Computational Electromagnetics and EMC
-- What's Next?

Colin E. Brench
Hewlett-Packard Company
200 Forest St, Marlborough MA 01752
colin.brench@hp.com

As I type this up I must admit to suffering from PC envy. My wife has a new laptop that incorporates a faster CPU and more and faster memory than mine. Over the years my CEM engine has migrated from a cluster of specially build VAX systems in the corner of my office through large servers and now primarily resides with my PC desktop. My laptop that was completely adequate for my needs a few months ago now seems a bit slow, though this is offset by being light in weight, which I do appreciate for traveling.

As computers became more capable I always assumed that the problems I would tackle would expand and always challenge the available resources. This really has not happened; I find myself running models and still have unused RAM. Similarly, the time I have to wait for results does not seem to be too long. Not only have computers improved but the efficiency of the tools I use have improved. So why is EMC modeling still such a difficult problem? – there are no more excuses about insufficient compute power or inadequate tools.

The challenge faced by EMC engineers is largely one due to the stray and parasitic nature of EMC issues. Recent discussions concerning losses on high data rate lines raised the issue of loss through radiation and how much impact it had to the numbers. Looking at the issue from a signal integrity engineer's viewpoint, losses attenuate the wanted signal and contribute to data errors; so all sources of loss are to some extent important. After a rather quick analysis with NEC it became clear that the loss due to radiation was 20dB or more less than other losses in the path. Microwatts rather than milliwatts, this fact put the issue of radiation loss out of view for the mainstream designer engineers. However, these losses are far from insignificant to the EMC engineer where a microwatt or so in the wrong place will cause major headaches.

Consider the EMC problem where high data rate signals are sent from one printed circuit card to another. For the signal integrity engineer there are copper and dielectric losses, discontinuities where signals transition from the source device to etch, from etch to connector back to etch, and then to the final termination. For the EMC engineer the picture may include many more elements. The source device alone may exhibit small loops that can radiate, it may couple to a heat sink or heat spreader on the package, and if not adequately decoupled or vias incorrectly positioned, there may be unwanted currents in the vicinity of the device. Each discontinuity adds a little extra uncertainty into the way the structure could radiate. A final issue that can be missed is the effect of positioning these two boards close to any other conductors. A small loop or plate on the source device might be a terrible antenna but, when placed in close proximity to the side of an enclosure or the backside of another printed circuit board, radiation may be greatly enhanced. The EMC engineer has a very complex problem that is difficult even to define.

The nature of the EMC problem often means solving the same general source structure a number of times each under different conditions. This often results in numerous, practically identical runs. Now, the computers don't mind this and as stated earlier they are getting faster. The basic fact is that 90% or more of the solution is identical each time – perhaps there is a place for EM modeling tools that allow for elements to be added or moved within the simulation in an intelligent manner such that only the segments that need to change do so. There are more cases like this than might be first thought, interactions between antennas on masts are important studies. Today, with the prevalence of cell phones and many other wireless devices, coupling issues become highly complex. Distance, polarization, and radiation patterns can change moment by moment with other key factors staying constant. These problems are quite different from those faced even ten years ago.

CEM has come a long way; computer technology has developed but also the world has become far more complex. One of the next challenges faced in the continuing creation of better techniques and algorithms may well be an entirely different approach to solving EM problems. An approach that is more general rather than specific, one that looks at the sensitivity of the elements within a structure to external influence as well as those internal to the primary structure – these might be the new techniques of tomorrow. I have some unused RAM and extra CPU cycles, so am ready and anticipating the next innovations.