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DISCOBOLE: A service architecture for interconnecting workflow processes

Karim Baïna [a], Khalid Benali [b,*], Claude Godart [b]

[a] ENSIAS, Université Mohammed V, Souissi, BP 713 Agdal, Rabat, Morocco
[b] LORIA–INRIA–CNRS (UMR 7503), BP 239, F-54506 Vandoeuvre-lès-Nancy Cedex, France

Abstract

Process interconnection mechanisms are necessary to coordinate geographically distributed business processes in order to strength awareness inside virtual enterprises, to facilitate multinational e-transactions, etc. Actually, existing business process modelling and enactment systems (workflow systems, project management tools, shared agendas, to do lists, etc.) have been mainly developed to suit enterprise internal needs. Thus, most of these systems are not adapted to inter-enterprise cooperation. As we are interested in workflow processes, we aim, through this paper, to present a model supporting dynamic heterogeneous workflow process interconnection. We consider the interconnection of enterprise workflow processes as the management of a "workflow of workflows" in which several heterogeneous workflow systems coexist. This paper introduces our process interconnection model, its implementation, and its validation through experimentation.
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1. Introduction

Our aim is to provide an architecture to support dynamic interconnection of enterprise workflow processes. By interconnection of enterprise workflow processes, we mean the management of a "workflow of workflows" in which several heterogeneous workflow management systems coexist. By dynamics of enterprise workflow process interconnection, we mean that process interconnection does consider neither predetermined communication primitives, nor scheduled points of rendezvous. In other terms, an enterprise, aiming to interconnect its workflow process with another organisation workflow process has to discover and co-decide an interconnection contract at run-time. To be interconnected with other processes, a workflow process out-sources dynamically parts of it to the other workflow processes. This enables interactions resulting from workflow interconnection to be limited in the time (i.e. to the out-sourcing period) and then to be well managed and controlled. Our process service

interconnection model contribution consists of enriching SOA (service oriented approach) with new paradigms and applying this enhanced approach to resolve heterogeneous workflow process interconnection problem. We propose a generic model for workflow process interconnection problem and validate this model on heterogeneous workflow management systems. Our paper is structured as follows. After a short introduction, Section 2 presents the process interconnection problematic, and the state of the art, Section 3 formalises our process service interconnection model, Section 4 presents an implementation of our model, and gives some hints on our system experimentation. Finally, a short conclusion ends this paper.

2. Process interconnection

Due to business process automation development, process interconnection becomes an important matter. Although a wide spectrum of tools for business process modelling and enactment exists (workflow systems, project management tools, shared agendas, to do lists, etc.), they have been developed to suit the intern needs of enterprises, and thus, are not adapted to inter-enterprise interconnection. Compared to other enterprise

* Corresponding author.
  E-mail addresses: baina@ensias.ma (K. Baïna),
benali@loria.fr (K. Benali), godart@loria.fr (C. Godart).

process systems, workflow processes are the most mature and operational. Meanwhile, they still have many drawbacks when considering enterprise process interconnection. In spite of WFMS normalisation efforts, existing workflow management systems are:

- *heterogeneous*: considering their definition and execution environments (disparate syntax and semantics of business process models and definition languages—BPDL, ad hoc process instance management), and their access means (neither standard compliant API nor protocol);
- *monolithic*: considering the absence or the poorness of their API, and the black box process instance encapsulation (e.g. within an enactment engine or a virtual machine).

Beside drawbacks related to workflow process entities, interconnection of these workflow processes implies several difficulties, among which, we can mention:

- *Process presentation*: how to present in a homogeneous manner workflow processes that have heterogeneous definition models?
- *Dynamic process interconnection*: which model to use for composing processes at run-time?
- *Composed process enactment*: how to be able to execute a process interconnecting workflow processes that have heterogeneous execution models?

Because of heterogeneous and monolithic aspects of workflow management systems, developing generic models for enterprise workflow process interconnection is a big deal. Among several approaches for interconnecting enterprise processes we highlight the most important:

- *Process message oriented communication*: [1,2], and BizTalk describe several techniques for workflow process communication through asynchronous typed message passing, and adapt paradigms like subscribe-notify, push, pull to workflow processes.
- *Process event synchronisation*: [3], ICN [4], OPERA [5], WfMC [6], and WF-nets [7] upgrade process message communication paradigms with event coordination languages and algebras for synchronising interleaving workflow processes.
- *Process data and interface interoperability*: Wf-XML, PIP, and e-speak establish interoperability frameworks for workflow data structures and interfaces.
- *Process data concurrency and access control*: [3,8], and IETF WebDAV & SWAP go beyond simple data interoperability to control access within shared workflow data spaces.
- *Process transactional exchange control*: COO [9], TRANS-COOP [10], WISE [11], and MQSeries [12] consider workflow processes as advanced transactions, and propose transactional models for workflow execution and data management.
- *Process service exchange*: service concept has been defined in many research fields: object oriented research, process

modelling research [1,13–15], distributed system research [16,17], etc. In workflow research, CMI [1], OCoN [18], Crossflow [15,19], eFlow [14], BPEL [20] define process service contracts for workflow process interconnection. To be more complete concerning process services, one may say that a process service can be seen as a software entity presenting process particularities and outcomes without totally revealing the process structure (i.e. its workflow implementation). A process service shows a functional abstraction of a process (or parts of a process) provided by an organisation. It specifies the amount of work that the organisation promises to carry out with a specific quality of service. It also specifies which parts of a workflow process it covers and how the requester could access to them. Process service concept has been studied from several points of view: process service execution semantics abstraction [1], sub-workflow process service selection [19], dynamic process service activities configuration [14], process service control flow level abstraction [15], service methods and events wrapping [17], etc. Process service structure is to be seen as a cooperation pattern that relevantly supports dynamic workflow process interconnection and cooperation behaviours.

Compared to other approaches, process service exchange approach supports enterprise cooperation modelling in a very effective way. Actually, by its forces of abstracting enterprise workflow processes to be interconnected, process services are the most adapted to build high level models for enterprise cooperation and generic models independent from workflow process particularities. Moreover, process service exchange approach offers a high level paradigm, which is very open to extensions dealing with other paradigms (e.g. communication: message passing, data interoperability; coordination: event synchronisation; execution control: data access control, transaction management, etc.).

Hence, to build our dynamic enterprise workflow process model, we have chosen the process service exchange approach. For process presentation problem, we consider processes, beyond any process model, as services, which are accessible object entities that possess object classification (category) and accept all object features (inheritance, overloading, etc.). Let call these specific services "process services". These process services possess application specific interface (API) and access rights to this API (visibility contract). A set of category specific typed values describe (profiles) of these process services. Our proposition for process presentation is in the same vain of workflow object vision of the OMG [21] even if this later does not take into account workflow application specific properties. We propose innovative service discovery concepts and algorithms, which can improve OMG trading service. As far as dynamic process interconnection problem is concerned, we merge the WfMC nested sub-process model [6] with process service out-sourcing based interconnection [1,14,15]. Our constraint was to interconnect workflow processes with changing neither their classical definition nor execution manner. So, we improved WfMC nested sub-process model, which was created for build-time process interconnection with