Infrastructure Model Development for High Power Electromagnetic (HPEM) Threats

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In the past several years, there have been significant efforts to understand the effects of high power electromagnetic (HPEM) environments acting upon electrical systems. In most cases, analytical modeling or experimental techniques are used to estimate how a targeted system might react when subjected to the HPEM threat. The results of such studies are often expressed in terms of a probability of effect, such as a failure or an upset, in the equipment of concern.

Recent events involving war, weather, earthquakes and the like have made it clear that to understand the impact of the failure of a piece of equipment on its operational group (or sector) and on the larger societal infrastructure, one must understand and quantify the linkages between all sectors of the infrastructure. Using ideas from the social sciences, a technical infrastructure consisting of communications, power production and delivery, transportation and health care can be thought of much like a network of "players" in society – linked together in different manners and with different degrees of closeness. Disabling one of the sectors in the infrastructure (say by an HPEM attack) can have a dramatic effect on the functioning of the remaining sectors. It is of interest to develop methodologies for studying these interactions between the infrastructure sectors.

Recent interest in the issue of infrastructure modeling at the Swiss HPEM Laboratory has resulted in a preliminary study of this topic, which is described in this paper. In our work we have examined several ways of modeling the response of an infrastructure to external excitations or perturbations. Specifically, we have summarized methods for representing or viewing an infrastructure, described ways of characterizing infrastructure responses, and discussed techniques for performing infrastructure simulation.

In the latter area of simulation, a new analysis model based on the BLT equation has been suggested. This model is similar to the input/output economic model of Leontief, but it contains time variations of the various input/output quantities at the nodes (the sectors) and transit-time delays along the network links (tubes).

While a few numerical calculations using this new BLT modeling approach have been performed and will be illustrated in the paper, it still remains to understand more thoroughly the implications of this model. For example, transient modeling needs to be more fully explored and the observed issue of non-physical solutions to the input/output relationships needs to be resolved.