

# Process Instance Migration: Flexible Execution of Distributed Business Processes

Kristof Hamann, Sonja Zaplata, Winfried Lamersdorf  
*Distributed Systems and Information Systems*  
Department of Informatics, University of Hamburg, Germany  
<http://vsis-www.informatik.uni-hamburg.de/>

**Abstract**—This research summary outlines results achieved by Hamburg University during its participation in the EU NoE “S-Cube” focusing on process instance migration. It includes corresponding results in the context of dynamic and mobile environments (as, e.g., provided by mobile web services, NFC-aware process execution, future-context-aware applications or interactive workflows) and focuses on the management of mobile processes as, e.g., ad-hoc monitoring and management, process as a service etc.

**Keywords**—business process management; process instance migration; service-based applications; mobile environments; context-awareness

## I. INTRODUCTION

Service-based processes are often executed in dynamic, heterogeneous environments. In such scenarios, both distribution and execution of business processes should be as flexible as possible in order to allow for ad-hoc adaptation to various changing conditions at runtime. In order to achieve that, decentralizing the separate execution of individual process instances at different sites is often advantageous. Such an approach also fosters increased autonomy and allows for maintaining local responsibilities of process participants which is crucial, e.g., for cross-organizational processes and mobile environments. In contrast to decentralization by physical fragmentation, the approach of process instance migration as proposed here allows for a much more flexible distribution of process execution – even at runtime. [1]

This research summary outlines research results of Hamburg University in the area of process instance migration as achieved during its participation in the EU NoE “S-Cube” project. Accordingly, Section II introduces briefly the fundamental approach, Section III discusses distributed process execution in the context of mobile environments, and Section IV describes proposals to manage respective migrating processes before Section V concludes this summary.

## II. PROCESS INSTANCE MIGRATION

As introduced in 1997 by Cichocki and Rusinkiewicz [2], *process instance migration* describes the approach of transferring the state of a running process instance to another engine in order to continue process execution at a new location. This could, e.g., become necessary when mobile devices change local contexts or when dynamically increasing process resource requirements advocate process

execution at another site. Process description without such execution details requires a formal or technical model to communicate the current state of the migrated process. For that, processes can be described based on a generic meta model which was proposed and presented in [1]. Such a model can then be used to enhance traditional processes (e.g. modelled in WS-BPEL or BPMN 2.0) with non-intrusive migration data. Migration data includes information about current values of variables, states of activities resp. the overall process as well as additional definitions regarding the requirements for specific process engines which are allowed to execute (parts of) the process instance. Additionally, access to certain process parts can be restricted to specific subjects or roles due to privacy and security reasons using a basic cryptographic key infrastructure. [1]

According to this methodology, execution of a running process can be stopped, the process model and the migration data can then be transferred to another process engine which is able to continue process execution at the actual state. Using this methodology, process instance migration fosters the flexible distribution of process executions in dynamically changing systems, such as mobile environments [3].

## III. PROCESS EXECUTION IN DYNAMIC AND MOBILE ENVIRONMENTS

Mobile environments as well as mobile devices have intrinsic characteristics which are relevant for respective process executions. These characteristics include limitations of available resources such as processing performance, network connections, and restricted input/output capabilities [4]. On the other hand, mobile environments also create dynamically changing contexts which can be utilized by process instance migration in order to realize context-based co-operations of, e.g., mobile and stationary devices, users and services [3].

Realizing mobile web services based on the standard protocol stack is therefore often inappropriate. In order to support complex and dynamic applications in mobile environments, a flexible system architecture was proposed in [5]. It supports both mobile web service consumers and providers by allowing to integrate multiple protocols depending on their capabilities and to dynamically access suitable service instances at runtime.

Actual service instances should be selected with respect to requirements and constraints of the process initiator re-

garding non-functional characteristics (NFC) of the process execution. Since availability of services in mobile environments is often highly dynamic, evaluating NFCs at runtime is usually unavoidable. Therefore, a corresponding NFC meta-model and a language have been proposed for supporting process modelers in expressing their non-functional requirements in ways which facilitate runtime decomposition and dynamic derivation of local NFC specifications from remaining global requirements at the process level based on a simple heuristic approach which is suitable for resource-restricted mobile devices [6].

Besides service selection and distribution, a dynamic context may influence all aspects of the behavior of context-aware applications. Furthermore, such applications can also pro-actively adapt to upcoming situations by making accurate assumptions about future contexts. Therefore, *structured context prediction* was proposed as a framework for the development of future-context-aware applications. It allows for integrating domain-specific knowledge and facilitates application, combination, and implementation of suitable prediction methods [7].

At the user-level, the interaction between service-based applications and end-users has to deal with limited and heterogeneous input and output capabilities of mobile devices. Therefore, an abstract and modality-independent description model was introduced as support for the development and execution of interactive mobile workflows [8].

#### IV. MANAGEMENT OF MOBILE PROCESSES

Advanced business processes such as cross-organizational processes and migrating processes often leave (maybe, in parts) their initiator's direct sphere of influence. In this case, both monitoring as well as instant reaction capabilities are becoming more important but also more difficult to realize. Here, flexible management capabilities have to cope with heterogeneity and temporal disconnectivity of participating execution sites. Therefore, a two-tier concept for monitoring and controlling distributed processes by representing a process management system as a manageable resource was proposed. An additional management component can execute user-defined management rules and adaptation actions based on complex event processing. [9]

Even more, the approach of process instance migration allows for the flexible outsourcing of the whole process execution. The resulting *Mobile Process as a Service* (MPaaS) enables (mobile) participants to share existing local and remote resources and to utilize process-as-a-service functionality of cooperating providers in a user-defined way. [10]

#### V. CONCLUSION

Using the proposed meta model for migration data, the concept of process instance migration has been evaluated for different process description languages (XPDL [1], BPEL [1], BPMN [11]). In summary, the approach allows for a

flexible distribution of the process execution at runtime while related research results provide solutions to problems of dynamic and mobile environments or provide ad-hoc management capabilities and process-as-a-service functionality.

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