# DESIGN OF A COLLABORATIVE PLATFORM FOR SUPPORTING CRISIS MANAGEMENT

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**ABSTRACT**
In many organizations today, efficiency strongly relies on critical decisions involving heterogeneous expertise and requiring collaboration to deal with complex data. Designing collaborative platform for crisis management in civil security involves dealing with numerous issues related to various parameters (e.g. users, data, tasks and context), which are extremely difficult to specify and assess in a general manner. The requirements in terms of reliability, intuitiveness, flexibility and robustness associated with such an application introduce the strongest possible set of constraints. Likewise, the highly hierarchical structure combined with the high stakes related to such a context demands a clean and optimal environment within which to evaluate the system. This article describes the civil security crisis context and requirements, the collaborative multi-touch solution we developed, which eases heterogeneous document sharing on a single multitouch-enabled meeting table, and the feedback we gathered from end-users.

Keywords: crisis management, collaboration, innovative technologies, decision support system

## 1. INTRODUCTION

After the enhancement of individual coordination solutions, easing the collaboration among actors involved in a crisis scenario is a significant challenge, as introducing new digital information can invade a crisis manager's usual approach. While discussing our product with end-users (such as actual crisis managers), we observed that all shared information currently converges fairly easily towards several digital devices that combine various data. The multiplication of information and communications technologies allows users to select the best available solutions for their individual challenges. However, this heterogeneity creates a steep hurdle for collaboration. Indeed there is still much more work to be done in order to arrive at the theoretical workspace where each actor can share information with collaborators regardless of compatibility issues. This paper introduces an overall solution to dealing with widespread issues of flexibility, whilst building on the analysis of crisis management requirements.

As described in Manuel Zacklad (2010), cooperative work is essentially defined as the output produced in common by several actors engaged in individual activities. Thus, the final challenge is definitely to raise a genuine interest from heterogeneous experts in terms of user experience, but also in terms of effectiveness with regard to their professional objectives. Several attempts have been made to achieve this objective, such as the framework for disaster response process management (Franke and Charoy, 2010). This framework provides support for modeling, execution, monitoring and cross-organizational aspects of disaster response processes. Another example, this time in the field of medical research, is the Multi-Knowledge project. This project validated a collaborative IT platform for knowledge management, allowing a geographically dispersed group of researchers, dealing with different data sources as well as dissimilar technological and organizational contexts, to seamlessly create, exchange and manipulate new information (Amoretti, Zanichelli and Conte, 2008).

In the crisis management process we are dealing with, the platform does not attempt to directly address the monitoring or the management of crises, but is instead designed to support communication during a crisis. Unique to this project is that it is not limited to previously defined, specific types of data or applications, but also includes a strategy for unexpected content. The design of this platform has been entirely conducted with the supervision of end-users, i.e. crisis managers, firemen, policemen, and civil security employees. This flexibility, also called malleability (Thomas Herrmann, 2008), is critical in ensuring the long-term use of a new solution in the ever-changing field of crisis response.
After introducing the crisis management process within which we devised a new collaborative solution, this paper presents the actual solution both in terms of hardware and software, as well as a final overview of the feedbacks we gathered from several workshops with civil security experts.

## 2. CRISIS MANAGEMENT AS A COOPERATIVE PROCESS

### 2.1. Challenges to contemporary crisis management

These days, crisis managers are faced with increasingly complex crisis management tasks. Beyond the notion that the frequency, nature and consequences of crises and disasters have changed, the increased interconnectedness of our modern day world inherently causes crises and disasters to – directly or indirectly – play out differently (Boin, 2009). That is, today's crises, more than before, are spanning multiple jurisdictions, undermining the functioning of multiple sectors and infrastructures at once, while escalating and evolving rapidly along the way (Ansell, Boin and Keller, 2010). In dealing with a transboundary threat and the urgency and uncertainty it brings, the need for a "response system that can reach across boundaries and bring together available capacities in an effective and timely manner" (Ansell, Boin and Keller, 2010) is thus ever more pressing.

#### 2.1.1. Crisis management as a cooperative process

Crisis management is indeed a collaborative process among available capacities. The stakeholders in a joint crisis response generally concern parties from the operational disciplines (e.g. on-scene police officers, firefighters and medical teams) up to the tactical (lower-level, on-scene command) and strategic levels (higher level, remote decision-making).

#### 2.1.2. Arriving at a Common Operational Picture

Ensuring an effective multilateral crisis response, a "uniform picture of the events" (Boin, Hart, Stern and Sundelius, 2005), among all levels involved is indispensable. However, this shared understanding, generally referred to as the Common Operational Picture, is hardly self-evident. To make sense of a situation and decide on actions accordingly, crisis managers often bring together information on flip-overs, whiteboards, and other helpful but somewhat outdated tools that prevent real-time integration and consolidation of all the available information. Moreover, the process of arriving at a Common Operational Picture is often inhibited by challenges pertaining to, for example, the limited interoperability of systems and organizations, and the multitude and diversity of information streams.

### 2.2. An integrated multidisciplinary operational picture

Given the slow speed and limited adequacy of information processing, cogent signals risk being overlooked. Therefore, a system that helps crisis managers overcome these challenges and facilitates the emergence of an integrated and multidisciplinary operational picture truly adds value. Yet, to facilitate such a process towards a Common Operational Picture, a few essential requirements must be fulfilled

#### 2.2.1. Requirements

In a state-of-the-art study of existing crisis management systems, the E-SPONDER project team researched these essential requirements. Results showed that for a tool to facilitate improved sense- and decision-making in times of crisis it should, for instance, at least comply with demands of user friendliness and interoperability of components, while having the ability to gather data from different information sources and to access data and systems through a single application. In other words, intuitiveness, practicality and the capacity to share among and connect with multiple disciplines are essential in a multidisciplinary operational picture. The Collaborative Solution, developed as part of the E-SPONDER project, aspires to meet these challenges. The following section outlines how this will be achieved, and with what applications and functionalities.

## 3. COLLABORATIVE SOLUTION

Building on these requirements and observations, our goal was also to cope with the daily constraints imposed by the Emergency Operational Centers' (EOC) physical environments, into which we wanted to bring the Collaborative Solution. Our priority was indeed to focus on the development of a fully operational system rather than experimenting with elaborate functionalities

### 3.1. Functional specifications and environmental constraints

One feature the users indicated as very important is the flexibility of the system and its capability to flawlessly integrate with the current habits of each user. While the strategy of innovation is often to suggest a revolution of tools, the source of this platform is to suggest a transparent evolution of the existing processes that make digital information available without requiring the learning of new, complex tools. In line with this idea, the challenge was to design a collaborative workspace where people could use their own device (e.g. computer, laptop, tablet) and share their own content while still using the multi-touch screen of the platform to visualize, consolidate and annotate any kind of information (e.g. 2-D, 3-D, text, image, multimedia, web). This meant providing users with the capability to:

- Share and combine various content by sending thumbnails of files from their own device to the shared space;
- Manipulate, organize, aggregate and duplicate the data that has been sent on the shared space with simple and efficient gestures;
- Add graphical and textual information on the collaborative surface;
- Allow for group discussions with the support of shared content, while having the capability to enrich this information with further annotations.

In addition to these features focusing on the users' inputs, the platform should also allow them to exploit the outputs from the collaborative exchanges. This therefore means the capability to:

- Export decisions to one's personal computer;
- Activate automatic local or distant archiving;
- Save important steps or conclusions;
- Drag and drop content in a report, e-mail or database.

Our research showed that no available solution existed that covered each of these requirements. Among existing software, none of them ensures the flexibility with regard to profiles and the number of users, the compatibility with many file formats, the naturalness and efficiency required to exchange and manipulate digital content in real-time, and the environmental considerations such as light and congestion

### 3.2. Hardware constraints and features

Figure 1: Modular multi-touch device

The platform's core is a 55'' multi-touch screen displaying the Common Operational Picture (Figure 1). Relying on the latest projected capacitive technology, the system allows several users to use the system in any environment, thus meeting the expectations about the low light sensitivity that was defined as critical. Furthermore, our studies showed that a screen size of between 46'' and 55'' seems to be the best choice for small group interactive sessions. A larger size would strongly decrease the spatial resolution, view angles and reachability when used in a horizontal orientation, while choosing a smaller size would reduce both the screen and the space around the table.

Touch input has been selected as the technology of choice for interaction. It is now well known that a well-supported touch input can greatly increase user confidence and interaction speed with the system (Mauney, Howarth, Wirtanen, and Capra, 2010; Sears and Shneiderman, 1991). This is especially true when the system is used to mimic the way actual users would interact with the real counterparts of digital objects, which is exactly the case with crisis management. That is, in managing the crisis response the actors involved are constantly manipulating paper maps, writing notes, and sticking paper notes or pictures onto whiteboards in order to create a shared understanding of the events. Nevertheless, multi-touch input is increasingly more common to crisis managers, as they are used to and attracted by such technology, provided the system works in the exact same way they expect it to work. Finally, multi-touch technologies enable several users to interact with the system simultaneously. Touch input is critical in such a collaborative situation not only to interact with the system, but also for other users to see, follow and understand what their colleagues are doing.

The projected capacitive technology is especially reliable as it ensures sub-millimeter touch precision at 1920 x 1080 HD resolution with near-zero parallax. Having their fingers directly touching the digital content, with close to zero space between the real and physical object, allows inexperienced users to focus on the management tasks without the disturbance of awkward technology. Finally, the ultra-low latency touch response also ensures a user-friendly experience (i.e. a 120 Hz frame rate for display and touch sensor). While this feature is not mandatory for the system to fulfill the users' requirements, it definitely adds to the system's performance and experience.

Outside lighting is not a constraint, as the platform is designed as a mobile and modular system in order to be easily moved and re-positioned. Users identified this solution as useful for briefing or debriefing with a small group or in front of a large team. For these reasons, the screen is mounted on a modular stand allowing users to switch between horizontal or vertical positions with an electronic command: table mode, tilt mode and wall mode (Figure 2). More generally, the design of the platform is aligned with ergonomic studies to ensure an efficient integration of this solution in a daily working environment.


Figure 2: Pictures of Collaborative Workspace prototype during E-SPONDER review or during LAVAL VIRTUAL 2014

### 3.3. Collaborative platform features


Figure 3: Pictures of Graphical User Interface supporting the Collaborative Solution

The Collaborative Solution is an integrated interactive platform designed to address processes and decisions requiring interaction among actors of all levels during a crisis. Crisis management, as a typical collaborative process, is used as a guideline to specify the components of this platform. The Common Operational Picture is the focus of the platform since it represents the pool of information that must be displayed, compared, enriched and discussed during the crisis response. The challenge of research related to this platform was that it simultaneously addressed common features such as reliability, intuitiveness, and user-friendliness, and ensuring the flexibility needed by the uniqueness of every crisis event. Indeed, Emergency Operational Centers (EOCs) can be installed in small rooms, in a large location or open landscape, outside or inside. An EOC is commonly used during crises. For example, the majority of airports have their own center.
Moreover, resolving a crisis can require sensitive data. For security reasons, one specification of this platform is to provide a session system and an automatic back up directory ensuring the protection of the content involved in each crisis. Once users have logged in, they can easily integrate their files into the Common Operational Picture from an external mass storage device if users have no personal devices. The compatibility is in line with all needs emerging from field requirements: images, pdf, video, office, 3D, and web content. Users can also upload and download all content on the interactive table with a memory stick or any mass storage device. Thus, they can intuitively organize documents on the common picture, and add comments using annotation tools and a post-it tool.

As illustrated in Figure 4, the design of the platform has moreover been studied to best forge a common view between several users with several data files and several kinds of personal devices.

Finally, to take advantage of the hardware capabilities, especially in terms of high precision and frequent multi-touch input, special care was taken when designing the interaction techniques. Indeed, while some people will use one or two fingers to gently interact with the application, others will use both their hands and perform gross gestures while expecting the same result. We therefore developed generic interpretation techniques of the multi-touch input that do not strongly rely on the number of fingers on the content, and took into account the frequent lifting of some fingers that would otherwise affect the device's use.

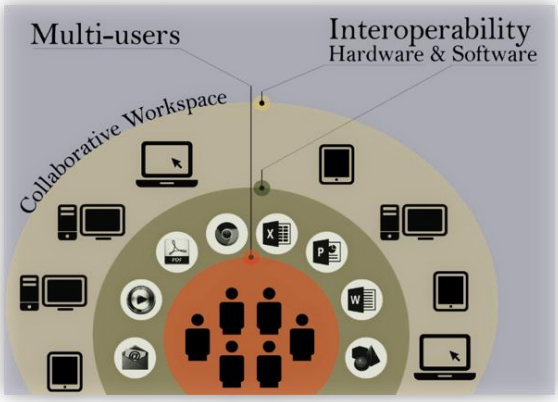


Figure 4: Schematic representation of the flexibility of the Collaborative workspace

From a personal device, a user can connect to the platform via WIFI network and share files instantly with a 'drag and drop'. In order to guarantee confidential requirements and hence avoid inadvertently sending critical files, users can just send a screenshot from their personal screen. In other cases, users can directly share their screen with other off-site collaborators. These features ensure a flexible experiment during briefing sessions regardless of technical specificities. Regarding debriefing, the requirement was to be able to grab the result of common reflections and decisions. The collaborative platform therefore allows user to grab the content from the Common Operational Picture and transfer it to his or her personal device, thereby producing reports in real time

## 4. FEEDBACK AND FUTURE WORK

At the end of September, a demonstration session was organized in Athens with end-users from France and the Netherlands. During this milestone event, end-users tested the solution and provided their feedback on the Collaborative Solution. Firefighters and crisis experts were enthusiastic about the multi-touch table and its quality of interaction. The initial desire to create this solution as a transparent layer easily supporting all interactions in an emergency center is a success. This transparency allows for movement, flexibility, and adaptation among different modes of interaction, which is necessary for modern systems design. The first contact with the solution was completely natural, as a « physical paper on a traditional table ». As it turned out, training professionals in using the platform would be relatively straightforward. Users have proven to be quickly capable of working with multiple screens, synchronizing content,

and exchanging information within a small group or with all collaborators around the table. The interoperability was a crucial requirement especially concerning the Common Operational Picture from the field. Actually this picture is traditionally a map including the geographic information required to get an overview of the situation. An interesting asset of the Collaborative Solution is its ability to extend the Common Operational Picture with other types of information, including non-geographic details.

Globally, end-users have seen the added value of the Collaborative Solution for crisis management. At this point the platform meets all critical requirements. Nonetheless, in addition to all positive points, end-users provided feedback for final improvements. They stressed the importance of the data backup process in crisis context where electrical issues could emerge. They also stressed the protection of user's data as these could be top-secret documents. And finally, they noticed that improvements could be made concerning the ergonomic features of the interactive table (e.g. a space for storing users' personal belongings).

In addition to those in crisis management, professionals in other fields have used the system. According to interviewed architects, the system allows users to have a more concrete vision of their project, and thus be in a position to validate hypotheses, and prevent and avoid mistakes. Working around technical plans and all data describing the project also proved to be critical for the strategy board, design review, brainstorming, and commercial presentation. Finally, the system has also been approved for formation by allowing trainers to involve learners, facilitate their learning and boost training efficiency (Figure 4). This early feedback highlights critical challenges of this kind of platform that goes beyond the framework of this paper. Yet crisis management seems to be a pertinent case to build an interesting list of requirements for collaborative processes.

Figure 5: Pictures from users' sessions: architectural firm (Bastia), Microsoft Technology Center (Paris), aeronautics formation center (Bordeaux)

## 5. CONCLUSION

This paper briefly introduced the Collaborative Solution, developed partially in the E-SPONDER project as a solution for crisis managers and the challenges they face. This solution aims to address issues of collaboration in a work session with a group of experts coming from different professional fields. During these sessions, all of them have to share digital information with all compatibility issues. This solution is the result of theoretical and technological studies in order to produce a professional solution that could be installed tomorrow in an Emergency Operational Center. Given the fact that the platform may be used in sensitive (information) environments, special precautions have been taken with regard to the setup of the system and its flawless integration in preexisting workflows. As such, the flexibility of this system in terms of inputs/outputs ensures its use without any major upheaval or break in current processes, while specific enhancements have been highlighted to further enhance the solution integration within daily processes.

Finally, the system will be even more strongly tested during field tests with real scenarios and a large audience of professionals. One exercise, for example, is planned at Amsterdam Schiphol Airport in the Netherlands. The main outcomes of the E-SPONDER project will be presented in 2014. More information regarding the activities organized as part of the E-SPONDER project can be found on the project's website: www.esponder.eu.

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