Statistics as a Toolbox for Electromagnetic Interferences Modeling

C. Kasmi* [1, 2], M. Hélier[2], M. Darces[2] and E. Prouff[1]
(1) French Network and Information Security Agency, ANSSI, France
(2) UPMC Univ. Paris 06, UR2, L2E, BC 252, 4 place Jussieu, 75005 Paris, France

Safety and security of critical infrastructures rely on the robustness of the involved systems to *electromagnetic interferences* from the electromagnetic compatibility point of view. In recent years, documented *electromagnetic interferences* attacks have demonstrated the susceptibility of devices (F. Sabath, European Electromagnetics EUROEM 2012*,* pp.65, 2-6 July 2012) as well as the potential *unintentional electromagnetic compromising emanations* radiated by the concerned information systems (Vuagnoux, M.; Pasini, S.; 2010 IEEE International Symposium on EMC, pp.121-126, 25-30 July 2010) that may result in the leakage of sensitive information. The damaging effects of EMI pose unacceptable risks in critical applications. It is therefore necessary to manage such interferences in order to reduce the risks to tolerable levels. Most studies and their inherited standards mainly focus on the general trends and central tendencies. Nevertheless it has been demonstrated in many domains (e.g. storms prediction or trading) that extreme events should be part of the analysis, especially when security and safety are under concern.

The power-grid acts as a guiding structure for electromagnetic interferences; it is hence a good context to derive statistical formalisms. Based on the *electromagnetic topology* (J-P. Parmantier and S. Bertuol, CRIPTE Training and Electromagnetic coupling on cable networks, 2011, ONERA, France), the modeling of Low Voltage distribution network has been achieved. It has been observed that the variability of the input modeling parameters may impact the accuracy of results. Those parameters were classified depending on their effects on the propagation of electromagnetic interferences in the power grid thanks to the *Generalized Experimental Design* (D. C. Montgomery, Design and Analysis of Experiments, Wiley, 2012). This method has also been applied to compute the interactions between parameters.

We consider a spurious current induced by an external excitation signal as a physical quantity. Its distribution can be described using the statistical moments. The analysis of the higher-order statistical moments of both central tendencies and extreme values (H. Taleb, The Black Swan: the impact of the highly improbable, Random House, New York, N.N. 2010) and the exhibition of their differences raised the need for a well-defined theory in order to precisely describe the extreme events. This has been achieved thanks to the *Extremal Types Theorem* (N. Tajvidi, PhD thesis, Department of Mathematics, Chalmers, Göteborg, 1996) and, more precisely, by following the *Peaks-Over-Thresholds* approach. This methodology consists in approximating the distribution of excesses over some thresholds by a *Generalized Pareto Distribution*. The distribution of the related quantities can be described using the so-called *Hybrid Pareto Distribution,* which is related to the combination of the adjusted central tendencies distribution with the adjusted extreme values distribution. The *Value-At-Risk* analysis can be applied to manage risks induced by electromagnetic interferences.