World Academy of Science, Engineering and Technology
International Journal of Civil and Environmental Engineering
Vol:9, No:03, 2015

Vulnerability Assessment of Healthcare Interdependent Critical Infrastructure Coloured Petri Net Model

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Abstract : Critical Infrastructure (CI) consists of services and technological networks such as healthcare, transport, water supply, electricity supply, information technology etc. These systems are necessary for the well-being and to maintain effective functioning of society. Critical Infrastructures can be represented as nodes in a network where they are connected through a set of links depicting the logical relationship among them; these nodes are interdependent on each other and interact with each at other at various levels, such that the state of each infrastructure influences or is correlated to the state of another. Disruption in the service of one infrastructure nodes of the network during a disaster would lead to cascading and escalating disruptions across other infrastructures nodes in the network. The operation of Healthcare Infrastructure is one such Critical Infrastructure that depends upon a complex interdependent network of other Critical Infrastructure, and during disasters it is very vital for the Healthcare Infrastructure to be protected, accessible and prepared for a mass casualty. To reduce the consequences of a disaster on the Critical Infrastructure and to ensure a resilient Critical Health Infrastructure network, knowledge, understanding, modeling, and analyzing the inter-dependencies between the infrastructures is required. The paper would present inter-dependencies related to Healthcare Critical Infrastructure based on Hierarchical Coloured Petri Nets modeling approach, given a flood scenario as the disaster which would disrupt the infrastructure nodes. The model properties are being analyzed for the various state changes which occur when there is a disruption or damage to any of the Critical Infrastructure. The failure probabilities for the failure risk of interconnected systems are calculated by deriving a reachability graph, which is later mapped to a Markov chain. By analytically solving and analyzing the Markov chain, the overall vulnerability of the Healthcare CI HCPN model is demonstrated. The entire model would be integrated with Geographic information-based decision support system to visualize the dynamic behavior of the interdependency of the Healthcare and related CI network in a geographically based environment.

Keywords : critical infrastructure interdependency, hierarchical coloured petrinet, healthcare critical infrastructure, Petri Nets, Markov chain
Conference Title : ICSDCI 2015 : International Conference on Sustainable Development of Critical Infrastructure
Conference Location : Prague, Czechia
Conference Dates : March 23-24, 2015