

## **A Multi-Perspective Approach for Modeling Workflows**

Zakaria Maamar\*

[zakaria.maamar@drev.dnd.ca](mailto:zakaria.maamar@drev.dnd.ca)

Interoperability Group

Information System Technology Section

Defence Research Establishment Valcartier

2459 Pie-XI Blvd North, Val-Bélair, QC G3J 1X5, Canada

&

Computer Science Department and Research Center in Geomatics

Laval University

Ste-Foy, QC G1K 7P4, Canada

### **1. Introduction**

With the recent advance in information technologies, such as the Internet, organisations face, at different levels, several types of challenges. At the external level, organisations have to remain competitive, when offering services to their customers and satisfying these customers' needs. At the internal level, organisations have to be able to react quickly and efficiently to the events that occur, for example the arrival of a new competitor on the market or the development of a new technology. In order to assist organisations, their business processes have to be well defined in order to meet flexibility, adaptability, and scalability requirements. To this end, WF technology seems to be a promising approach to define, enact, and monitor organisations' processes. According to the workflow management coalition, a WF is defined as "the automation of a business process, in whole or part, during which documents, information, or tasks are passed from one participant to another for action, according to a set of procedural rules". WF technology is used in several application domains, eg. manufacturing [1] and healthcare [2].

Furthermore, with the recent progress in programming languages for distributed applications, such as Java, and communication middlewares for these applications, such as Object Request Brokers (ORBs), advanced approaches for modeling WFs are required. These approaches have to integrate in a common framework the relevant aspects of an organisation, for instance distribution - where do the operations take place, role - who is responsible for executing these operations, and resource - what do these operations require. In this position paper, we present the 6-P approach that aims at modeling a WF as a combination of six interacting perspectives, namely process, role, resource, information, place, and finally time. In the 6-P approach, a WF is analysed according to each perspective. Then, the obtained perspectives are gathered together to constitute the WF global-model. Here, a perspective means a view.

At the Defence Research Establishment Valcartier (DREV), we aim at modeling and, eventually, automating the processes that are involved in monitoring air space. The Fighter Operations Center (FOC) is responsible for this monitoring. FOC consists of an executive element and a support staff. The support staff has two groups: G3 Operations and G3 Plans. Currently, the different groups carry out their operations manually. For example, monitoring an area of operations requires from a soldier to detect events, analyze the gathered information, and produce documents. At DREV, we believe that it would be more appropriate if such operations could be "packaged" into multiple WFs. In this position paper, we briefly illustrate how the 6-P approach has been used in modeling the FOC's processes, in order to constitute the appropriate WFs.

### **2. The 6-P approach**

This section is decomposed into three parts. The first part consists of an overview of the 6-P approach. The second part focuses on role perspective, because of the organisational flavor of this perspective. Finally, the third part illustrates an application of the 6-P approach to FOC.

## 2.1 Presentation

The 6-P approach comprises six perspectives (Figure 1): process (WF core), role, resource, information, place, and time. Each perspective is supported by a meta-model that consists of several meta-concepts. According to the application domain, eg. FOC, the meta-concepts are instantiated. We recall that a WF is a set of processes, which themselves are a set of primary tasks. In what follows, the several perspectives are explained:

- Process perspective: focuses on the tasks that constitute a process and on the execution chronology of these tasks. The process perspective represents “What to carry out” in a WF.
- Role perspective: focuses on the organisational actors that participate in the execution of a process. The role perspective represents “Who is responsible for” in a WF.
- Resource perspective: focuses on the software as well as hardware means that are committed to achieve the execution of a process. The resource perspective represents “What to use” in a WF.
- Information perspective: focuses on the data that are manipulated by a process. As with the resource perspective, the information perspective represents “What to use” in a WF.
- Place perspective: focuses on the distribution of the execution context of a process. The place perspective represents “Where to carry out” in a WF.
- Time perspective (gathers the other perspectives): focuses on the progress of the execution chronology of a process, according to a time scale. The time perspective represents “When to carry out” in a WF.

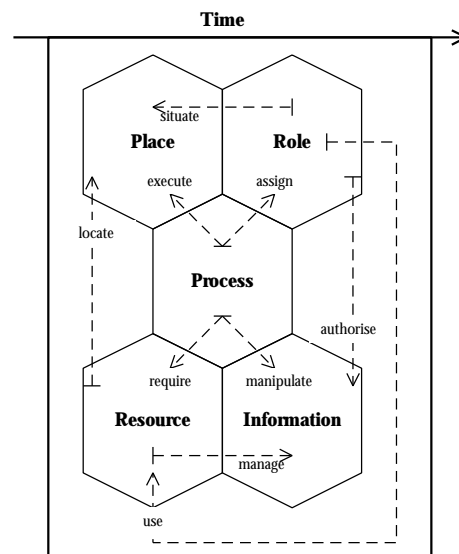


Figure 1 Representation of the 6-P approach

In the 6-P approach, the different perspectives are in interactions (Figure 1, dashed lines). In what follows, we describe the relationships that support these interactions, except the interactions that involve time perspective. Nine relationships are identified and summarized as follows:

- Assign(Process-Role): a process is assigned to actors that have roles in the organisation.
- Execute(Process-Place): a process is executed in several places of the organisation. Thanks to the place concept, the distribution aspect, particularly for a multi-organisational case, can be illustrated.
- Manipulate(Process-Information): during its execution, a process manipulates several input as well as output information. In addition, the execution chronology of a process depends on the values taken by these information.
- Require(Process-Resource): in order to be completed, a process requires several types of resources.
- Situate(Role-Place): a role is situated in a place of the organisation.

- Manage(Resource-Information): a resource manages several information that are available in different formats.
- Locate(Resource-Place): a resource is located in a place of the organisation.
- Authorise(Role-Information): a role is characterized by the information it is authorised to access, whether in read, write, or read/write modes.
- Use(Role-Resource): in order to carry out its responsibilities, a role uses several resources.

In Figure 1, time perspective represents a framework that gathers the other five perspectives. Indeed, time perspective requests periodically these perspectives about their internal states, such as the tasks in progress from the process perspective, the committed resources from the resource perspective, the involved actors from the role perspective, etc. This provides a snapshot of the WF progress. In the 6-P approach, intelligent components, called software agents [3], support the perspectives' management and interaction. Therefore, six types of agents are needed (Figure 2): Process-Agent, Role-Agent, Time-Agent, Resource-Agent, Place-Agent, and Information-Agent. Each agent is associated with a perspective.

- A Process-Agent, considered as the WF engine, is responsible for process and task manipulation. Hence, this agent deals with all the aspects that are related to a process, in terms of initiation, assignation, monitoring, adaptation, and validation.
- A Role-Agent acts on behalf of an actor who fills a role in the organisation. This agent manages details regarding this actor, in terms of availability, experience, and background.
- An Information-Agent is responsible for information management. Hence, all the requests of using as well as updating information have to go through this agent. Moreover, the Information-Agent avoids conflicts on information, by dealing with concurrent operations.
- A Resource-Agent acts as a proxy on a resource and hence, manages its period of use. Furthermore, this agent supports the well functioning of a resource, by requesting its maintenance when it is needed, for example
- A Place-Agent identifies a place and its content, in terms of roles, resources, and information. Moreover, this agent returns information on a place's position, such as floor number, with respect to other places of the organisation.
- A Time-Agent is in charge of invoking the other perspectives, through their respective agents. The purpose of this invocation is to know the WF progress.

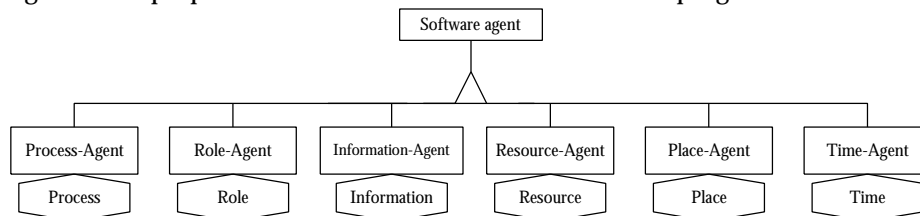


Figure 2 Software agents in the 6-P approach

## 2.2 Role perspective

In the 6-P approach, role perspective identifies the roles that will participate in the WF execution. Generally, a role identifies a position that is filled by one or several actors. These actors meet this role's requirements.

Figure 3 presents a meta-model of the role perspective. This meta-model is decomposed into two levels: conceptual level with role, requirement, and service classes, and domain level with actor and qualification classes. Role class is an abstract description of a position, eg. plan developer in FOC. In the same figure, a role is in relation with other roles through supervise/supervise-by relationship. In an organisation, supervision means authority. A role is associated with responsibilities to achieve, by using different resources (link to resource perspective). In Figure 3, service class identifies responsibilities. In FOC, responsibilities may include air plans and air

tasking orders. Performing the services of a role means that a WF has been initiated. Actor class represents either a moral or physical entity, eg. Capt. M. James, who is going to play a role. Requirement class describes the aspects that are needed to fulfill a role, in terms of expertise, technical background, and years of experience. Finally, qualification class represents actors' abilities to meet roles' requirements.

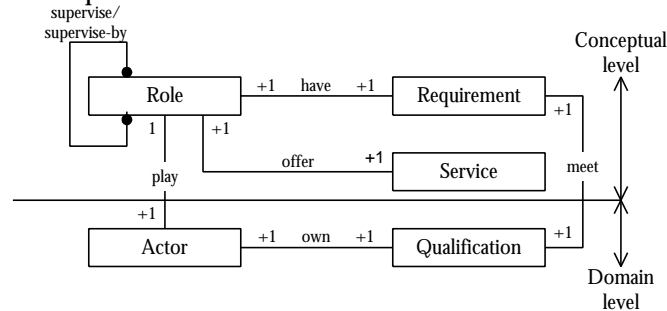


Figure 3 Meta-model of role perspective

When a task is initiated for execution by a process-agent, the next step consists of identifying potential actors. Each actor is associated with a role-agent. Once these actors are obtained, two assignation strategies can be used. A first strategy consists of doing an automatic assignation; a process-agent selects appropriate role-agents. To this end, diverse parameters are taken into account, such as actor's availability, actor's workload, task's deadline, and task's priority. A second strategy consists of doing a manual assignation; a person selects appropriate actors, always through their role-agents. As with the automatic strategy, the same parameters of selecting actors could be applied in the manual strategy. In the 6-P approach, the automatic strategy is privileged. Enhanced with appropriate mechanisms, such as negotiation, and taking into account the characteristics of the environment in which they evolve, process-agents could be able to decide to whom assign tasks.

### 2.3 Place perspective

In the 6-P approach, place perspective presents how the execution of a WF is distributed according to the places of the involved organisations. Figure 4 presents a meta-model of the place perspective. In this figure, a place is considered as a geographical position that can be whether an office, a building, or a meeting room (additional types of places could be considered, if needed). Interesting to note that place perspective could be used to illustrate organisational dependencies that concern the decision distribution.

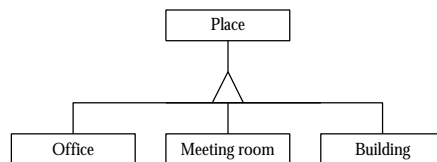


Figure 4 Meta-model of place perspective

### 2.4 Application to FOC

In what follows, the application of the 6-P approach to FOC has been simplified for the purpose of explanation (Figure 5). The WF that we intend to set up, and hence to model, is called battle management. It consists of the following processes: assessment of situation and generation of options. Each process takes place in a specific building; assessment of situation in building<sub>A</sub> and generation of options in building<sub>B</sub>. Assessment of situation process consists of two tasks: evaluate events and compile resources. Generation of options process consists of three tasks: identify options, evaluate resources, and select an option. Building<sub>A</sub> and building<sub>B</sub> contain respectively two offices and one meeting room. In what follows, we focus on evaluate events task. A soldier who plays the monitor role carries out this task. He uses sensor application – version 1.3- that runs on top of a PC station. This application receives formatted messages from

remote sensors, parses these messages, and finally updates appropriate data, among them event type and event priority. According to time perspective, the state of battle management WF at  $T_1$  time is as follows:

- Involved processes/tasks: assessment of situation/evaluate events.
- Involved roles: monitor.
- Involved resources: PC station, sensor-application -version 1.3-.
- Involved places: Office<sub>1</sub>.
- Involved information: event\_type, event\_priority.

Once evaluate events task is completed, compile resources task is launched. Another soldier who is in office1 carries out this task. However, to carry out this task successfully, this soldier has to move for security reasons to office<sub>2</sub>, in order to use personnel application that accesses personnel database. In Building<sub>B</sub>, select an option task of generation of options process is handled by the commander and his executive element at  $T_3$  time. This task takes place in meeting-room<sub>1</sub>.

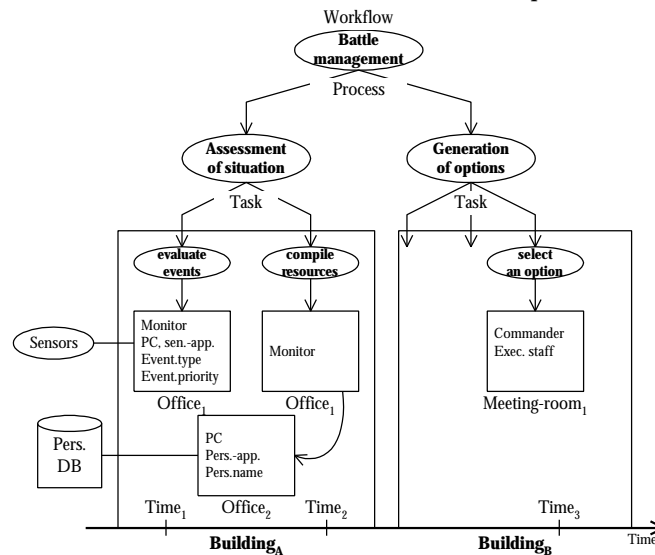


Figure 5 Application of 6-P approach to FOC

### 5. Summary and Future Research

In this position paper, we outlined the 6-P approach for modeling WFs that relies on six perspectives, respectively called process, role, resource, information, place, and finally time. Software agents that assess their environments before committing themselves manage these perspectives. The approach is applied to model FOC's processes.

Furthermore, the proposed approach could be used in other application domains, in which distribution and adaptability constraints should be dealt with. For instance, the place perspective supports distribution while role perspective and software agents support adaptability.

Currently, the 6-P approach has been used in the context of one organisation. Further work needs to be done in multi-organisational contexts. The following perspectives could be subjects of research:

- Role perspective: in an organisation, roles interact together; they invoke their respective services. Such invocations have to take into account authority as well as cooperation relationships that could exist between roles. Interesting to analyse situations in which roles belong to different organisations. Normally, agreements should dictate how roles should behave, for instance by specifying who is authorised to answer whom? To this end, a social network, linking the role perspectives, should be built.

- Information perspective: in order to handle process interactions in a multi-organisational context, representation formalism, such as XML, of the data to be exchanged should be used. Furthermore, semantic conflicts because of information heterogeneity should be dealt with. To this end, a semantic network, linking the information perspectives, should be built.

### **References**

- 1 C. Hanachi and Z. Maamar. "Database Agentification for Flexible Workflows", *in The 3rd. World Multiconference on Systemics, Cybernetics and Informatics and the 5th. Int. Conference on Information Systems Analysis and Synthesis, session on Agent-Based Collaborative Design and Manufacturing*. Florida 1999.
- 2 J. Sutherland and S. Alpert. "Big Workflow" for Enterprise Applications, *in* Patel, D., Sutherland, J. & Miller, J. (eds.), *Business Object Design and Implementation III: OOPSLA '99 Workshop Proceedings*. Springer-Verlag. Denver 1999.
- 3 N. Jennings, K. Sycara, and M. Wooldridge. A roadmap of agent research and development. *Autonomous Agents and Multi-Agent Systems*, 1(1):7-38, 1998.

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\* The different aspects presented in this article are those of the author and should not be interpreted as representing the official policies of DREV.