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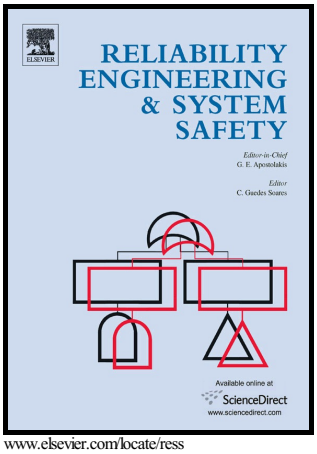

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PII: S0951-8320(16)00050-8
DOI: http://dx.doi.org/10.1016/j.ress.2016.02.009
Reference: RESS5509

To appear in: *Reliability Engineering and System Safety*

Received date: 12 March 2015
Revised date: 16 February 2016
Accepted date: 22 February 2016

Cite this article as: Enrico Zio, Challenges in the vulnerability and risk analysis o critical infrastructures, *Reliability Engineering and System Safety* http://dx.doi.org/10.1016/j.ress.2016.02.009

Challenges in the vulnerability and risk analysis of critical infrastructures

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ABSTRACT

The objective of this paper is to provide a systematic view on the problem of vulnerability and risk analysis of critical infrastructures. Reflections are made on the inherent complexities of these systems, related challenges are identified and possible ways forward for their analysis and management are indicated. Specifically: the framework of vulnerability and risk analysis is examined in relation to its application for the protection and resilience of critical infrastructures; it is argued that the complexity of these systems is a challenging characteristic, which calls for the integration of different modeling perspectives and new approaches of analysis; examples of are given in relation to the Internet and, particularly, the electric power grid, as representative of critical infrastructures and the associated complexity; the integration of different types of analyses and methods of system modeling is put forward for capturing the inherent structural and dynamic complexities of critical infrastructures and eventually evaluating their vulnerability and risk characteristics, so that decisions on protections and resilience actions can be taken with the required confidence.

Keywords: *critical infrastructures, complex systems, systems of systems, electric power grids, smart grids, vulnerability, risk, resilience, uncertainty*

1. INTRODUCTION

In this paper, we consider critical infrastructures (CI) like the energy transmission and distribution networks, the telecommunication networks, the transportation systems, the water and gas distribution systems. These are complex systems made by many interacting components assembled by design to provide optimal performance, reliable operation and functional safety (Rouse 2003; Ottino 2004).

CI are designed to function for long periods of time (several tens of years), through maintenance, updating and integration of new technologies. Extensions of capacity are also often required to meet changing and growing service demands. This leads to the need of injecting flexibility and adaptabiliy to the system engineering design, to respond to the ever-changing domains of technology, society, economy, legislation and politics, which determine the profiles of service demand and the corresponding expected performance.

In this scenario of technologically and structurally evolving (and more and more interdependent) CI, understandable concerns are arising on their vulnerability and risk of failure, i.e. on the danger that:

- the allocated system capacities may not be adequate to support the growing demands in scenarios of greater CI integration and market deregulation;
- the safety margins preventively designed may not be sufficient to cope with the expected and, most of all, unexpected stresses arriving onto the systems.