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Construction, Communication and Caring for Contextual Workflows: Scenarios from Homeland Defense

Edward J. Glantz and Sandeep Purao
School of Information Sciences and Technology, Pennsylvania State University
315 Beam Business Administration Building, 3F Joab L. Thomas Building, University Park, PA 16802
phone: 814-863-7243, fax 863-2381, 814-865-4461
ejg8@psu.edu, Sandeep-purao@psu.edu

INTRODUCTION

Exception handling[1] (van der Aalst, Basten et al. 2000) and adaptive workflows[2] (Rahm 2000) represent two prevalent directions to handling adjustments to workflows brought on by unexpected changes. The two directions suggest somewhat different approaches to workflow adjustments, the former involves direct adjustments at the case (instance) level, and the later addresses adjustments based on knowledge available at the definition (meta) level. The adjustment problems, however, can become severe, when the workflow instances occupy a large footprint in time and space. First, long-lived workflows need to withstand changes in the environment. Second, workflows spread across multiple organizations need to respect the decentralized, and sometimes, conflicting goals of the participants.

Issues that need attention to support such workflows include goal-articulation, goal-communication, and goal-sharing. Goal-based approaches[3] (Kuechler and Vaishnavi 1998) address some of these concerns. However, they fail to address these adequately in response to changes in environment. Nickerson (Nickerson 2003) describes a limited exploration of these issues by suggesting an alternative to workflow reference models (Hollingsworth 1995), with the use of sequence diagrams (to capture the distinction between human actors and machine processes). Luo et al (2002) suggest a bundled exception-handling approach that includes case-based intelligent reasoning and reuse of exceptions for cross-organizational exception handling processes to resolve workflow failures[4]. Both the Luo and Nickerson approaches, however, cannot account for important workflow components such as resource restrictions, roles, responsibilities, and explicit goal-articulation – concerns that become more relevant for large-footprint workflows. In a world, where long-lived workflows across organizational boundaries are likely to occur with some frequency, a comprehensive approach is necessary for their construction, communication and caring.

In this paper, we use multiple homeland defense scenarios (including one similar to that used by Nickerson (Nickerson 2003) with a view to *identifying key issues that need to be addressed in workflows that possess a large footprint in space and time*. Specifically, we focus on the articulation of goals, their evolution, and sharing across time and space to guide the monitoring of long-lived workflows that take place across multiple organizations.

PRIOR RESEARCH

Most current approaches to exception handling involve drawing on a knowledge-base stored at the meta-level. A few approaches allow dealing with these problems on a case by case basis, allowing human participants to intervene and adjust the workflow as desired, resulting in evolutionary changes that are ordered and result in universal changes (van der Aalst, Basten et al. 2000). Both can result in coordination and tracking problems referred to as dynamic change bugs (van der Aalst and Basten 2002). Dynamic change bugs cause errors either within the ability of a case to maintain its integrity or omissions that affect the ability to track and report changed processes (van der Aalst and Basten 2002). Inheritance-preserving transformation rules have been proposed for workflow processes, with the intention of eliminating the dynamic change bug (van der Aalst and Basten 2002). Situations exist, however, where the quality of the process implementation is not necessarily within the control of the workflow designer and their carefully devised workflows using inheritance. This is a typical situation for workflow processes that are spread across organizations, where goals are not likely to be aligned or shared (Zhuge). We present multiple homeland defense scenarios, which serve as specific instantiations of these types of workflows, which in turn allow us to identify and articulate important problems that must be tackled as important research questions.

Homeland Defense Scenarios

We describe and briefly analyze three specific homeland security scenarios to illustrate practical challenges to large-footprint workflow processes in a changing environment, and non-aligned or conflicting goals across participants in each scenario. The first scenario refers to the process used by the army for adjudicating security clearances. The second scenario introduces the early stages of an automated workflow process by the U.S. Immigration and Naturalization Service (INS) to assign and track student visas. The third involves the complex processes involving the coordination of public health, public policy and private health practitioners responding to bio-terrorism threats. Table 1 shows a summary of these scenarios[5].

Challenges to Workflow Support and Automation

The homeland defense scenarios outlined above suggest several interesting challenges. Each represents a long-lived workflow that crosses organizational boundaries. In the situations described, sharing of data across organizational boundaries is an important mechanism to support the overall workflow. However, such sharing, without clear communication of intent or goal alignment does not allow effective continuation of workflows. Each scenario reveals situations that include possible goal conflicts (scenario 3) or, at minimum goal indifference (scenario 2), seen from the perspective of the initiating organization. While several other traditional challenges continue to exist, including issues such as data formats for exchange, understanding task dependencies, and handing off of responsibilities, the important concern appears to be one of arriving at a shared goal structure that ensures that the workflow proceeds effectively.

Specifically, the key challenge consists of articulating goals and maintaining (or negotiating) their understanding as the workflow instances move across organizational boundaries, and in response to changes in the environment. Current work on operationalizing goals to specific tasks such as creating procedural paths to the goal states (Kuechler and Vaishnavi 1998), can be adapted and extended to address a part of this concern. However, including the human actors in the loop for the workflow process, allowing them to articulate, negotiate, map, share, and interpret goals; and create or change procedural paths from tasks to goals represents a key problem that has not been addressed by current research. Further, the problems that arise from a large-footprint workflow require that the goals in question must be adjusted in response to changes in the environment. This responsibility need not lie with the participant currently engaged in monitoring or executing the workflow but

Table 1: Challenges from Homeland Defense Scenarios

Scenario	Current Effort	Partners and Goals	Comments
Army Security Clearance	Integic Corp. e.Power WF/document management, Expedited "clean security clearance"	Currently, only 2 partners, with fairly aligned goals	Current partners, though represent different institutions, are under a central authority, easier to streamline other clearance types
INS Student Visa Tracking	Peoplesoft & EDS In process	37,000 + partners, Conflicting goals across universities and government agencies	Large number, though primarily two classes of partners: educational institutions and one government agency.
Public and Private health and Public response to bio-terrorism threats	Not really in process	Several and shifting (federal, state & local public officials; CDC, private health systems). Conflicting goals including compliance incentives, jurisdiction, respect, privacy, pride, etc.	Several and changing classes of partners, Limits on ability to support multiple/ parallel threats due to CDC limitations

may also include other, currently passive participants. Identifying mechanisms that allow such changes to be recognized constitutes the second important challenge.

Consider, for example, scenario 2 (see Table 1). The goals of participants may be broadly articulated as 'accurate tracking[6] of foreign students' for the initiating participant (Immigration and Naturalization Service), and 'ensuring a supportive and free environment for learning' for the responding participant (the Educational Institution). These goals, as articulated, can be in conflict[7]. However, a goal-decomposition strategy can suggest a sub-goal for the educational institution such as 'tracking students for billing' that may be more closely aligned to the goal articulated by the initiating institution. Articulating, identifying and mapping such goals can facilitate the execution of a workflow. Consider another framing for the same example. Without the benefit of the mapping suggested above, the task of tracking students for the purpose of reporting to the INS suggests extra work for the colleges with no corresponding, visible benefit. On the other hand, articulating a quid pro quo such as 'tracking alumni after they graduate' in return for 'tracking foreign students' may be articulated that will allow greater compliance with workflow tasks required by the initiating participant.

As a second set of examples, consider scenario 3 (see Table 1). The goals for a response to a bio-terrorism threat can be several and may require a satisficing approach. The complicating factor, however, involves monitoring the environment to ensure that the current goal articulation takes into account the most current environmental assessment. However, the triggering event, resulting from current environment monitoring, is often poorly implemented. The problem here is twofold. First, doctors do not typically track certain diseases as required, or even the myriad forms needed to report them. Compliance would even be problematic since the forms, even if completed, would reflect historically flagged events, and would not detect new threats. Physicians, therefore, report only a small percentage of new diseases. The largest percentage comes from infection-control nurses in hospitals and laboratories that have "been able to make reporting part of their routine." Although private practitioners are legally responsible for sending reports of specific infectious diseases to local health agencies, penalties are not usually enforced. This lapse exists even though it is not uncommon for doctors to complete medical records describing symptoms and treatments, often times in electronic formats. The second problem is diagnosis without context and risk. For example, the general medical community was basically unfamiliar with anthrax symptoms and treatment (antibiotics) was counter to currently accepted medical practices[8]. One approach to improving the overall workflow to monitor the environment can, therefore, include mapping the private medical community's sub-goal, 'accurate medical records,' with the public health community's sub-goal of 'tracking new and evolving health threats.'

Proposed Research Approach

We envisage a workflow modeling and support environment that allows workflow goal and sub-goal articulation, and mapping to tasks for each workflow participant. Instead of layering additional systems or processes, our objective translates to one of identifying intentions of participants, and mapping these at the closest common instance of alignment to facilitate workflow execution across organizational boundaries. By discovering and exploiting existent synergies and integrating a possible reward structure, we envision an environment that can create robust workflow processes, which can be resilient over time and distance. Our approach, therefore, does not preclude integration of existing research on exception handling and adaptive methodologies, but relegates them to a more appropriate "supporting" role rather than one of artificial enforcement. We are currently in the process of articulating the requirements for such an approach, and modeling the conceptual design of such a support environment.

ENDNOTES

1 Exception handling refers to making changes, on-the-fly, to the workflow execution for individual cases as exceptions are encountered.

2 Adaptive workflows refer to the "automation potential of knowledge bases to dynamically adapt the control and data flow of running instances" (http://dbs.uni-leipzig.de/de/Research/workflow.html)

3 Goal-based inter-organizational workflows refer to a "high level specification of a desired system state that implicitly includes many (possibly an infinite number) of procedural paths to the goal state, termed extensions or instances." (http://www.cis.gsu.edu/~vvaishna/process/wits98.pdf)

4 Cross-organizational workflow execution failures are attributed to "underlying application, controlling WfMS component failures or insufficient user input." (http://lsdis.cs.uga.edu/lib/download/LSKA02-TR.pdf)

5 Descriptions of these scenarios are available at http://purao.ist.psu.edu/workflow/scenarios/homeland

6 PeopleSoft student administration application, called PASS, automatically detects and reports changes in administrative information about students to immigration authorities.

7 Examples of the multitude of INS/ University issues to be resolved: http://chronicle.com/colloquylive/2002/09/monitor/

8 Thomas Morris, Jr. was a postal worker who died of inhalational anthrax after exposure at the Brentwood mail facility. His flu-like symptoms were not, per current medical practice, treated with antibiotics. Medical experts feel that the context and risk could not have been identified at the local level. (http://www.abcnews.go.com/sections/living/DailyNews/anthrax_misdiagnosis011120.html)

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