ABSTRACT
Modern crises are progressively changing their character from ‘predictable’ emergencies capable of being countered with existing crisis management tools and techniques, to unpredictable events. Governments and first responders require new, innovative and affordable solutions to be better prepared before an incident, and to respond more efficiently and effectively during an incident. The use of simulation technologies can offer a big improvement on current practices because it allows the decision makers to evaluate different alternatives not just with static data but with continuously evolving scenarios. Within this context, the SICMA FP7 capability project aims at demonstrating if and how an integrated suite of modeling and analysis tools could improve the effectiveness of the decision making process. The aim of this paper is to provide an overview of the mission area, the critical operational issues and the role of the SICMA project in the depicted context as well as the current achievements.

Keywords: decision support system, crisis management, healthcare organizations, modeling and simulation.

1. INTRODUCTION
A crisis can be defined as an event involving major damage and injury to people and property of sufficient magnitude to create a temporary imbalance between the large scale needs of a community and the availability of resources able to provide the emergency care to address these needs (Frykberg 2007). Moreover a crisis may:

- cross jurisdictional boundaries, resulting in multiple organizations being faced with overlapping responsibilities,
- exceed the capacities of single organizations requiring them to be supported by other organizations that are unfamiliar with the procedures.

As a consequence, the response to a crisis is the result of the activities of:

- different services (e.g. police, medical care, rescue forces, fire fighting, etc),
- interacting vertically (i.e. with components of the same organization) and horizontally (i.e. with components of other organizations),
- in a complex environment.

Within this context, the main operational issue lies in the difficulty to have even a rough estimate of how the crisis management system will respond to the crisis and, as a consequence, the impossibility to identify those key leverage points of change that enable the overall system to produce significant shift in its performance.

Several causes of the unpredictability of the response can be identified at different levels:

- **Service level**: the overall response to the crisis will depend not only on the quantity and quality of the individual entities but also largely on how those entities cooperate in harmony with one another through the entire scenario, at national and at trans-national level.
- **Cross-service level**: although individual service organization may be quite effective, the system as a whole may experience a significant “failure to respond” due to a faulty or deficient inter-service interaction.
- **Context Level**: such complex system of systems made of components strongly interrelated, self-organizing and dynamic will
have to operate in a complex environment where the situation evolution will be determined by predictable factors (e.g. responders behaving according to the agreed procedures) to a given extent and will be subject to unpredictable factors (e.g. crowd behavior, traffic gridlock, human behavior etc) otherwise.

Last but not least, during an emergency an organisation responds by performing specific tasks according to defined procedures. The most effective procedures need to be implemented correctly to provide the expected results.

2. PROJECT OBJECTIVES
The role of the SICMA project is to demonstrate “if” and “how” an integrated suite of modeling and analysis tools providing insights into the collective behavior of the whole organization in response to crisis scenarios could improve the effectiveness of the decision making process.

With respect to the four phases the Crisis Management process is usually divided into (i.e. Mitigation, Preparedness, Response and Recovery), the SICMA project aims at improving crisis managers decision-making capabilities in the following phases:

- **Preparedness**: assisting in the identification of the best way to employ available assets, the limits of the achievable response and the effectiveness of different inter/intra services cooperation procedures
- **Response**: providing a forecast of scenario evolution, proposing doctrine-based solutions and evaluating the effects of alternative decisions.

The main focus will be on the Health Service response where decision-making support will be provided through the achievement of the following main objectives:

- **“Bottom-Up” Health Service modeling**: to provide insights into the collective behavior of the whole Health Service system (namely Medical and Ambulance Services) in response to different crisis situations and decision implementations by modeling the behavior of its components as well as the rules they operate by (A.L.S.G., 2002).
- **Procedure Support**: to make use of state of the art technology to provide the user with the correct procedures to better solve the problem (once the problems to solve and the decisions to make are identified).
- **Analysis of the effects of unpredictable factors**: to study the effects of unpredictable factors (like human behavior, size/specifies of the incident) to present the user with a “distribution” of the effectiveness of a certain “decision” rather than the effectiveness of that solution deterministically dependent on the preconceived scenario.

The combined effects of the above points will allow to document both the unexpected bad and good things in the organization(s) thus leading to better responses, fewer unintended consequences and greater consensus on important decisions.

Last but not least, the use of simulation technologies in the SICMA system can offer a big improvement on current practices because it allows the decision makers to evaluate different alternatives not just with static data but with continuously evolving scenarios in which:

- casualties are generated in response to certain events;
- each component of the emergency management system is simulated, giving insight into how the diverse elements of the architecture (i.e. different services or different components within one service) interact with one another throughout the entire scenario.

3. SCENARIOS
The following scenarios have been selected:
- **Conventional weapons terrorist attack**: being the most common and hence the most likely threat in the future, this scenario will be used to evaluate the decision support achievable with the SICMA prototype in the management of casualties.
- The focus will be on the management of the most likely category of casualties that can be generated by a large number of different types of disasters that is: trauma casualties.
- **Chemical weapons terrorist attack**: specific types of disasters may result in additional decision making activities to be carried out by the crisis manager. This scenario will be used to highlight the additional support that can be provided to decision making activities specifically related to the kind of accident.
- The CCS/decontamination-station deployment and hazard estimate/update will be used as case study in the chemical attack Scenario.

4. CURRENT ACHIEVEMENTS
The project has been divided into four phases: User Requirement Analysis, High Level System Design, Prototype Development and Case Study Implementation.

At the end of the first year of activities the first two phases have been closed. More in detail:

- the user requirements have been identified starting from an analysis of the mission area and the critical operational issues and defining the role of the SICMA project in this context;
• the system requirements have been defined;
• the high level design (i.e. the identification of the system components and the allocation of the required functionalities to each component) of the simulator and tools suite has been performed.

The high level architecture of the system and the different modes of operation are reported and detailed in the following paragraphs.

5. ARCHITECTURE AND TECHNOLOGIES
The SICMA prototype distributed architecture (Fig. 2) is composed of: an Integration Infrastructure, a Graphical User Interface (GUI) and several modules.

![Figure 2: High level Architecture And Technologies](image)

The core of the Integration Infrastructure is a web server developed in php5, one of the most widely-used general-purpose object-oriented scripting language that is especially suited for Web development and can be embedded into HTML. The web server grants access to the implemented services to any application implementing the standard SOAP protocol.

The web based GUI allows the users to exploit the system functionalities with different HW (hand-held, laptop, desktop etc) and from different location (e.g. the accident location, the police head quarter etc). It makes use of an embedded map, provided by Google services, allowing the user to place objects on the map and interact with them.

The GUI makes a large use of AJAX philosophy that is the web development techniques used for creating interactive web applications or rich Internet applications. The AJAX engine located on the client, ensures faster response from the lighter web server.

The AJAX engine changes the HTML DOM of the page (using, if needed, a background server interaction) thus reducing web traffic and resulting in an intuitive and easy-to-use interface.

Finally the SICMA Modules and the HLA federation, will support both the user decision making process (allowing to simulate the context evolution, and to perform a statistical analysis of the simulation results) and the procedure implementation training.

6. SYSTEM MODES OF OPERATION
Three different modes of operation will be available to the user. For each mode of operation a brief description of the kind of support provided and a figure are reported hereafter.

Contingency mode: this mode of operation will be used to support contingency planning activity of anti-crisis services for an hypothetical crisis situation.

The planner will be provided with a rough estimation of the results achievable with his plan. This will allow him to identify the best way to employ available assets, the limits of the achievable response and the effectiveness of different inter/intra-services cooperation procedures.

![Figure 3: Contingency Mode](image)

Response mode: this mode of operation will be used to help local commanders of anti-crisis services to make better decisions in case of a real crisis situation in progress. The decision support is provided in the form of what if analysis and in the form of guide to help the user in the implementation of the correct procedure.

![Figure 4: Response Mode](image)
Training mode: aim of this mode of operation is to train the user in:

- making use of the SICMA system,
- implementing the correct procedure,
- making decisions.

Figure 5: Training Mode

7. CONCLUSIONS
The SICMA FP7 capability project started in March 2008 to demonstrate “if” and “how” an integrated suite of modeling and analysis tools could improve the effectiveness of the Crisis Managers decision making.

At the end of the first year of activities the requirements have been identified and the system architecture has been designed.

The final result is expected to be a prototype able to demonstrate the improvement (in terms of e.g. performance, reliability, speed and cost) achievable in the decision making process through the support of M&S technology.

More in detail a significant improvement is expected in the activities listed hereafter (highlighting the Crisis Management phase they refers to):

- Preparedness Phase: assisting in the identification of: the best way to employ available assets, the limits of the achievable response and the effectiveness of different inter/intra-services cooperation procedures.
- Response Phase: providing a forecast of scenario evolution, proposing doctrine-based solutions and evaluating the effects of alternative decisions.

Considering that the main focus of the project is on the Health Service decision makers, a successful achievement of the project objectives would suggest to extend the experimentation to the domains of the other services involved in the Crisis Management process.

REFERENCES


AUTHORS BIOGRAPHY
Giuseppe La Posta was born in Roma (Italy) on 1969; he graduated from Rome University “La Sapienza” in 1996 with a first class honours degree in Electronic Engineering.

In the years 1998-2000 he worked at Alenia Aerospazio S.p.A. as designer of satellite telecommunications systems. Since 2000 he has been working at Elsag Datamat S.p.A a Finmeccanica company. During the period from 2000 to 2002 he was involved as a software analyst and team leader in several R&D national and international projects. Since 2003 he is Programme Manager in the Defence R&D Unit (Government and Institutions Division), in charge of the management and coordination of the research activities on M&S systems for training, planning and decision support. He is currently the coordinator of the FP7 SICMA capability project.

His main skills include Programme Management, Requirement Analysis, System Design and Software Design.

Tiziano Mischi was born december 30, 1975 in Rome, Italy. He graduated from “Università degli Studi di Roma Tre” in Rome in 2001 as an electronic engineer. Despite his electronic studies, he has decided to work as a software engineer. He’s been working in the Defence R&D unit at Elsag Datamat since 2002 and has been involved in several projects, both in international and national field.

Until 2007 he has been the main developer for decision support tools in logistics and tactics for several project in the R&D unit. Since 2007 he is the technical coordinator responsible for the developing of a multi-purpose Graphic User Interface (GUI) for a geo-referenced data access. Since 2008 he’s also developing the SICMA GUI as an implementation of the mentioned multi-purpose GUI.