeared and became of such importance for organizations to achieve their business targets. We discuss the context in which business process modeling takes place and give a comprehensive overview of the techniques used in modeling. We consider bottom up and top down approaches to modeling, also in the context of developing correct-by-construction models of business processes. The correctness property we focus on is soundness, or weak termination, basically meaning that at every moment of its execution, a process has an option to continue along an execution path leading to termination, which is an important sanity check for business processes. Finally, we discuss analogies between business processes and software services and their orchestrations and argue the applicability of the described modeling techniques to the world of services.

1 Introduction

The concept of a *business process* (BP) is as old as humanity. A BP is the set of interdependent tasks and resources needed to produce some service or product. On top of this set there are constraints or business rules that have to be met. Business processes form the heart of organizations: they should make possible that organizations can realize their goals. Although business processes always have existed, the description, or modeling, of BPs started only recently. In the twentieth century auditors and accountants started working on BP specifications in their field and later it became a hot topic in quality management. In these early days process descriptions were used for documentation, and for facilitating communication between persons. As a result, these descriptions were informal, often in a natural language enriched with some diagrams.

Around the year 1990 business processes became a hot topic in industry, as people became aware of the fact that we were not fully exploiting the power of computer systems. Information systems supporting business processes were

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data-oriented, meaning they were targeted in recording the status of objects that played a role in business processes, in a database. Consequently, database technology was the main technology at the beginning of the nineties. Moreover, information systems were built to support existing business processes by automating their tasks by imitation of the human work by a computer. The papers and books of Hammer and Champy [32, 33] gave very convincing examples of inefficient use of computers and they advocated the re-engineering of business processes before the development of supporting information systems. This was also the first time that the term "engineering" was applied to business processes. Indeed computers can process information in completely different ways from people and it is logical to exploit these possibilities to make business processes more effective and more efficient.

The awareness of the importance of business processes has triggered the introduction of the concept of *process-aware information systems*. Information systems became more than recorders of the status of objects—they started to also focus on business-relevant *events*. The information systems became proactive in the sense that they, for instance, started to control the right order of task execution, keep track of deadlines and distribute the work between resources.

The most notable implementations of the concept of process-aware information systems are *workflow management systems*, a class of generic components for the construction of information systems. Workflow management systems have become the counterparts of database management systems. While a database management system is configured by a database schema and a set of constraints, a workflow management system is configured with a process model. A workflow engine can be embedded in a larger information system the same way as database engines can. From ca. 1995 up to around 2005, there was a strong focus on the support of single business processes with workflow engines. After that, the interest shifted to *cooperating business processes*, as encountered in supply chains and in BP outsourcing.

One of the most recent forms of composition trend in the last decade is the Service Oriented Computing (SOC) [14, 68]. In this paradigm for systems development, closely related to the paradigm of Service Oriented Architecture (SOA) [18, 68], systems are considered as components that deliver services to each other, like businesses in a supply chain. Each component runs a process, to orchestrate the service and in fact such a processes can be seen as a business process. The business processes in the real world are in a way mirrored in the components of the information systems. So here we also encounter the cooperation of business processes, which generates new scientific challenges to develop correct working systems.

The focus of this article is to give insight in the role of business processes, the modeling of business processes and the use of these models in BP management. Instead of presenting new theoretical results we try to give insight as well as an overview of theoretical results. In Section 2 we study the context of business processes, i.e. the world in which business processes play their role. Then in Section 3, we study the modeling of business processes, in particular a bottom