Activity Planning and Management in Business Organizations

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Abstract -- New models and new tools are needed for analyzing and improving strategic and operational decisions within an extended enterprise. This paper proposes to exploit the expressiveness of UML diagrams to facilitate the analysis of the enterprise processes involved in activity planning and management. An extended enterprise is decomposed into business units which exchange data, negotiate and collaborate. The distribution of work among business units results from a negotiation process, which is analyzed through the sequence of messages exchanged by the business units. The internal elements of a business unit perform functions, such as: activity analysis and decomposition, task evaluation and monitoring.

1. INTRODUCTION

In both the manufacturing industry and the sector of services, the increasing complexity of a modern enterprise mainly results from an important number of different actors concerned by the activities and from the distributed nature of information and commercial networks. The progress of information technology and telecommunication media has generated new business opportunities, new organizations of work and resources, and new definitions of the boundary of an enterprise. In particular, the concept of extended enterprise stresses the importance of relations between a company and its business partners: customers, retailers, subcontractors, employment agencies, banks, shareholders, and so on.

Business organizations are also subject to rapid structural changes as a result of dynamical evolutions in the global market economy. The effort to manage and master such complex systems has led to proposing new models and new methods to describe the organization of an enterprise, not only in terms of product flows, but also in terms of information flows and decision processes. The importance of this trend, specially in the USA and in Europe, is well illustrated in the book [1] which presents several enterprise modeling approaches proposed during the last decade.

In this paper, it is proposed to use the generic term "business unit" to describe any elementary group of people and/or machines, who is related to an enterprise and performs tasks in relation with some business activities. Each activity is under the responsibility of the decision module of a business unit, which decomposes the activity into tasks, assigns these tasks to business units, and manages their execution. The system is analysed using UML diagrams [2] and some "agent" concepts.

However, the considered agents are active groups with human beings, hardware and software objects, used to support negotiation and decision. Here, in the description of a network of business units, the multi-agent approach is used as a paradigm rather than in the strict sense of [3].

For each activity of the enterprise, the deciding unit decides the assignment of tasks to business units after a negotiation on requirements, resources, and rewards. A UML view of such complex collaborations may contribute to an integrated characterization of the enterprise, by representing interactions among the specific processing tasks of different business units, specific activities being modelled using business objects and business rules, as defined in the OMG (Object Management Group) project [4] and [5].

The negotiation process analyzed in this paper is general. It can be applied to autonomous partners looking for an association in a joint venture. But, it can also represent hierarchical cases, in which requirements are imposed. In such cases, the negotiation reduces to simply evaluating the ability of the business units to meet the requirements. An illustration of the last case can be found in the automation of large industrial complexes [6].

II. BUSINESS UNITS

A business unit is a basic component of an enterprise. It performs tasks related to the activities (or projects) of the enterprise. Each activity is under the authority of a particular business unit, which acts as a deciding unit for this activity.

An activity is decomposed into tasks. An activity itself can be seen as a (macro-)task. From an external viewpoint, a task can be described by its requirements. In relation to each of its assigned tasks, a business unit may have more or less decision authority (over other business units) and execution autonomy. Typically, a department in a company is a business unit with a high degree of decision authority and execution autonomy in most of its activities, whereas a production unit, such as a pool of machines or a manufacturing shop, generally has less decision authority. Depending on the considered task, it may or may not have a high degree of execution autonomy.

A business unit has three main functions to perform: decision, evaluation and execution. These functions can be
concurrently performed, using the resources and methods available. A business unit has resources, that it allocates in the most efficient way to the tasks which are under its responsibility, as a result of negotiations with other business units.

The negotiation part of a business unit prepares its tactical and strategic decisions with the help of specific software tools. Some software tools are designed to collect and process real-time information on the current state of resources and tasks. A knowledge management system is used to support its execution proposals in terms of duration, cost and quality. Other business objects prepare the negotiation data and the communication with different business units.

The software executive part of a business unit can be modelled by using the business object architecture (BOA) of the Object Management Group (OMG) [4], [5], [7]. BOA is based on the concepts of business objects and business rules. A business object is a computational abstraction representing an entity of the real world utilized in a particular business domain application. It covers many different kinds of elements, such as: a product, an employee, a payment order, an invoice, the production capacity, etc. A business rule is a statement about how the business is done [8], generally represented by a three components rule as defined in active databases [9]. These components are event, pre-condition, and action (EPA). An event is an instantaneous happening of interest to the enterprise and is attached to a time point, pre-condition defines what has to be checked before the action, and action determines what has to be done [10].

III. ACTIVITY PLANNING

The business unit in charge of organizing an activity can perform three functions.

1. It sets the basic requirements and rewards associated with an activity, partitions the activity into tasks and enumerates the specifications, the goals and the possible execution units for each task. The global requirement analysis is performed by the job analyzer. It leads to a decomposition of the activity into tasks. Some of the strategic objectives (requirements) for a task are technically well defined in the form of specifications. The other objectives can be denoted as "goals". They relate to performance criteria such as cost, quality, cycle time, and so on. Desired values are established for each criterion. Following a description proposed in [11], the two types of strategic objectives for a task, named specifications and goals, can be represented by two different boxes, as on figure 1, using the UML formalism [12].

2. Once a task has been defined by a job analyzer, the information on its requirements and rewards becomes available to business units. After an evaluation process which results in a recommendation from the evaluation unit, the decision unit may emit a task execution proposal, as represented in figure 1.

3. Task execution proposals emitted by various units are compared with each other and with the current tasks requirements and rewards defined by the job analyzer. The business unit who defined the task is also responsible for its assignment for execution (what, who, and how). A negotiation may then take place between the business unit which is the task manager for this task and the business units candidates for executing the task. The decision on who and how is finally taken by the task manager and the execution stage may start for this task.

In relation with a particular task to be executed, a business unit has four states named: evaluation, negotiation, decision, and execution/supervision, which can be observed in figure 2. These states are represented by rounded rectangles identified by their names. A black circle and its name indicate the initial state. Transitions between states are represented by arrows, to which is associated a named event representing the entry/exit action between the states. Each action can have an associated condition in brackets. The task is identified by t, a result by r, a partial result by pr, and a correction by c. The execution/supervision state is considered a "superstate" containing two "substates" named execution and supervision. The final state is called taskFinished and it can be reached by the completion of the task or by the decision to abort the task.
IV. THE NEGOTIATION PROCESS

Prior to selection of one or several business units for completing the tasks of an activity, a negotiation process often has to be performed. The negotiation process is initiated and conducted by the business unit having the responsibility of the considered activity.

A. The evaluation phase

A business unit candidate for the execution of a task, analyzes the strategic objectives of the task and evaluates its own possibility to meet these objectives. Such an evaluation is performed by the evaluation unit on the basis of the response of a behavioural model. The processing capability of the unit are evaluated on the basis of its knowledge and experience, taking into account the current and future states of its resources. The evaluation stage uses the task specifications as inputs and if the task execution is judged possible and valuable, the unit produces a proposal as close as possible to specifications. The heart of the evaluation unit is the behavioral model, which can either be a knowledge-based system for a large business unit and for complex specifications, or, in simpler cases, a simple software performing the matching between specifications and performance. The main elements of the evaluation unit are represented on figure 3.

A typical evaluation phase is described on figure 4. The internal loop adjusts the internal requirements and the model so as to produce the best proposal to meet the external requirements.

This phase is initiated by receiving a task specification from a Requirement object in the EvaluationUnit object, which fires the evaluate operation in the BehavioralModel object. The evaluation process uses the task specification and its internal requirements to produce provisional results that are sent back to the EvaluationUnit object to initiate the comparison process. This last process compares the provisional results with task specification returning either a proposal or a positive response, which is communicated to the DecisionUnit object.

Figure 2. State-transition diagram for a task.

Figure 3. Elements of the evaluation unit.
B. The negotiation phase

If the result of the evaluation phase meets the requirements for a particular task, then the candidate business unit gives a positive answer to the deciding business unit. If the evaluated results do not meet the requirements, then the candidate business unit may answer in the form of a proposal for feasible requirements. A negotiation may then take place between the two business units, in particular when proposals are unable to meet requirements or when competition between business units is severe. The deciding business unit can modify the requirements until eventually reaching an agreement on a new proposal.

A typical negotiation phase is represented on figure 5. It is initiated by the candidate business unit. However, a negotiation can also be initiated by the deciding business unit. In the latter case, the negotiation phase is initiated by the negotiate operation, which runs until having reached an agreement for both units.

C. The decision phase

At the strategic level for an enterprise, the main decision is whether or not the company should perform a particular activity. Such a decision is taken by the business unit responsible for the analysis and organization of this activity. It is based on the outcome of the negotiation processes between this business unit and all of the business units candidate for executing tasks that belong to this activity. Extending the limits of an enterprise to potential partners, suppliers and subcontractors, increases the competitiveness of task execution proposals. It also provides more opportunities for the negotiation processes to converge. Ultimately, the quality and profitability of the activity can be improved in the context of the extended enterprise, provided that the activity management does not become too complex and the risks of failures too high, as it is often the case in collaborative projects.

As long as a decision to execute cannot be taken, the negotiation phase may keep going. However, within each business unit, the use of resources should be balanced between the evaluation unit, the decision unit, and the execution unit. The question of whether or not each business unit of an enterprise should generate a profit does not have a general answer, but some constraints on resources should be active in all the business units.

Once the decision to perform an activity has been taken, the deciding business unit takes the assignment decision for each task on the basis of one or several criteria.

Each business unit has resources at its disposal, such as workforce, machines, money and materials. As shown on figure 6, it may allocate some of these resources to other business units to complete tasks, which can be services, studies or production.

V. ACTIVITY MANAGEMENT

Once the decision to perform an activity has been taken, the tasks which have been assigned to business units may start, provided that resources and input products are available and
that precedence constraints between them are satisfied. Task execution is under the responsibility of the particular business unit which has been selected for performing it. As represented on figure 7, the main execution elements for the executing unit are resources and requirements.

A. Task execution

In the execution phase of a task by a business unit, internal and external resources may be utilized to meet the task requirements. An execution phase is described on figure 8. The execution phase begins when the ExecutionUnit object receives the authorization to use some resources in the task execution.

The ExecutionUnit object monitors this phase until the message of a successful completion is sent to the Result object. Some task executions may also involve exchanges of data and collaboration between different business units.

B. Collaboration between business units

In [13], four typical architecture templates are introduced to describe the collaboration between the business units in the execution phase: sequential, parallel, integrated, and distributed. The process architectures are constructed by mapping the process representation into templates. By nature, collaboration mechanisms are difficult to represent with precision, mainly because of the human interactions that they imply. Externally, their requirements are incomplete, and internally they are harder to monitor. Collaborative tasks are often created to perform a highly qualified multi-disciplinary work. Their outcome may be difficult to predict, in terms of time duration and quality.

C. Activity execution and supervision

The business unit in charge of an activity management obeys the same scheme of authorization, monitoring and report as for task execution. However, the monitoring phase involves sequencing, co-ordination and supervision of the tasks which compose the activity. It compares the actual results to the expected ones as they were defined by the requirements. It may even modify some specifications and the resource allocation policy to compensate for real-time disturbances and minimize the risks of project failure.

As shown in figure 9, a business unit compares the actual results to the expected ones and adjusts accordingly its policy for resource allocation and reward allotment.

V. CONCLUSION

Considerable modelling efforts remain necessary to better understand and analyze a modern enterprise, specially under an extended vision of its limits. The models proposed in this paper have been extracted from the description of real cases, but they tend to grasp some general mechanisms, to better understand the nature of interactions within the enterprise and communication between suppliers, sub-contractors, and distributors. An extended enterprise is not just larger and more complex than a traditional one. It is also more open to changes and reconfiguration. This openness sheds light onto some
processes and mechanisms which are present in traditional enterprises, but which have been often institutionalized or masked by hierarchy or routine. Among such mechanisms, one of the most important ones is negotiation. Although it has been recognized by sociologists as a basic ingredient in human communities, it is rarely studied in the context of an enterprise. However, the fact of identifying negotiation as one of the most basic mechanisms for decision, has allowed to better articulate the organization of activities through the stages of requirement analysis, evaluation, resource assignment, and execution.

VI. REFERENCES