Improving the Design of Interoperable Platform Through a Structured Case Study Description Approach: Application to a Nuclear Crisis

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ABSTRACT

In this article, we briefly describe a crisis management case that has been chosen (in the European funded project PLAY) to test the federated-open-trusted platform for event-driven interaction between services. A description of such complex use case in natural language is obviously limited and should be completed with a formal description methodology to gather the necessary knowledge. Considering our technical requirements we suggest to combine the S-Cube approach with the model driven architecture approach to propose a complete and structured case study description framework. Then this article presents a nuclear crisis case modeled according to these guidelines.

Keywords

Use case framework, model driven architecture, crisis, collaborative process, BPMN, UML, S-Cube project.

INTRODUCTION

The European funded project PLAY (Grant Number : 258659) (PLAY, 2010), started in October 2010, aims at providing IT systems with a solution to mutualize the events that these systems have individually generated. Then the goals of PLAY are to improve the interoperability of the services through the development and the validation of an elastic and reliable federated Service Oriented Architecture (SOA) for dynamic, complex and event-driven interaction in large highly distributed and heterogeneous service systems. Such architecture will enable exchange of contextual information between heterogeneous services, providing the possibilities to optimize/personalize the execution of them, resulting in the so-called situational-driven adaptivity. If during their own execution system A generates the event a and system B generates the event b, then the PLAY platform could infer the event c (from a and b) to impact the run of system C. The main outcome will be a federated – open – trusted (FOT) Platform for event-driven interaction between services, that scales at the Internet level based on the proposed architecture and that addresses Quality of Service (QoS) requirements. The system will be tested through several use cases which one of these concerns a crisis management use case. In this article, we will develop a structured method to turn the whole « natural language » use case description into a relevant, representative and usable models containing the numerous pieces of information, interactions and events to take into account in such a situation.

CRISIS MANAGEMENT USE CASE: NUCLEAR ACCIDENT IN FRANCE

One of the main goals of the PLAY project is to deal with event-driven situations. The general problem of such situations concerns three main elements: generation of lots of events from heterogenous actors, generated events have to be of different types, generated events have to strongly interact with each other. A crisis management use case is a typical situation which covers all these points. It illustrates the general problem of PLAY project.

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General description of use case domain

The global scenario will be the following: a large quantity of radioactive substance is accidentally released in the atmosphere, due to a critical accident in a French nuclear plant. In such a circumstance, the proposed federated – open – trusted (FOT) Platform would be considered on the decision level, linking actors of that layer in order to help them to adjust the crisis reduction workflow according to identified events. Several actors will then be involved as events providers and all the expected partners on the field will also be involved and will also provide events. The studied use case will especially be dedicated to the threaten and leakage phases (called the emergency phase) (IRSN, 2003) during which there is a strong events generation due to all necessary measurements (radiation, wind, etc.) and all the ran actions. Such a use case provides some specific characteristics:

- Lots of heterogeneous actors may be involved, implying the difficulty to manage crisis situations,
- Furthermore, there are a lot of critical dependencies between the actions of these heterogeneous actors (collaborative processes describe the chronology of activities but also how activities might pre-condition or post-condition for each others),
- Besides, crisis situations are obviously the kind of context where agility (especially reactivity and adaptability) is one critical point. It is crucial that workflows and action remain perfectly adapted to the possibly changing situation,
- Moreover, crisis situations are also the kind of context where optimization and efficiency are critical. It is also crucial that workflows and actions provide the most effective answer to the situation,
- Finally, crisis situations management provides also a context where partners (and their services) might be possibly widely distributed.

All these characteristics make this use case a potential relevant illustration for Internet of Services, although it is not easy to imagine this context as a strongly computed environment where services could easily send their events to the clouds.

Description of the problem

Currently, that kind of situation would be treated through a Crisis Management Cell. Each actor on the crisis field would act according to its missions and would report its own events through specific networks (radio, security telecommunication networks, etc.). The main problem is that those events would be received at the Crisis Management Cell as informal events: they would be centralized, eventually shared, but they would surely be humanly managed only, that is to say, the crisis management cell responsible persons would be in charge of the complex-events processing. Some limitations of the structure (as rigidity and scalability) are due to both used communication networks (events impacts are predetermined) and human processing of events (quantity and speed of event treatment are limited). However, such an organization should be able to deal with all the calculable consequences of each event in order to propose on the fly changes in the activity flow. Besides, the results of actions on the field should also be considered as events able to change workflows. We propose to build a simulation tool dedicated to run a crisis example (with all the involved services and the events generated by these services from heterogeneous partners) in order to experiment the elastic and reliable architecture for dynamic complex event driven interaction of the PLAY proposal.

Description of a possible way to tackle this problem

Each actor has his own abilities, the events it is listening to and the events it is able to generate and to send to the clouds. The crisis reduction organization is structured according to three workflows (with regards to standards of business processes cartography): decisional workflow, operational workflow and support workflow (as shown on Figure 1). Technically, the simulation tool will be based on ESB technology and on web-services orchestration to simulate the several collaborative workflows, the actors' behaviors and the events production. We will not focus on the implementation in this paper. To reach this goal, a framework is required to completely describe each action, event, actor, relationship, workflow (i.e. each entity of our use case). In a SOA context, this means that we need to formalize the information to identify the services, the data, the workflows (last three items are related to the architecture), the events and the adaptation services (last two points traduce the agility). This is crucial to create a realistic use case and reproduce the processes that would happen in the real word. The complexity of the events, the numerous actors and interactions make the whole description in basic natural language quite hard to make a direct parallel with process modeling (through the use of Business Processing Management Notation (BPMN) (OMG, 2009)) or rules, ontologies in order to realize a Model Driven Architecture (MDA) (OMG, 2003) of our use case for an implementation on a SOA platform.

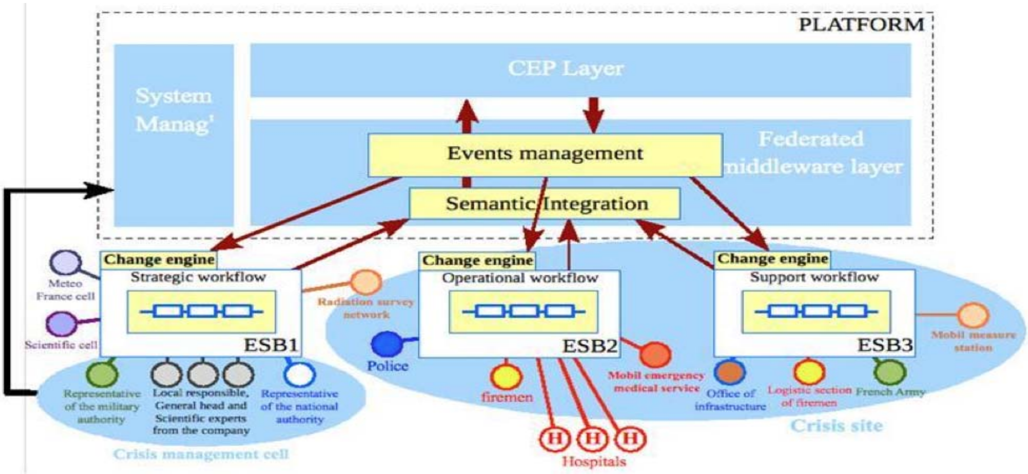


Figure 1. Crisis use case architecture

USE CASE MODELING: THE S-CUBE APPROACH

PLAY project will use several use cases, based on event generation and event management, to validate the overall FOT Platform: the nuclear crisis use case (described in this article) is one of them. In order to make our case studies comparable in the PLAY project and easy to understand, we need a framework to properly describe them. The PLAY project, based on a state of the art concerning the use-case definition frameworks, selected S-Cube framework. S-Cube is an European FP7 Network of Excellence in Software Services and Systems (S-Cube, 2010), which has defined a case study description approach, as shown in (Di Nitto, Plebani, 2010). According to the S-Cube methodology, a case study is described in terms of a list of Business Goals (BG) and Domain Assumptions (DA) for the case study, a Domain description, a list of Scenario descriptions.

Business Goal and Domain Assumptions

BGs define the objectives to be pursued and the functionalities that will be offered. DAs describe the properties that are assumed to be true in a certain domain. As shown in Table 1, (Di Nitto et al., 2010) defines a template for describing DAs and BGs. It includes a unique ID and a short name for the BG and DA, a type (BG or DA), a description field, the rationale, the involved stakeholders, the supporting material, the priority of accomplishment and the scheduling supporting the description, if any.

Domain description

The domain description is composed of five items that are (i) **the glossary** (where all the terms of the studied case are listed), (ii) **the relations between the glossary terms**, (iii) **the laws** (it may be physical/social/economical law, conventions to respect), (iv) **the domain dependencies** (between the different actors in the organizational context), (v) **the domain context** (that helps to identify the agents that operate in a certain context and highlights the phenomena shared between agents and machine).

Scenario description

In order to realize a given task, the machine and the world entities follow needed steps, described by the scenarios, which are mainly operational. According to (Di Nitto et al., 2010), the template to detail and describe a single scenario includes a unique ID and a short name for the scenario, uses data about the BGs or the DAs they refer to, the description of the scenario, the involved actors, the possible aims and the supporting material.

USING THE S-CUBE APPROACH TO THE NUCLEAR CRISIS MANAGEMENT

Combining S-Cube methodology and the Model Driven Architecture

When we have made the crossover between the S-Cube methodology and our requirements (MDA), we obtained improved templates to describe the use case. Some items remain the same, as the BGs and the DAs, but some part of the S-Cube framework may be improved to match our needs (easy switch from description to MDA). For example, the Domain Description may be based on an **ontology** (which represents the glossary and the domain model of S-Cube guidelines (items 1, 2 and 3 from Domain description section)), **UML use-cased diagrams** (OMG, 2006), representing strategic dependency diagram of S-Cube guidelines (item 4 from Domain description section), and **UML analysis class diagrams** (OMG, 2006), representing context diagram of S-Cube guidelines (item 5 from Domain description section). Then, the Scenario Description could be based on the table provided by S-Cube guidelines and enriched with BPMN diagrams.

Using the improved templates to describe the Crisis Management use case

Business Goals and Domain Assumptions

We have identified three BGs and two DAs. In Table 1, we will present the BG Play_UseCase_Crisis_BG1.

Unique ID	Play_UseCase_Crisis_BG1
Short name	Reduce the impact of a nuclear crisis
Type	Business Goal
Description	Reduce human/social/environmental/economical impacts of the nuclear accident
Rationale	Give a justification of the goal/assumption
Involved Stakeholder	Consultation/Operational/Support/Decisional actors (cf. UML use case diagram)
Supporting materials	French Institute for Radioprotection and Nuclear Safety (IRSN) database
Priority of accomplishment	Must have: The system must implement this goal/assumption to be accepted
Tentative scheduling	Real time

Table 1. BG and DA description table (according to (Di Nitto et al., 2010)) used for the Crisis Management use case

Domain Description

The Domain description is modeled through UML use case diagram (see Figure 2) and UML class diagram. We build an ontology (an OWL file) for the description of the first section of this article "General Description of Use Case Domain" (involved concepts, relations between these concepts). Due to paper length restrictions, the diagram representing the UML class diagram and the ontology file are not shown in this article.

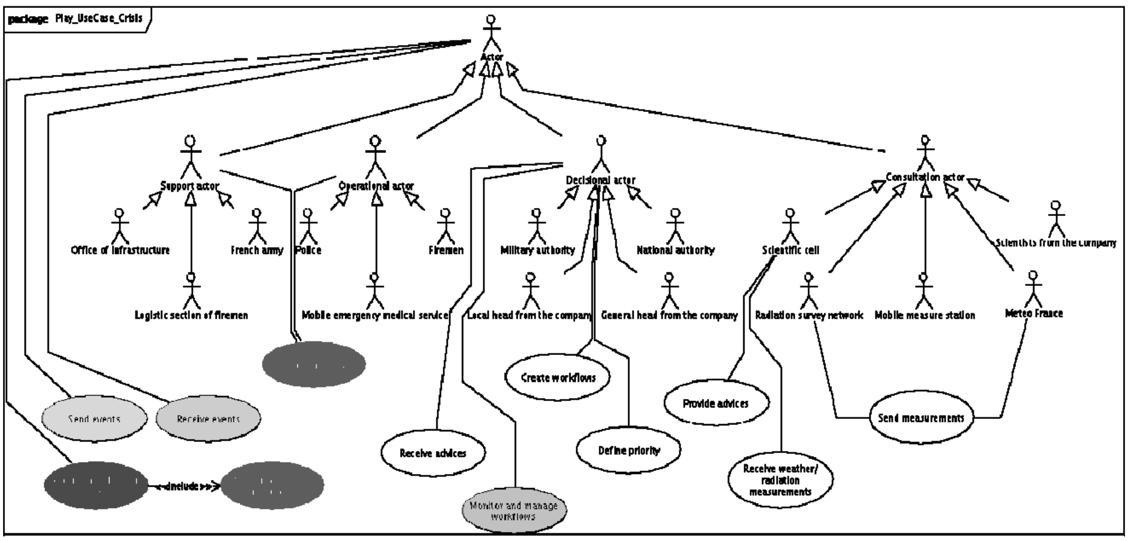


Figure 2. UML use case diagram

Scenario Descriptions

We have identified seven scenarios. In this paper we will focus on Play_UseCase_Crisis_S6 (see Table 2).

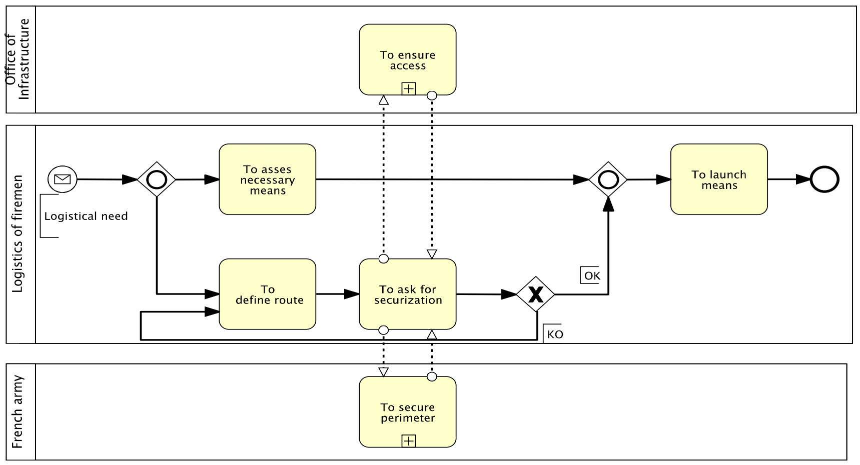
Unique ID	Play_UseCase_Crisis_S6
Short name	Continuous support step
Related to	Play_UseCase_Crisis_BG2 / Play_UseCase_Crisis_BG3 / Play_UseCase_Crisis_DA1
Involved actors	Consultation actors / Support actors
Detailed operational description	This support workflow aims at ensuring the logistics of the continuous step, by providing operational actors with means, and furnishing decisional actors with relevant reports and data
Problems and challenges	Internal coordination between the operational actors / External coordination between the three types of workflows / Adaptability of the support workflow
Additional material	

Table 2. Scenario description table (according to (Di Nitto et al., 2010)) and the additional BPMN diagram used for the Crisis Management use case

CONCLUSION

In this paper we have shown that implemention of a platform for events interactions between the heterogenous information systems of a crisis response actors requires the extraction of requirements and constraints related to the crisis context. The use case formalization and its exploitation means are therefore a very important issue for the design of such a platform. The developed proposition consists of adaptating the S-Cube formalism in order to have the most complete, accurate and above all structured description as possible of the use case. Through a nuclear crisis example, we have shown that the obtained result was compliant with a MDA approach, notably in a SOA context. We have completely defined a use case with its components: objectives, actors, events and processes (using the S-Cube framework). The next step is to develop the simulation tool able to deal with such a use case and all of its correlated components. This simulation tool will be used to feed the FOT Platform to ensure its ability to manage numerous and heterogenous events and high interactions between events. Finally the main challenge of this use case is to be a realistic situation that integrates and covers the whole (or at least a maximum) requirements that the PLAY project aims to answer.

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