Studying the resilience of communications in organizations using formal modelling and simulation

Cristina Ruiz-Martin[[1]](#footnote-1)2, Gabriel Wainer1, Adolfo Lopez-Paredes[[2]](#footnote-2)

After the nuclear accident at TEPCO’s Fukushima Nuclear Power Plant (NPP) different studies pointed out that the emergency plan was not resilient [1]. After these analyses, we decided to ask ourselves: How can we design resilient emergency plans?

To answer this question, since emergency plans can be considered a virtual organization, we started reviewing the concept of organizational resilience and how to measure it. We found a close relationship between resilient and viable organizations. Taking into account this relation, we proposed to apply the methodology to design viable organizations, introduced by Pérez Rios [2], to the design of resilient organizations. This methodology, based on the Viable System Model (VSM), highlights the importance of the communications for the well-functioning of the organization.

Due to the importance of the communications, we have focused on their study. The communications inside organizations can be studied as a diffusion process in multiplex networks. Researcher at the Laboratoire de l'Intégration du Matériau au Système (IMS) at University of Bordeaux developed an architecture to simulate information diffusion processes in social networks [3]. We studied this architecture and we tested its applicability to study resilience of communications inside organizations. We used as case study a real Nuclear Emergency Plan (NEP) from Spain. We found that their architecture, although it was successfully proven to study the information diffusion process in social networks [4] and adapted to study business processes in the healthcare sector [5] was not suitable to include all the attributes specified in plan. For example, in our case, the behavior of the people is defined using complex rules that do not fit in a table format. Storing the properties in a table is a restriction of this architecture since it uses MySQL. We need structures that are more complex in order to store the behavior of the agents. Moreover, the *Server-Proxy* architecture does not allow us to include all the properties of our model. We are studying the diffusion of information between people, which use different devices, and these devices are connected through different networks. We are interested in studying different scenarios where both the devices and networks can fail. Therefore, it is crucial to include both of them in the model. Finally, to simulate dynamic networks, they use Dynamic DEVS (DS-DEVS). The use of DS-DEVS implies that we need to store all possible network configurations we want to simulate, which is not efficient in time of definition efforts and storage.

Based on the architecture presented in [3], we propose an improved version that overcomes these issues. We also use Network Theory, ABM, and formal Modeling and Simulation (M&S), in our case we also use DEVS. A main difference is that this new architecture is general and can be used for any type of diffusion process in multiplex dynamic networks. There are many other aspects that differ. We introduce a development process (and a generic implementation of the architecture). We define a generic Diffusion Abstract Model (DAM) that can be modeled and implemented using other formal M&S methodologies different from DEVS. The design of the DAM is flexible and it allows modeling diffusion processes without storing all possible network configurations. It also provides several advantages such as including other properties of the network, as detail in the rest of the thesis.

Using the proposed architecture, we were able to proposed improvements to the communications in the emergency plan.

**References**

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1. Department of Electric and Computer Engineering. Carleton University. Ottawa, Canada, USA, E-mail: cruiz@eii.uva.es; gwainer@sce.carleton.ca [↑](#footnote-ref-1)
2. INSISOC, Universidad de Valladolid, Valladolid, Spain, E-mail:aparedes@eii.uva.es [↑](#footnote-ref-2)