

# Workflow Process Creation by Pellucid Agents

Michal Laclavík\*

laclavik.ui@savba.sk

Zoltán Balogh\*

balogh.ui@savba.sk

Ladislav Hluchý\*

hluchy.ui@savba.sk

**Abstract:** In this paper we present how agent technology can be used to improve Workflow Management Systems. We propose Pellucid Agent Architecture which helps with Workflow Process creation and with integration Intra Organizational Workflow. Proposed architecture was created as a part of European Union IST Project named Pellucid.

**Key Words:** Software Agents, Workflow

## 1 Introduction

Platform for Organizationally Mobile Public Employees (Pellucid) is European Project IST-2001-34519. The overall objective of Pellucid is to develop an adaptable platform for assisting organizationally mobile employees, in effect to re-engineer their work in the organization. This will improve organization effectiveness and efficiency by formalization, recording, storage and preservation of experience and knowledge; and supporting workers during integration in a new department or role by giving access to specific knowledge and experience accumulated in the past. At the technical level, the objective is to develop and integrate several advanced technologies in a customizable agent-based architecture. These technologies include autonomous cooperating agents; responsive interaction with the end-users; organizational memory; workflow and process modeling; and metadata for accessing document repositories. The objective is also to obtain experience with customization and to formulate guidelines for the best practice in using the Pellucid platform in assistance of organizationally mobile workers [1].

We would like to develop a flexible and adaptable architecture, which would be able to control intra- and inter-organizational workflow, thus to assist organizationally mobile workers in organizations in distributed virtual heterogeneous environments.

Pellucid project was launched on March 1st 2002 and currently it is in the prototype creation stage.

## 2 Workflow and Workflow Management Systems

There is a workflow in each organization. Many organizations use Workflow Management Systems to automate the workflow in an organization. The workflow can be defined as automation of a business process in whole or part, during which documents, information or

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\* Institute of Informatics, Slovak Academy of Sciences, Dubravska cesta 9, Bratislava, Slovakia

tasks are passed from one participant to another for action, according to a set of procedural rules. Automation of processes involved in workflow is often called workflow management system (WfMS).

Different WfMSs were developed with more or less the same functionality. Since large organizations started to exchange electronic data and also WfMSs needed to integrate other application, some standardization was necessary and this resulted in establishment of Workflow Management Coalition (WfMC). WfMC issued several standards for process definition language, workflow application interface and others. When we will talk about WfMS we will mean the WfMS which follows WfMC standards. Pellucid will integrate WfMSs based on these standards [2].

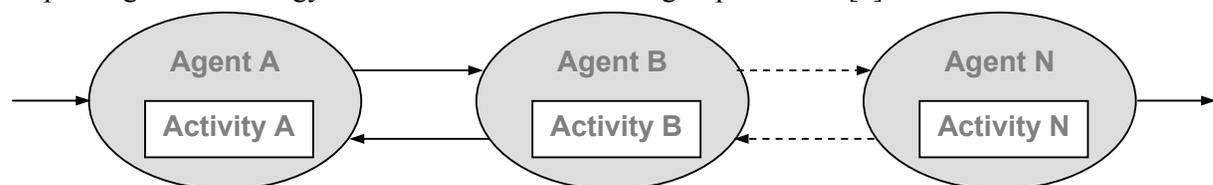
## 2.1 Workflow and Agents

Agents can improve workflow; they are especially useful in distributed workflow environments, where the advantages of the agent's mobility can be exploited. Agent technology can also add some value in cross organizational workflow and its integration.

Basically we can define two approaches for creating workflow with agents:

- Agent Based Workflow
- Agent Enhanced Workflow

Agent based workflow systems have been developed by a number of teams [Jennings et al 1996], [Harker, Ungar 1996], [Borghoff et al 1997], [Debenham 1998] each offering their own particular enhancements and features. In agent based workflow, the software agents take full responsibility for process provisioning, execution and compensation, with each agent managing and controlling a given activity or set of activities. However, these tools do not appear to have been adopted and are not, at the time of writing, in common usage. In addition, a move to agent based workflow is likely to incur high re-engineering costs, and the resulting step change in technology will create extensive training requirements [3].



*Figure 1: Agent Based Workflow*

In order to address the problems identified above, a software agent enhancement to a widely used third party workflow tool was developed. British Telecom [CrossW] explored the possibility of adding an agent layer with the added value of providing mechanisms for handling and repairing workflow failures [Judge et al, 1998], while retaining the user's confidence in the workflow tools they were familiar with. This approach is called agent enhanced workflow, in contrast to the more common agent based workflow. Agent enhanced workflow is achieved by combining a layer of agents with a commercial workflow system. The agent layer is given responsibility for the provisioning phase of business process management, whilst the underlying workflow system handles process execution. This approach provides a number of benefits (including automatic provisioning, interoperability, support for visualization and verification services), whilst protecting the original investment

in workflow technology. The use of workflow technology ensures that the business process is explicitly represented and easily maintained [3].

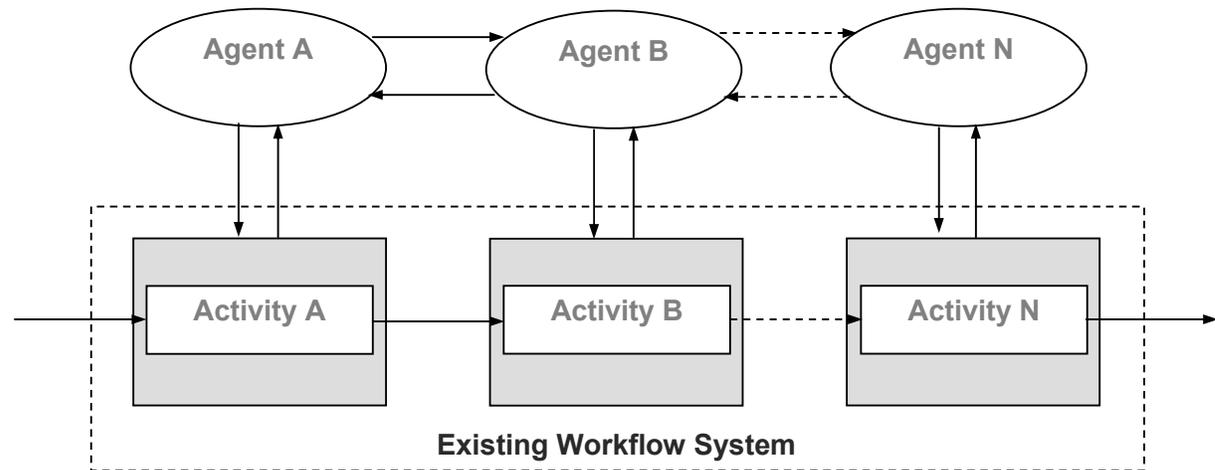


Figure 2: Agent Enhanced Workflow

### 3 Architecture

#### 3.1 Architecture Description

Our Approach is similar to BT's Agent Enhanced Workflow, but agent based workflow features can be used in some cases too. Basic architecture has 4 elements:

- Workflow Management Systems (WfMS)
- Pellucid Activity Agents (AA) monitored by Monitoring Agent (MA)
- Organizational Memory (OM)
- User Interface represented by Personal assistant Agent (PAA) connected with Role Agent (RA)

We can have several WfMS connected to Architecture. Each running activity in WfMS is represented by one Activity Agent (AA). Activity Agents which represents Agent Based Workflow can be included also. In this case information about such activity agents is stored in OM directly.

Organizational Memory (OM) has several types of data:

- OM has access to WfMS stored processes, activities
- Historical data such as past process instances
- Organized knowledge
- Agent specific data

User can start processes or activities through Personal Assistant Agent (PAA). Role agent (RA) is responsible for serving access to possible activities or processes in user role.

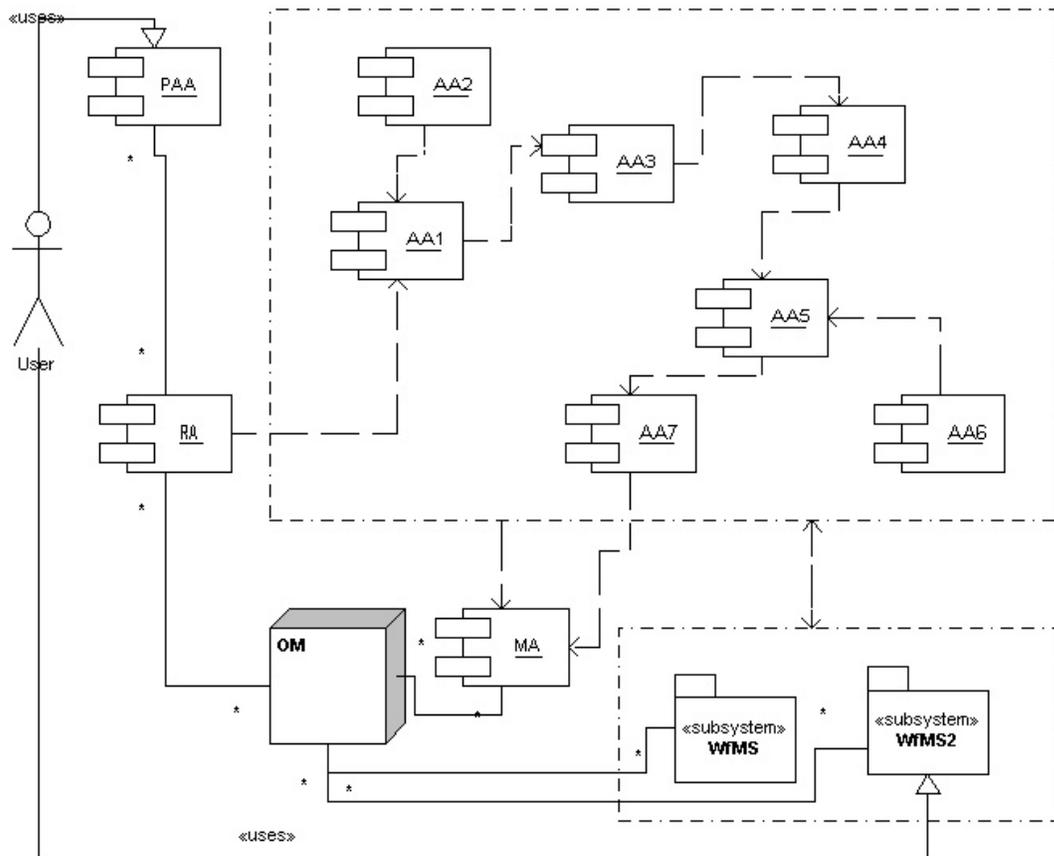


Figure 3: UML Scheme of Pellucid Architecture

We can describe our architecture also more abstractly by sets and graph theory. We have a set of activities, processes and tasks to be done. Each activity has some properties like permissions, time to accomplish, set of activities required to finish before current activity. Process is oriented, valued graph of activities, because activity has some properties.

- Set of Activities = Activity Agents
  - Time to accomplish, permissions
  - Set of activities required to finish before
- Set of Processes = Graph of Activities
  - Valued Graph - activity has certain permissions
  - Graph algorithms – best accomplishing of tasks
- Set of Tasks = certain goals to be accomplished by processes

Monitoring agent (MA) is monitoring AAs. It stores and manages information such as, which AA is running, when it started, when it finished, who started it, which task it tries to accomplish. MA agent creates process graph  $P_x$  which contain activities  $A_{1m} \dots A_{in}$ , which can fulfill task  $T_y$ . When a user wants to work on task  $T_y$ , PAA will ask RA for all possible processes to fulfill this task and by graph algorithms it can find the best one for the user. If

there is no process to fulfill task  $T_y$  in OM or user think that he/she has better solution to accomplish  $T_y$ , he/she can start activates one by one and accomplish task this way. MA monitors those activities and creates process as already described, this way other people can use created process and knowledge of other people.

### 3.2 Technology Used

Pellucid is agent based system requiring Multi-agent System (MAS) platform. Several MAS were evaluated and 3 MAS systems were recommended:

- Grasshopper – commercial MAS supporting FIPA and MASIF standards, developed in Germany [4]
- JADE – Academic MAS supporting FIPA standards, developed in Italy [5]
- Aglets – commercial MAs from IBM Japan, currently open source [6]

All of those platforms are Java based. Java is very good programming language for MAS, because supports following features:

- supports migration of classes
- interfaces for ACL, KQML communication (message passing) are available
- XML support
- platform independent (great for heterogeneous environments)
- SQL interfaces to DBMS systems
- development environments available (e.g. JBuilder)

Pellucid will be based on following standards:

- FIPA ACL - Agent Communication Language & other FIPA standards [7]
- MASIF (based on CORBA)
- Workflow Management Coalition Standards [2]
- RDF, XML - eXtensible Markup Language

## 4 Conclusion

When Organization wants to install WfMS creation of processes is consuming time and money the most. The same can be said about reengineering workflow processes later when WfMS is already running. Pellucid architecture helps create and recreate workflow processes. Pellucid can integrate several WfMSs. Usually not all the employees are working with WfMS in an organization; however all the employees are involved in workflow of the organization and many of those not using WfMS, use computers anyhow. This is because WfMS does not support all the software or WfMS is used only for document flow etc. In this case, programmers can create activity agents of agent based workflow which would fulfill gaps in WfMS. Those agents can migrate to certain users ask them for information or provide some real work activity. WfMS is defined as automation of workflow but with no intelligence. PAA in our architecture adds intelligence because it use graph algorithms to find the best process to accomplish tasks. MA provides also data mining techniques on historical data in OM and organizes knowledge in OM, so when PAA search for the best solution, activities in process graphs are better valued. However there are many open problems in the architecture such as integration of WfMS, because OM have to be able to read process and activity information and also AAs have to run in Pellucid according running activity in WfMS. Other problem is

user interface, because PAA has one user interface and WfMS has other. Solution is to integrate them together.

This article provides our view on pellucid project before pilot sites of the project were presented. Currently Pellucid prototype architecture looks little bit different because all pilot sites have well defined workflow processes and also they do not need to interact with other workflows, so intra organizational workflow does not have to be supported. Proposed architecture has main benefits with process creation and intra organizational workflow and current pellucid architecture had to focus more on knowledge management assign to current workflow activity such as intelligent contact list, verification of process, critical points and supporting user with intelligent search of data and documents according to current workflow activity of user. However, we view proposed architecture as possible future extensions of Pellucid.

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