

Towards a unified approach of interoperability to facilitate the transfer from research to industry: application to crisis management

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Abstract

This paper presents the objectives of the Criz'Innov French project. This project aims to fill the gap from the research to the stakeholders of crisis management. This gap is essentially due to a lack of maturity and an interoperability issue for the results of R&D projects. Therefore, this paper presents the software architecture of CrizLABTM, a middleware based on Event-Driven Architecture that proposes a unified approach of interoperability and helps to use the results of R&D projects in relevant situations in order to increase their maturity and thus facilitate the demonstrations.

Keywords

Crisis management, interoperability, Event-Driven Architecture

1. Introduction

The news is full of major events leading to numerous damages and losses (deaths, destruction of habitats...). Examples could be found both at the international level (Tsunami of 2011 leading to the disaster in Fukushima: about 20,000 deaths, €60 billion ...), and at the national level (fire, explosion and atmospheric emissions of the company SEVESO Lubrizol in 2019: 240 firefighters mobilized, 13 municipalities have set up a crisis unit ...) and at the regional level (floods in Occitania in 2019: cumulative rainfall of up to 200 mm in less than 6 hours, about €100 million of damage ...).

These situations, called "calamity", "incident" or "major event" depending on the context and sources, occur in a vulnerable environment (areas with high human stakes, industrial activity zones, interconnected networks, etc.) and evolve according to an unfavorable outcome called a crisis according to [1].

Crisis management aims at solving problems (e.g. reducing effects and preventing the occurrence of risks) in order to return to a stable situation. Crisis management could be divided into four main steps: Prevention, Preparation, Crisis Response, and Recovery. During these steps, several stakeholders need to collaborate, share information, understand the situation and anticipate its evolution in order to stabilize the situation and reduce the number of possible effects. Moreover, crisis management requires to make complex decisions under stress and based on uncertain, incomplete and possibly inconsistent information, especially during the crisis response step.

Therefore, crisis management is and becomes more and more humanly difficult to apprehend and the use of digital solutions is nowadays a necessity. However, Crisis cells are equipped with outdated, non-interoperable, unsuitable solutions that are slowing down the dissemination of information.

This observation is all the more surprising given that lots of research and prototypes exist in the field of crisis management as the research projects ISYCRI (2007 / 2010), GENEPI (2014 / 2017), i-

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Nondations (2018 / 2021), ACRIMAS (2011 / 2012), CRISMAS (2015 / 2017), DRIVER+ (2014 / 2020), I-REACT (2016 / 2019) or the research communities like ISCRAM.

Based on this context, we assume that there is a leak from the results of R&D projects to the stakeholders of crisis management and industry.

This paper presents the proposal of the Criz’Innov French project, which aims at facilitating the transfer from the results of R&D projects to their demonstration in a representative situation. The first section tries to explain why it is difficult to directly use the results of R&D projects in a representative situation. The second section presents the objectives of the Criz’Innov project. Finally, the last section introduces the architecture of the CrizLAB™ the Middleware used to provide interoperability.

2. . Towards a need to unified the perception of the crisis situation

This section aims to explain the possible reason for the difficulties in transferring the results of R&D projects to the stakeholders of crisis management and industry.

2.1. Needs to increase the maturity level of technologies

Technological Readiness Level (TRL) is a framework that has been used to provide a measurement of technology maturity from ideas on the paper to commercialization [2]. Regarding the computer science field, the framework TRL could be divided into three main stages:

- *From 1 to 3:* Proof of concept.
- *From 4 to 6:* from Proof of concept to demonstrator usable in representative situation.
- *From 7 to 9:* from demonstrator to commercialization.

R&D activities are focused on Proof of Concept level whereas industries are interesting in technology from the demonstrator level. Therefore, one reason for the difficulty to transfer R&D results to the industry is due to the maturity level. Based on this observation, we want to offer a solution able to facilitate the increase in maturity. The increase in maturity is linked to the use of technology in a representative situation with other technologies.

2.2. Needs to unified the perception of the situation

In crisis management, especially during the crisis response, the main concerns of stakeholders are always to know what is going on. This is the aim of Situational Awareness. In [3], the authors remind that even there are numerous definitions of Situational Awareness; Situational Awareness could be seen in three levels:

- *Level 1:* Perception of the situation.

The first level is to perceive the status, attributes, and dynamics of relevant elements in the environment

- *Level 2:* Comprehension of the situation.

Based on level 1, this level aims to go beyond simply being aware of the elements that are present. It aims to help decision-makers by making advice based on the treatment of knowledge.

- *Level 3:* projection of future status.

This level aims to project the future status of the elements in the environment or to predict the results of actions in order to help the decision-makers.

Regarding the results of R&D projects in crisis management, we assume that the results are more focused on the comprehension and the projection level of Situational Awareness. Moreover, each R&D result is focused on a specific aspect of crisis management or on specific kinds of crisis situations (flooding, forest fire, ...). Thus, there are numerous proposals to describe the perception of the situation due to the fact that each project proposes its own perception model or ontology [4] [5] [6] [7] [8]. Furthermore, these proposals do not include or are not based on the standard established for crisis management exchange as the ISO standard: CAP (Common Alerting Protocol) message [9] or the EDXL (Emergency Data Exchange Language) [10].

In conclusion, we can assume that a constellation of technologies is needed in crisis management because one technology could not manage at the same time the whole possible situations and the three levels of Situational Awareness. We assume also that a unified perception of the situation is needed to facilitate the transfer from the results of R&D projects to industry.

3. CrizLAB™: middleware to support a unified approach of interoperability for Crisis Management

It is obvious that digital solutions will be useful for crisis management due to the amount of data to manage and share in a hurry. Thus lots of R&D projects proposed solutions to help the stakeholders. Nevertheless, as highlighted in previous sections, the transfer from the results of R&D projects to stakeholders is difficult due to mainly the maturity of the solutions and the lack of a unified perception of the situation. This lack is due to the fact that a constellation of solutions is needed in crisis management.

Based on these observations, we want to propose a middleware, named CrizLAB™, which aims to facilitate the transfer from the results of R&D projects to stakeholders or industries. Therefore, the middleware allows to:

- tests the results in various crisis scenarios
- facilitate the interactions between results and existing solutions in crisis cells
- support for demonstration

To achieve these objectives, CrizLAB™ needs to be able to support a unified approach of interoperability. As defined by [11], the unified approach of interoperability is based on a common vocabulary, taxonomy. Thus, each result keeps its own way to structure the data and a gateway is used to transform the exchanged data from the specific model to the unified and shared way to describe the data.

Based on previous experiences, it seems that the unified approach of interoperability is relevant only regarding the exchange of data between applications. Furthermore, crisis management is mainly based on the occurrence of events. Therefore, CrizLAB™ is based on EDA (Event-Driven Architecture), illustrated in Figure 1. Indeed, event-driven systems or architectures are designed to process events as they occur, allowing the system to observe, react dynamically, and issue personalized data depending on the recipient and situation [12]

Moreover, CrizLAB™ proposes the following functionality:

- Manage the COP (Common Operational Picture): COP is an overview of the situation, generally showing on a map. This COP is modified on each received event.

- Manage the history of the situation: the history of the situation is saved and accessible for humans as well as other applications.
- Manage the link between applications. Several applications have to be executed in sequence in order to make advice or provide an added value information

In order to ensure these functionalities, the unified model used for CrizLAB™ is based on three taxonomies of events:

- Situational event: this kind of event is used to maintain the COP and share data between stakeholders. At the moment, this kind of event is based on CAP message.
- Workflow event: this kind of event is used to manage the interaction between applications.
- Historical event: this kind of event is used to manage the history of the situation and thus the history of the COP. Thanks to this kind of event, CrizLAB™ could provide a “main courante” (in French, it stand for a log of all the events and it is used after the crisis for return of experience).

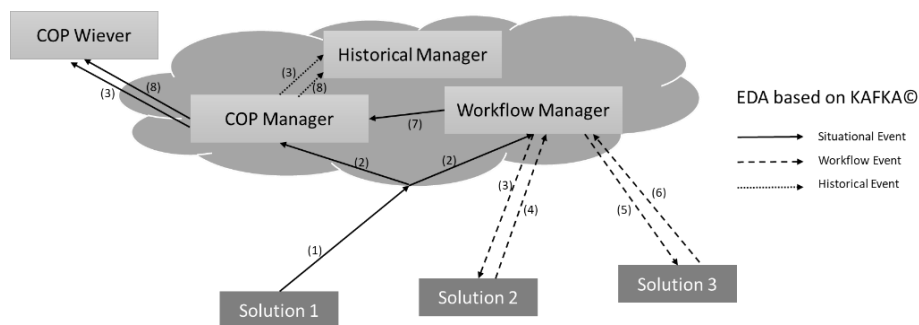


Figure 1: Overview of CrizLAB™

4. Conclusion and Future works

This paper presents the aims of the Criz’Innov French project. This project aims to fill the gap between the research and the stakeholders of crisis management. This gap is mainly due to the maturity level of the results of R&D research whereas stakeholders want demonstrations to be convinced to use the results. This observation implies a problem of interoperability. The aims of CrizLAB™ is to provide an Event-Driven Architecture that aims to support a unified approach of interoperability as well as added-value services. The added value services are used to unify the perception of the situation and thus facilitate the sharing of a COP.

For the two next years, CrizLAB™ is going to be used to demonstrate and increase the maturity level of six research projects thanks to three crisis exercises: one simulate exercise and two real exercises.

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