Business Process Modeling in UML for Interactive Digital Television

Paloma Maria Santos, Marcus de Melo Braga, Marcus Vinícius Anátocles da Silva Ferreira, Fernando José Spanhol
Post-Graduate Program in Knowledge Management and Engineering – Federal University of Santa Catarina
Campus Universitário, Trindade, Florianópolis/SC, Brazil
paloma@egc.ufsc.br, marcus@egc.ufsc.br, marcus.ferreira@hotmail.com, spanhol@led.ufsc.br

ABSTRACT
The modeling of business processes related to Interactive Digital Television is still an under explored research area in the literature. This paper discusses the application of Unified Modeling Language (UML) and its extensions to the modeling of business processes in the Digital Television environment. The modeling technique proposed here is applied to a particular t-Government case as an illustration. The application of this technique enables the project's graphic representation and facilitates the understanding of modeled business processes, thus contributing to its implementation.

Keywords
Business Process, Modeling, Interactive Digital Television (iDTV), Unified Modeling Language (UML).

1. INTRODUCTION
Business Processes (BPs) can be defined as a sequence of steps conceived to make products and services available to a customer [1]. By and large, iDTV models bring about meaningful changes to traditional BPs that are created for a particular environment. When applied to a digital context, these changes require a more dynamic view of the BPs due especially to the inclusion of new actors and stakeholders into the new model. Therefore, the conceptualization of new modelling forms are needed with a view to reflecting this structure and enabling a greater understanding of the processes linked to iDTV.
One of the suitable tools for BP modeling is the traditional Unified Modeling Language (UML). UML can be applied to various modeling types for presenting a high level of generalization and extensions that expand its applications. This study specifically addresses the modeling of business processes, using the extension mechanisms proposed by [2]. According to [3], UML can be used as a knowledge modeling technique.

Section 2 presents the concepts related to the modeling of processes that are needed for the understanding of the proposal suggested here. Section 3 shows an application of the technique developed for the modeling of iDTV BPs, considering the use of UML extensions. Finally, Section 4 discusses the main findings and points to some final considerations.

2. BUSINESS PROCESS MODELING
To facilitate the identification and modeling of BPs, [4] suggests a set of questions adapted from the proposal presented by [2]:

- **Which activities are involved?** They will be described as processes or activities in the diagram.
- **When are the activities performed and in which sequence do they occur?** This information will correspond to the flows in the chart.
- **How are the activities performed?** This will be mapped in the process flow chart, usually by decomposing the processes into subprocesses.
- **What is the aim of the process?** This will be mapped in the process diagram.
- **Who or what is involved in the execution of activities?** This information refers to the resources that participate in the process.
- **What is consumed and produced?** This information refers to the resource that will be consumed or produced in the process.
- **How are the activities to be performed?** This question is defined by a flow control in the process or by a set of business rules.
- **How does the process relate to the business organization?** This can be shown by means of *swimlanes* in a process diagram.

[2] proposes an integrated view on the context of BP modeling by means of a set of stereotypes that seek - with the support of four views and their respective diagrams - to reflect upon the environment and organizational structure that will be supported by the modeled systems. The four views proposed are described as follows:

1. **Business Vision** deals with the presentation of business requirements. It is the starting point of the modeling business process. It is under this view that the business goals are recorded;
2. **Business Structure** details the resources (physical, human, or information) that the company consumes, utilizes or produces;
3. **Business Process** is the business modeling core. It shows the activities performed to achieve the goals as well as obtain the resources needed to do so;
4. **Business Behavior** gives details of the way in which resources and processes behave over time.

The combination of these views forms a comprehensive business model, and depending on the project needs some of these views can be suppressed.

According to [2], the essential elements for the description of a business process are:

- **Resources** represent everything that a company consumes, utilizes, refines or produces and they are manipulated by processes or they manipulate and manage these processes. Resources can be categorized as physical, abstract, informational and personnel;
- **Processes** represent the business activities performed in a business in which the state of the resources changes. These processes are delimited by rules and they describe how the work is performed;
- **Goals** represent the general purpose of a business or the results that a business is expected to achieve. They express the desired state of resources and they are reached by executing processes;
- **Rules** represent the definitions or restrictions of any business aspect. They are categorized as functional, behavioral and structural.

All these elements are related to each other. The business goals are achieved by executing the processes that use, transform and generate resources, following a set of rules. This way, the goal of business modeling is define these elements and show the interactions and relationships among them [2].

BP modeling can be realized from the perspective of 4 UML diagrams and their extensions: (i) business process diagram; (ii) assembly line process diagram; (iii) use case diagram; and (iv) activity diagram.

2.1. Business Process Diagrams

According to the extensions proposed by [2], a business process diagram extends the UML activity diagram and is determined along with the stereotypes that describe the activities performed in the business process and their interactions, events, resources, goals, outputs, rules and process information (Figure 1).

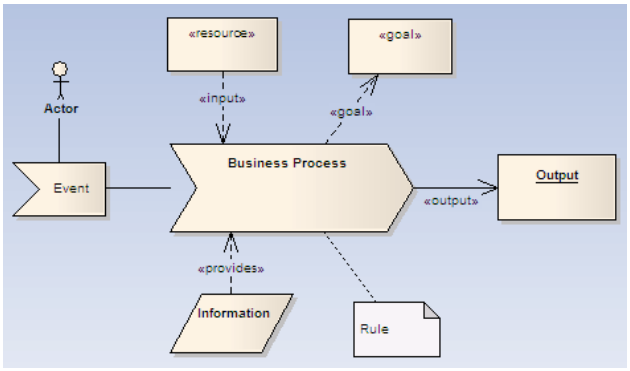

Figure 1 - Business Process Diagram.

In this diagram, the actors of a process interact with it and generated events that affect the system behavior and its execution. A resource is an object that operates or is used for business, and it can be consumed, transformed, produced or utilized by the business processes. A link of the <<provides>> type means that the object is not consumed, but used in the transformation processes. A link of the <<input>> type, in turn, indicates that the object is consumed. The stereotype of the central element (i.e. the business process) has a traditional process icon and indicates that the flow of activities will move from left to right. A rule is an essential complement that aims to guarantee the representation of information related to the business functioning [4]. The goal (stereotype <<goal>>) is the reason by which an organization adopts a process and it is linked to it by means of a dependency-type relationship [5]. By definition, every process has at least one output that can be a business result, a physical object (e.g. a report), or the transformation of resources in organized objects (such as a daily schedule) [5].

A link of the <<output>> type indicates the output flow of a process. The diagram illustrates the information inputs and outputs that are read and recorded by systems, showing how they enable (or impact upon) a business process.

2.2. Assembly Line Diagram

The assembly line diagram is a variation of the process diagram and is particularly useful for those processes that are directly implemented by information systems [2]. The processes communicate with the system packages called assembly line packages by means of interactions that record the flows between the information system and the business process. These interactions also define the use cases to be foreseen by the information system [4].

The goal of this type of diagram (Figure 3) is demonstrate how processes interact with the information system in order to show what information is accessed by means of the system and used by the processes [2]. The assembly line diagram enables the connection between BP modeling and system requirement modeling based on use case [2].

2.3. Use Case Diagram

The use case diagrams (Figure 4) are used to identify and model the context by visualizing the scope and elements of the problem domain and modeling the system requirements that include a set of tasks that lead to an understanding of the system impact upon business, customer's needs, and interaction of the final user with the system [6].

2.4. Activity Diagram

Activity Diagrams (Figure 5) facilitate the representation of interaction flows in a way similar to that of a diagram. Rectangles represent functions, arrows correspond to system flows and decisions, and diamonds represent decisions [6]. In possession of these four diagrams, it is possible to apply UML to BP modeling in the iDTV environment.

3. APPLYING UML TO AN iDTV BUSINESS PROCESS

To apply BP modeling to the context of an iDTV model, we provide a t-Governament application as an illustration. In this context, the four-stage classification for t-Government initiatives proposed by [7] was adopted. These four stages are (i) informational; (ii) interactional; (iii) transactional; and (iv) collaborative. We selected a business process of the collaborative type to better illustrate the kind of modeling purposed here.

The selected process refers to participatory budgeting in the municipality of a city. This process may involve several sub-processes, namely: (i) consult with the accounting of previous years and the investment plan of the municipality for the current year; (ii) verify the information on projects already approved and completed, (iii) send new demands for investment to the municipality, (iv) vote for projects in the municipality, (v) monitor developing projects; and (vi) participate in the choice

of the neighborhood representative. Due to space constraints, this analysis will focus only on the modeling of the subprocess number (vi). A more detailed analysis of the processes involved can be obtained in [8].

The choice of neighborhood representative can be made by means of electronic voting. Every citizen resident of the neighborhood may become a candidate for representative, provided that they meet the deadline set by the government for registration and complete the application form with their personal data and proposed action. The application of t-Government for this collaborative process must enable a virtual keyboard.

After completing the form electronically, the data is routed by the system to a service center (Figure 2).

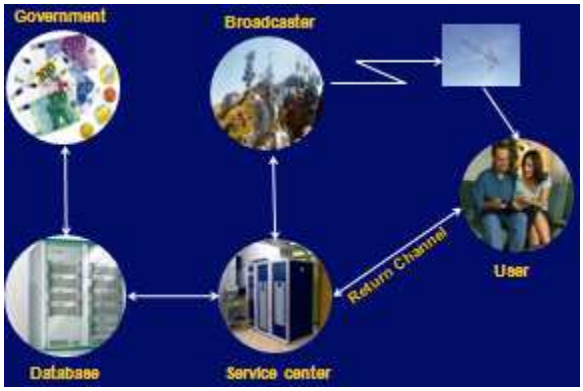

Figure 2 – Scheme for provision of t-Government applications [8].

There, the data is processed and stored in a database. The sector of the municipality responsible for that activity accesses the database, selects the new applications and takes the necessary measures to keep the process going. After being examined, all applications are available for the citizens to vote. The neighborhood, within the period specified for the voting process, analyzes the profile and the proposal for each candidate and votes for one candidate. The vote of each citizen is routed through the system to the service center for further processing and storage. Ended the voting period, the candidadate with the largest number of votes is elected. Citizens can then obtain contact information with the new neighborhood representative and monitor his/her performance, sending suggestions or complaints to this representative.

For this subprocess, the system enables three options: (i) candidate application, (ii) vote for a candidate, and (iii) consultation with the elected candidate. Figure 3 presents the modeling of the voting process.

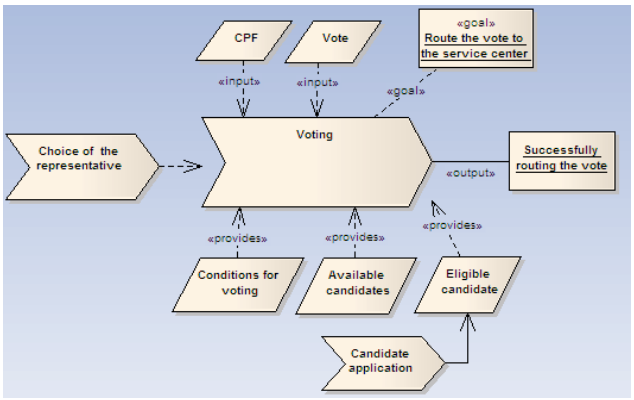

Figure 3 - Voting Business Subprocess Diagram.

Figure 4 shows the Assembly Line Diagram for the voting process.

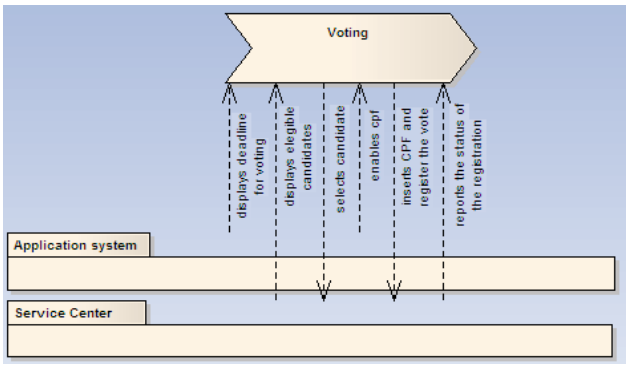

Figure 4 - Assembly Line Diagram for the Voting Subprocess.

Figure 5 displays the Use Case Diagram for the citizen Actor of the voting subprocess.

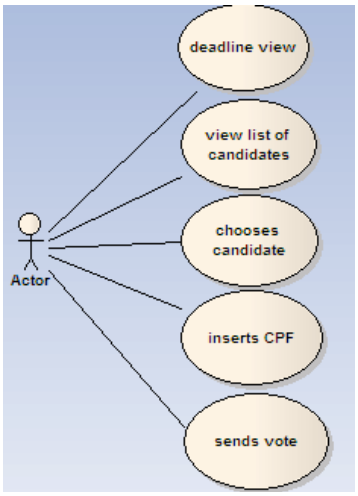

Figure 5 - Citizen Use Case Diagram in the Voting Subprocess.

Finally, Figure 6 presents the Activity Diagram in the Voting Subprocess.

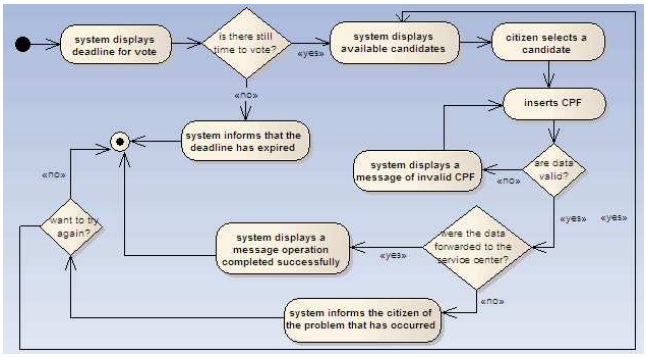

Figure 6 - Activity Diagram related to the Voting Subprocess.

Based on the diagrams above, one can identify the following system requirements for the voting subprocess:

- RQ1 - The system should display the time to vote for the candidate;
- RQ2 - The system, if there is no more time to vote, should display a "deadline expired" message;
- RQ3 - The system, if there is still time, must display a list with information about eligible candidates;
- RQ4 - The system, after the candidate being selected by the citizen, should verify if a return channel is working properly in order to enable a field for CPF [Individual Taxpayer Registry] number insertion;
- RQ5 - The system can only send data to the service center after checking the CPF number inserted;
- RQ6 - The system must inform the citizen about the status of the procedure performed.

4. FINAL CONSIDERATIONS

Generally speaking, the proposed model facilitates the understanding of business processes and the identification of opportunities for improvement. It is worth mentioning that we are dealing here with t-Government applications accessible via iDTV (a fixed device). It is also understood that such applications are not tied to a specific TV program, since they are treated as resident applications, that is, citizens download them from STB TV Channel and can interact with them whenever they want, regardless of the program that is being aired at the moment.
The questions suggested by [4] and adapted from the proposal by [2] served as a guide and proved suitable for the survey of the integral elements of business processes and activities required to implement it.

The application of the BP diagram has enabled us to obtain an overview of all elements participating in the process. No matter if they were resources, goals, rules, events, input or output elements as well as the relationship between them in a single diagram to facilitate the understanding of the process as a whole and assist its implementation.

The Assembly Line Diagram not only highlighted the interaction between business processes and information objects read and written in the assembly line, but also aided the identification of use cases that support the actors of the system and, consequently, in the preparation of the t-Government application requirements.

The presentation of the activity diagram for the illustration provided highlights how the activities that comprise the processes interact among each other and what flow of action is necessary to achieve the goal of the business process.

According to [7], the subprocesses modeled here are all of the collaborative type. These subprocesses require a more advanced view on the government, a new paradigm, completely different from the traditional managerial model in which the citizen is seen as a customer and business perspective seeks essentially for the efficiency and effectiveness of public management.

In this new paradigm, the main value is co-production. The citizen is no longer seen as a client, but as a partner who is actively participating in the process, helping to build public policies, measure and manage government resources.

This new paradigm perspective demands that the government invests in modes of political representation that include new components (e.g. e-democracy, e-participation and e-citizenship) in order to expand the opportunities for citizen participation and interaction in new governmental business processes.

Further studies along these lines may investigate the application of the model in more complex Proposed t-Government applications or in other iDTV applications.

5. REFERENCES

[1] DAVENPORT, T. *Process Innovation: Reengineering Work Through, Information Technology.* Harvard Business School Press, Boston, 1993.

[2] ERIKSSON, H. E.; PENKER, M. *Business modeling with UML: business patterns at work.* New York: John Wiley & Sons, Inc., 2000.

[3] KINGSTON, J.; MACINTOSH, I. *Knowledge Management through Multi-Perspective Modeling: Representing and Distributing Organizational Memory.* Knowledge-Based Systems, Cambridge, april 2000. 121-131.

[4] LIMA, A. D. S. *UML 2.0: do requisito à solução.* São Paulo: Érica, 2005.

[5] SALM JR, J. F. *Extensões da UML para descrever processos de negócio.* Dissertação de Mestrado, Departamento de Engenharia de Produção e Sistemas, Universidade Federal de Santa Catarina, Florianópolis, Brasil, 2003.

[6] PRESSMAN, R. S. *Software Engineering: A Practitioner's Approach*. 5th Ed., McGraw-Hill, New York, Nov. 2001.

[7] KOK, C.; RYAN, S.; PRYBUTOK, V. *Creating value through managing knowledge in an e-government to constituency (G2C) environment.* The Journal of Computer Information Systems, v. 45, n. 4, p. 32-41, july 2005.

[8] SANTOS, P. M. *Modelagem de processos para disseminação de conhecimento em governo eletrônico via TV Digital*. Dissertação de Mestrado. Departamento de Engenharia e Gestão do Conhecimento. Universidade Federal de Santa Catarina, Florianópolis, Brasil, 2011.