Building VECM-based Systems with a Model Driven Approach: an Experience Report

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Abstract. Recently, we took part in a project with two local companies about the creation of a UML-based Model Driven rigorous method to develop VECM-based systems. VECM is a way to abstract from the details of different Enterprise Content Management (ECM) systems used within the same organization. This report details the experience made using our method to develop V-Protocol: a system able to protocol, sign and archive public competition announcements received by a company.

1 Introduction

The authors have been recently involved in the VirtualECM project[1] aimed at developing the VECM technology and a UML-based Model Driven (MD) rigorous method for building systems based on VECM. A VECM-based system (shortly V-System) is a system that uses the VECM software interface (Sect. 2). In a nutshell, a VECM abstracts the basic operations offered by an ECM. An ECM is a system used to capture, manage, store, and deliver enterprise content. It provides operations on documents such as: *createDocument()* and *deleteDocument()*. There are a lot of ECM systems available on the market, e.g., Alfresco (open source), SharePoint (Microsoft), Oracle Content Management (Oracle), and Documentum (EMC).

On the top of this heterogeneous ECM environment, usually, the companies build their systems using several ECM systems characterized by different interfaces; for example, a bank that uses an ECM system to manage credit transfer and another one for loans. Often, the consequence of this practice is the development of a system highly coupled with the underlying ECM systems. The VECM software interface solves this problem. In practice, the VECM allows to develop systems not tied to the specific characteristics of a particular ECM.

In this paper we propose a UML rigorous method useful to develop VECM-based systems (Sect. 3). It follows the MD approach [2] for the development of software systems. In particular, several UML models are created starting from the business process model to obtain a detailed design model that can

[1] VirtualECM project was supported by "Programma Operativo Regionale POR-FESR (2007-2013)", Liguria, Italy

be transformed/refined in a running system. We have applied this method to build V-Protocol, the selected case study for the project, which is a system used to protocol, sign and archive public competition announcements received by a company.

2 VECM and ECM

In this section we explain what a VECM is and report on the factors that have motivated the development of the VECM software interface, which is the aim of the VirtualECM project.

There are a lot of ECM systems available on the market. Even if each of them has some distinguishing features, they provide substantially the same operations often called in different ways and with different parameters.

Usually, in a big company it is possible to find different ECM systems chosen by and used in different branches of the same organization. This can happen for several reasons: for example because different branches of the same company have chosen different ECM systems for money matters, licence or specific characteristics. Thus, a company often has to build a system in an heterogeneous ECM environment using different underlying ECM systems. The result of this practice is a system that interacts with different ECM systems with their own interfaces, languages, and characteristics. Systems built in this way are tightly coupled to the set of used ECM systems, and thus tend to exhibit well-known problems (e.g., difficulties in changing, reusing, and testing software).

That problem can be solved with an additional layer of abstraction placed between the system and the different ECM systems. Such software layer is called VECM, a sort of *virtualization* of ECM systems. In practice, without the VECM a system has to interact with a set of different ECM systems and it has to know their different interfaces; instead, with the VECM a system has to know only the VECM interface. The management of the interaction with the different underlying ECM systems is totally delegated to the VECM. When the system uses a functionality offered by the VECM, it does not to know what type of ECM is actually used. In this way it is possible to replace an ECM with another without problems.

Fig. 1 shows a simplified definition of the functionalities offered by the VECM, which are an abstraction of a well defined subset of operations typically offered by an ECM. As we can see, the VECM operations cover different areas and work on or produce content.

3 The Method

We propose a method for the development of systems based on the VECM that follows the MD approach. The starting point is a UML model representing the target business process including at least an activity diagram and the final result is a detailed design model that can be transformed into a running system. In

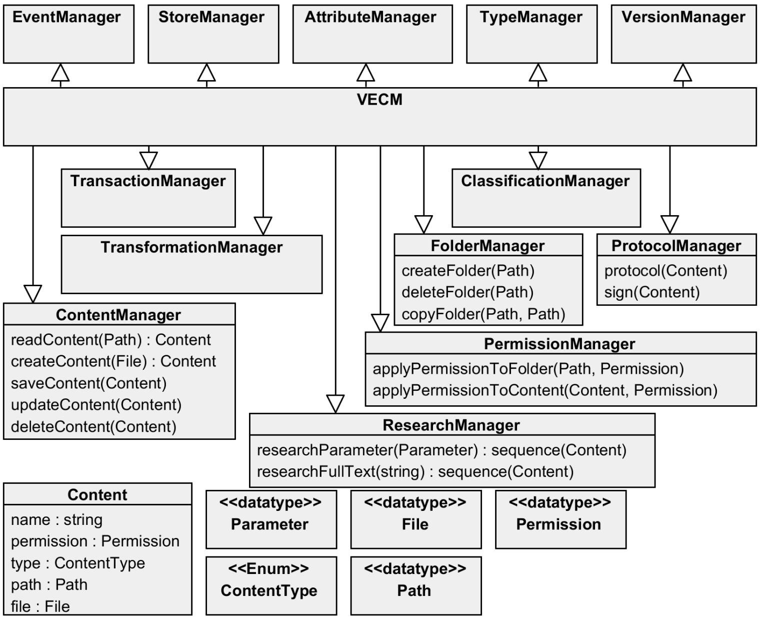


Fig. 1. UML presentation of the VECM functionalities

our method, the activity diagrams used to represent the business processes are created following the "precise style" introduced in [6].

In a nutshell, the "precise style" prescribes that the participants of a business process are explicitly listed and precisely modelled with UML by means of classes. Moreover, the behavioural view of the business process is given by an activity diagram where the basic activities and the conditions are written by respectively using the language for the actions of UML and OCL (the textual language for Boolean expressions part of UML). Thus, our UML precise model of a business process consists of: a class diagram, introducing the classes needed to type its participants, the list of its participants, and an activity diagram representing its behaviour, where all nodes (arcs) are decorated by operations calls (OCL expressions). From a previous study, we have seen that this style improves the quality of the business process models expressed as activity diagrams [5], and that it is better than a "light stile" [1].

The method for developing a V-System consists of four phases:

- Business Process Modelling
- V-System Placement
- V-System High Level Design
- V-System Detailed Design

We present our method using the Protocol case study selected in the VirtualECM project for the realization of a demonstrator named V-Protocol. The system V-Protocol has been developed by the two companies following the above four phases. The Protocol case study is about the management of the announcements of public competitions received by a company. It can shortly be described in this way: "*First an announcement is received by the company and managed by a clerk. Subsequently, the announcement is checked by a clerk to verify its validity, and if it is valid the announcement is protocolled, digitally signed and saved in a repository*".

3.1 Phase 1: Business Process Modelling

The first phase of our method consists in describing the business process/domain "*as it is*", i.e., by means of the UML model called *BusinessProcessModel* that represents the business before the introduction of the system based on the VECM. At this level the UML model has to be close as much as possible to the given description of the business. Participants of the business will have a name and will be typed by a class with stereotype either ≪businessWorker≫ (human being) or ≪system≫ (hardware/software systems). Also the business objects will have a name and will be typed by a class stereotyped by ≪businessObject≫.

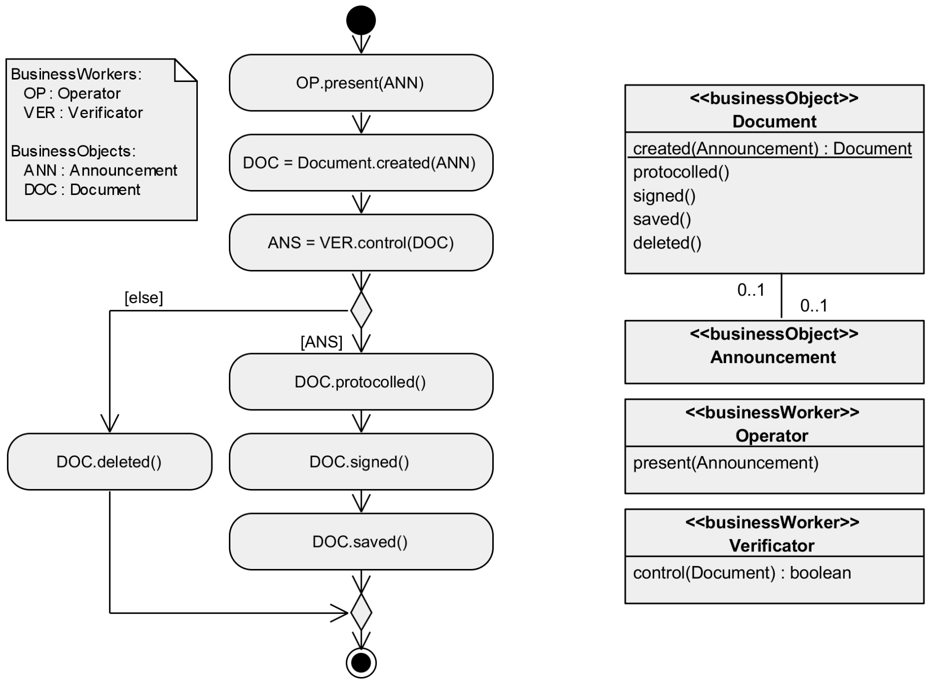
Since it is not possible to use the V-System in the *BusinessProcessModel* and moreover the textual description could be incomplete or quite abstract, in some cases it could be difficult assigning the activities involving a business object to a business worker or to a system (e.g., in the business underlying the Protocol case study, it is not specified who will protocol, sign and save an announcement). In those cases, it is advisable assigning such activities directly to the business objects over which they will be executed. We have decided to describe those activities in the model using the passive form (e.g., DOC.saved() in Fig. 2).

The result of this activity in the Protocol case study is a UML model reported in Fig. 2. That model is composed by two diagrams: an activity diagram and a class diagram. In the activity diagram, as reported in the side note, there are two business workers (the operator and the verificator) and two business objects (an announcement and a document). Note that in the class diagram the operations of Document are given in passive form, and that the created() operation is declared as static because in this phase it is not known who creates the document.

3.2 Phase 2: V-System Placement

The aim of the second phase is deciding which of the activities described in the previous phase will be performed by the V-System. The placement of the V-System is done using a swimlane labelled by the name of the system (in our case V-Protocol). During this phase a set of models are created and finally a UML model called *PlacementModel* is obtained. The activities that have to be performed by the V-System will be placed inside the swimlane, the others will remain outside. It could happen that an activity is not totally of competence of the V-System: in this case the activity has to be subdivided in two or more sub-activities assigned to different participants.
The placement is correct only if the following constraints are observed:

- at least one activity is placed inside the V-System swimlane (no activities in the swimlane mean that the system will do nothing);



(a) Activity Diagram (b) Class Diagram

Fig. 2. Protocol Case Study: *BusinessProcessModel*

- no activities performed by business workers are inside the swimlane (the system cannot replace the behaviour of a human being that it is unpredictable and not computable, e.g., an examiner of future employees or of the artistic value of a novel);
- at least an activity should be placed on the border of the swimlane (such an activity will result in communication between the system and some external entity);
- no activity flow (control and object) can cross the swimlane boundary (a crossing flow means a hidden communication between the system and some external entities).

Therefore only the following types of activities can be placed inside the V-System swimlane:

- passive activity of a business object: this means that the V-System will execute the activity on the object (e.g., DOC.saved());
- activity performed by a pre-existing system: this means that the system under development will replace the existent system in the execution of the activity.

Since that is not allowed to place an activity assigned to a business worker inside the V-System swimlane, if the activity has to be performed by the V-System then it can be placed inside the swimlane only after a model refactoring step in which the activity has to be assigned to a participant stereotyped by ≪system≫ (or ≪businessObject≫ using the passive form). This means that the system will perform an activity that previously was done by a human.

During the placement of the V-System in presence of constraints violations the following cases can occur:

- the placement becomes corrected after performing one or more business process model refactoring;
- it is not possible to refactor the model to satisfy the constraints; in such case the developer has to either change the placement or to conclude that the intended system is not doable.

The result of this phase is the *PlacementModel*, having the form of a *BusinessProcessModel* where part of the activity diagram is included in one swimlane named as the system to develop.

The creation of the *PlacementModel* (that for space limitations we do not report here) for V-Protocol has required a model refactoring step in order to create the activities for the messages exchange between the participants. For example, the activity control(DOC) has been broken in several activities because it involve both the operator and the system.

3.3 Phase 3: V-System High Level Design

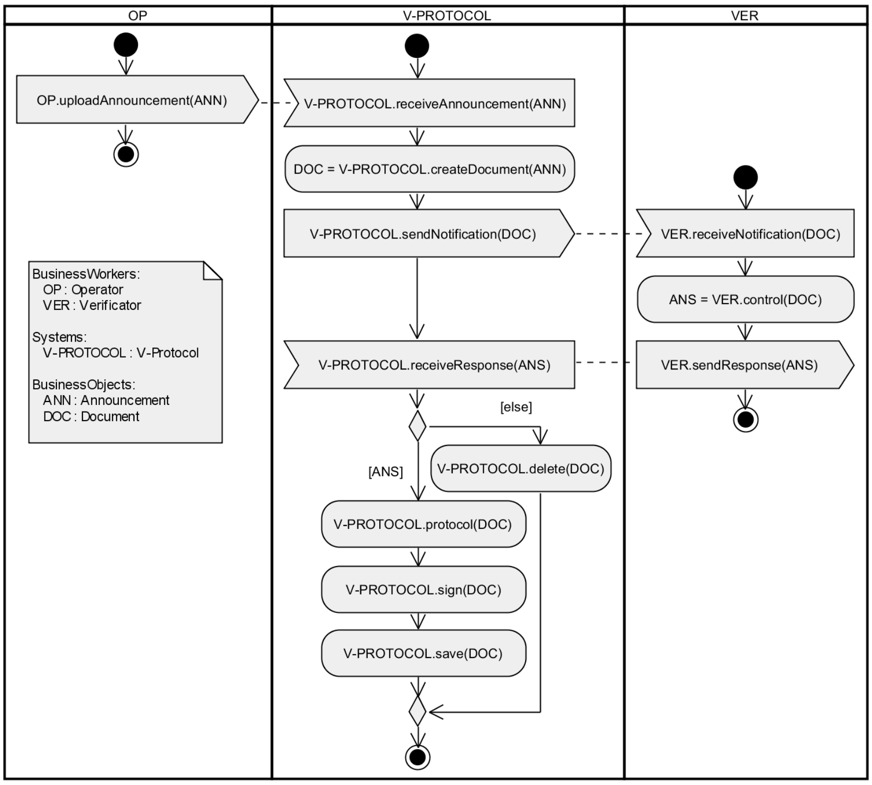
The goal of this phase is providing a high level design of the V-System with a detailed description of the activities carried out by the system. During this phase a UML model called *DesignModel* is produced.

We start from the *PlacementModel* and perform a refinement step. For each participant of type ≪businessWorker≫ and ≪system≫ in the activity diagram we introduce a swimlane labelled by its name. In this model, the involved participants communicate using two type of UML actions: – the call action[2] ( ) used when a participant sends a message to another one and – the accept action ( ) used when a participant receives a message from another one.

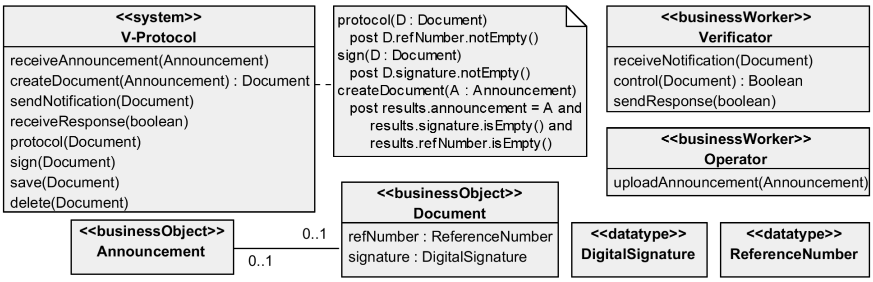
At this level of description, all the activities in the V-System swimlane are reported as executed by the system as a whole. There are no details about the inner structure of the V-System (e.g., information about the number of ECM used).

In Fig. 3 we report the *DesignModel* for the Protocol case study. It contains three swimlanes: one is for V-Protocol and two are dedicated to the business workers that interact with it. The operator, the verificator and V-Protocol perform some actions on the business objects announcement and document. The business process implemented by V-Protocol is triggered by the arrival of a message with attached an announcement (each message exchange is depicted in the activity diagram by means of a dashed line). The starting message is sent by OP (see Fig. 3). The system interacts also with the verificator that checks the correctness of the document. In the end, V-Protocol executes some operations on the document DOC (e.g., VProtocol.save(DOC)) and next the process stops.

[2] We are aware that only send signal actions can be represented in this way, but here we use this icon also for call actions.



(a) Activity Diagram



(b) Class Diagram

Fig. 3. Protocol Case Study: *DesignModel*

In Fig. 3(b), we show the class diagram associated with the activity diagram of Fig. 3(a). The class diagram is used to type and specify the stereotype of each participant and to specify attributes and/or operations of each participant. Moreover, the class diagram can contain datatypes (e.g., DigitalSignature) used to type attributes or operation parameters. The activity diagram created at this level ought to be structured [7] because unstructured diagrams make difficult the translation of business process models into executable models (e.g., written in BPEL [3]) that often offer structured-programming constructs only.

The models created following our method can be enriched at each phase with other UML diagrams or details that increase the level of information provided; for example in the class diagram in Fig. 3(b) we added some constraints.

3.4 Phase 4: V-System Detailed Design

The fourth and last phase produces a UML model called *ArchitectureModel* that depicts the system architecture.

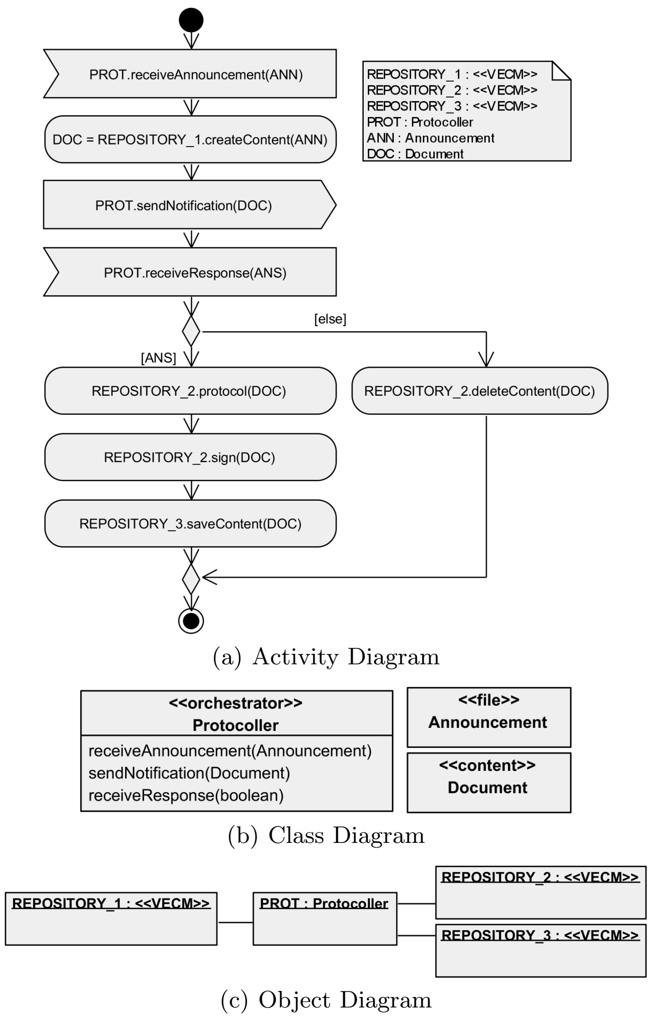


Fig. 4. Protocol Case Study: *ArchitectureModel*

The detailed design is given in terms of the subsystems that constitute the system. The subsystems can be: (1) one or more VECMs that abstract the underlying ECMs; (2) an *orchestrator* that coordinates the execution of the different VECMs and, if necessary, performs some data elaborations. Note that all the computations not assignable to the VECMs are done by the orchestrator. Moreover, the orchestrator manages the interaction with the outside participants (e.g., sending and receiving messages). At this level, for simplicity, the participants not included in the V-System swimlane are removed from the model. The attention is uniquely focused on the V-System architecture.

The subsystems that are typed by VECM can perform only a predefined set of operations (see Fig. 1). All the operations not supported by VECM have to be executed by the orchestrator and if it is not possible they have to be substituted by calls to external services and this require a modification of the V-System design.

In Fig. 4 we show the V-Protocol *ArchitectureModel*. The system is composed by four subsystems: one orchestrator (Protocoller) and three repositories of type VECM. All the operations performed by the repositories are included in the UML presentation of the VECM functionalities in Fig. 1. Note that the repositories do not communicate each other.

4 Lessons Learnt

Based on the experience that we have acquired during the development of our method, we summarize the lessons learnt and discuss opportunities for future research.

- It is possible to apply MD to build VECM-based applications without investing in complex tools and expensive training. It is sufficient a UML design tool (e.g., Visual Paradigm[3]) and a basic knowledge of UML. In the case of the VirtualECM project the involved companies had an adequate expertise for the execution of the method.
- Usually business process descriptions and models used in practice and given as starting point to develop a system are ambiguous, inconsistent, over-specific or too generic. Often, models given in "light style" format [6] seem very simple and easy to understand but often they contain subtle flaws that could bring to different interpretations and meanings. Using the "precise style" helps to reduce more common errors and flaws [5].
- The use of VECM is complementary to the use of SOA and not an alternative, given that they differ in the level of application. Indeed, VECM can be placed above a set of SOA-based ECM that though they have a SOA-based interface, the signatures of their operations are not standardized. For this reasons also in a SOA-based ECM environment it is useful to adopt VECM. Moreover, VECM exposes a SOA interface so it can be invoked as a web service.

[3] a UML modeller covering all kinds of UML diagram types. See http://www.visual-paradigm.com/

- Methods for developing ECM based systems are difficult to find. Some tools that permit to integrate different ECMs exist (e.g., ECM integration layer of SAP NetWeaver or FusionEnterprise) but they are part of complex technology platforms. Instead VECM is a light interface that does not require complex and expensive solutions.
- The adoption of CMIS[4] [4] does not replace the use of VECM. Indeed, even if CMIS will reach in the future a great diffusion among ECM users, a lot of companies will still use obsolete ECMs.
- Currently, the two companies involved in the VirtualECM project implemented by hand the system as a web application starting from the V-Protocol Architecture Model. Future work will be devoted to automate this task.

5 Conclusion and Future Work

In this experience report we have presented: (i) an MD method useful to develop VECM-based systems and (ii) its application to the development of the V-Protocol case study. Preliminary applications of our method (as the one reported here) show its effectiveness.

Future work will be devoted to refine our method and test it with more complex real case studies. We also intend developing a tool able to assist the designer in the construction of VECM-based systems. The tool should automatically transform the orchestrator produced during V-System Architecture Design phase in executable code.

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[4] Content Management Interoperability Services is an OASIS specification for improving interoperability between Enterprise Content Management systems