Workshop on Workflow Management in Scientific and Engineering Applications — Report

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Introduction

On the 1st and 2nd of September a workshop was staged at the 8th international conference on Database and Expert Systems Applications (DEXA'97) in Toulouse, France. The workshop was entitled 'Workflow Management in Scientific and Engineering Applications' and was organized by Richard McClatchey of the Complex Cooperative Systems research center at the University of the West of England (UK) and by Gottfried Vossen of the University of Muenster (Germany). The workshop followed up many issues raised at the NATO Advanced Studies Institute on Workflow Management and Interoperability held in August in Istanbul and in particular was aimed at dynamic or ad-hoc aspects of workflow management which come to light in engineering or scientific applications.

Motivation for the Workshop

The workshop was motivated by the fact that, up to now, there have been relatively few examples of the application of workflow management outside the business domain. Workflow management allows the combination of a data-oriented view on applications, which is the traditional one for information systems, with a process-oriented one in which activities and their occurrences over time are modeled and supported properly. Since workflow management combines influences from a variety of disciplines, including cooperative information systems, computer-supported cooperative work, groupware systems, or active databases, it has recently attracted the attention of non-business application domains. Two of these, the domain of scientific applications (in particular in the natural sciences) and that of engineering applications, seem particularly appropriate for the exploitation of workflow technology, since they involve processes in which humans and machines interact in considerable numbers, and could benefit from the automation in the execution of such processes. However, the requirement for workflow management in these areas differs significantly from those in business. Consequently, there has been little work so far towards an in-depth understanding of the relevant issues. It was the goal of this workshop to contribute towards closing this gap.

During the last few years, workflow management has become increasingly interesting to scientists and to engineers who, for example, carry out experiments in a laboratory (e.g., soil analysis, DNA sequencing), design work in a computerized environment or perform once-off processes (such as critical detector assembly). What such applications have in common is the fact that the processes to be executed are frequently (sequences of) events with outcomes which can evolve as the experiment advances, so that the structure of the entire process is difficult to determine in advance. Nevertheless, modeling, execution control, and documentation (for the purpose of reuse) are highly relevant.

From a workflow point of view, the important features found in these applications include:

- flexibility in structuring and modeling (open-ended, sometimes ad-hoc workflow definition, allowing decision-making whilst a workflow is being executed)
- workflows with a complex (or nested) inner structure of individual steps (such that multi-level modeling becomes appropriate)
- the treatment of failures which can be more complex than dealing with ordinary cases
- system functionality features such as browsing and visualization, documentation, or coupling with external tools, e.g., for analysis.

Moreover, their workflow execution requirements ask for features like:

- support for long-running activities with or without user interaction
- application-dependent correctness criteria for executions of individual and concurrent workflows
- integration with other systems (e.g., file managers, DBMSs, Product Data Managers) that have their own execution/correctness requirements
- reliability and recoverability w.r.t. data
- reliable communication between workflow components and processing entities.

Workshop Topics

In the light of these demanding questions and the fact that commercial developments in the workflow management area have so far largely ignored scientific and engineering applications, this workshop seeked to bring together researchers in the field and aimed at advancing the knowledge about so-called 'scientific' workflow management. Given the fact that the NATO workshop was unable to concentrate on this rather specific workflow area, the workshop organizers particularly encouraged participation those groups with research projects in the domains described above. The call for papers included the following suggested topics:

- modeling tools for incomplete and ad-hoc workflows

- dynamic modification of workflow specifications
- platform independence
- experience from applications such as geoprocessing, molecular biology, laboratory management systems, mechanical and electrical engineering
- integration of workflow management and product data management
- laboratory information management systems
- exploitation of Internet technology
- exploitation of distributed systems technology in workflow management

Delivery of the Workshop

The workshop was organized into five sessions and was kicked-off by one entitled Distribution and Interoperability. This session investigated some of the aspects introduced at the recent NATO workshop and comprised two long papers. The CRISTAL research team (Univ West of England, CERN, LAPP (France) and Univ of Rome) discussed the problem domain of large- scale scientific apparatus construction at CERN and presented the novel idea of merging Product Data Management tools with workflow management to facilitate version management in dynamic evolving workflows. Next Cevdet Dengi of the Middle East Technical University presented the Dflow workflow management system. Dflow addresses problems of automatic recovery in its model and problems of concurrency control and heterogeneity in its architecture.

The second day of the workshop saw Prof. Amit Sheth from the Large Scale Distributed Information Systems Laboratory at the University of Georgia, Athens, USA present an invited keynote talk entitled "From Contemporary Workflow Process Automation to Adaptive and Dynamic Work Activity Coordination and Collaboration". In this informative and comprehensive talk Amit outlined a research agenda for researchers in the area of workflow management. His basic tenet was that workflow systems should evolve into what he termed "work coordination and collaboration systems" or WCCS. According to Amit WCCSs should be able to adapt to changes in organizational process definitions and support an unified framework for managing coordination, collaboration and information-based decision making. A multidisciplinary approach was encouraged as an essential component of WCCS development.

The third session of the workshop was devoted towards the definition and enactment of so- called ad-hoc workflows. Hartmut Wedekind of the University of Erlangen-Nuremberg, Germany gave the first of two long papers and stimulated the workshop audience with a paper entitled "Specifying Indefinite Workflow Functions in Ad-hoc Dialogs". He suggested a dialog system to handle indefinite (i.e vague or imprecise) workflow situations. His delivery was highly entertaining and multi-lingual in parts and was thoroughly appreciated by the workshop. Ad-hoc workflow specification and enactment was discussed further in a paper given by Marc Voorhoeve from Eindhoven Univ of Technology in the Netherlands. This paper proposed a class of Petri nets to describe workflow processes, featuring safeness and guaranteed termination. Marc also investigated issues surrounding the monitoring and control of ad-hoc workflow enactment.

The afternoon session of the second day of the workshop was entitled "Dynamic Change" and turned out to be one of the most interesting of the workshop. Two papers were presented, the first of which was given by Manfred Reichert from the University of Ulm in Germany. Manfred presented a framework for the support of ad hoc structural changes of workflows. Their approach is based on a graph-based workflow model (called ADEPT) which has a formal foundation in its syntax and operational semantics. Based on this model they have developed a complete and minimal set of change operations which support users in modifying the structure of workflows at runtime, while preserving their correctness and consistency. Manfred's paper sparked off quite some discussion which was taken up by interested parties over tea and coffee. The second paper in the Dynamic Change session was "Modeling Samples Processing in Laboratory Environments as Scientific Workflows" given by Mathias Weske of the University of Muenster. Mathias described how the workflow paradigm can be employed in the domain of scientific laboratory information systems. He indicated how the management of processes and the processing of samples in laboratory environments could be improved through the deployment of the WASA (Workflow Architecture for Scientific Applications) software currently being prototyped at the University of Muenster.

The final session of the workshop concentrated on applications of workflow management in scientific or engineering environments. Three shorter papers were delivered the first of which from Katrin Stein of the University of Erlangen-Nuremberg. Progress was reported on the modeling of workflows in a compact manner from experiences with a large European market research company. She reported the introduction of descriptive workflows, dynamic change and ad-hoc modeling to provide flexibility in workflow management in scientific computing. Following this Daniel Chan from INRIA presented a novel application of workflow management in the domain of tools for controlling software development. He argued that the software development process is sufficiently dynamic in nature to require control through workflow techniques which provoked discussion in the questions section. The final talk of the workshop was given by Gregor Joeris and was entitled "Cooperative and Integrated Workflow and Document Management for Engineering Applications". Gregor concentrated on cooperation support within workflow management on both a document level and workflow level. He proposed an integrated and flexible approach to process and document management based on an object-oriented modeling framework.

Concluding Comments

The workshop was successful in isolating some issues which up to now have been specific to the application of workflow techniques in science and engineering, but which begin to penetrate traditional approaches and systems to an increasing degree. These issues included aspects of ad-hoc workflow modeling and execution, the incorporation of dynamic changes in workflow management systems, aspects of distributed workflow management and the need for control and coordination of multiple and concurrent workflow executions. After Amit Sheth's forward look into future workflow research directions it has become clear that these hitherto 'scientific' workflow issues are high on the research agenda of future workflow management systems in a wider arena which encompasses commercial systems as well as research projects. Furthermore the requirement for collaboration between the actors or agents which use workflow systems has also been highlighted. In this sense, the workshop achieved its goal of producing further awareness of the aforementioned issues, which seem to have arrived at the mainstream of current research in the area.

Full List of Workshop Papers

R. McClatchey, N. Baker, W Harris, Z. Kovacs, F. Estrella, Univ West of England, Bristol, UK, J.-M. Le Goff, CERN, Geneva, Switzerland, A. Bazan, T. Le Flour, LAPP, Annecy-le-Vieux, France:
Version Management in a Distributed Workflow Application

C. Dengi, S. Neftci, Middle East Technical University, Ankara, Turkey:
Dflow Workflow Management System

A. Sheth, University of Georgia, Atlanta, USA
From Contemporary Workflow Process Automation to Adaptive and Dynamic Work Activity Coordination and Collaboration

H. Wedekind, University of Erlangen-Nuremberg, Germany:
Specifying Indefinite Workflow Functions in Ad-hoc Dialogs

M. Voorhoeve, W. van der Aalst, Eindhoven University of Technology, The Netherlands:
Ad-hoc Workflow: Problems and Solutions

M. Reichert, P. Dadam, University of Ulm, Germany:
A Framework for Dynamic Changes in Workflow Management Systems

T. Reuss, G. Vossen, M. Weske, University of Muenster, Germany:
Modeling Samples Processing in Laboratory Environments as Scientific Workflows

S. Jablonski, K. Stein, M. Teschke, University of Erlangen-Nuremberg, Germany:
Experiences in Workflow Management for Scientific Computing

D. Chan, INRIA Rocquencourt, and K. Leung, Hong Kong Polytech:
A Workflow Vista of the Software Process

G. Joeris, University of Bremen, Germany:
Cooperative and Integrated Workflow and Document Management for Engineering Applications

These papers appear on pages 7–73 of the general proceedings volume of the 1997 DEXA workshops, whose full reference is as follows:
Proceedings of the 8th International Workshop on Database and Expert Systems Applications 1997, IEEE Computer Society Press, Los Alamitos, CA, ISBN 0-8186-8147-0