SIMULATION AND SIGNAL INTEGRITY IN POWEREDGE SERVERS

Tech Note by:
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SUMMARY

Signal integrity in a server platform is critical to data fidelity and high performance.

Dell EMC ensures signal integrity through a sophisticated, simulation-driven process in which we run millions of simulations for each server generation.

The simulation process is the result of our goal to provide the highest quality, highest performing servers that simultaneously deliver superior TCO and ROI to customers.

The speeds at which various server sub-systems such as memory, storage, and I/O, communicate have steadily increased over time. While at the inception of computing, communication was through discrete voltage levels representing a '1' or a '0', now the signals between components, which can switch billions of times a second, act more like a wave. With a wave, any discontinuity in the path of the signal can dampen and distort the signal. If a signal is weakened enough, it may not accurately transmit data.

Since servers contain discrete components such as memory DIMMs and disk drives, items such as connectors, circuit boards, and cables must be used to connect them to the CPU, and to each other. Every transition the signal has to make from one component to the next represents a discontinuity. To ensure that the signal is accurately received, a great deal of effort goes into designing the 'channel'. The communications channel is all of the elements that connect a transmitter and a receiver, such as shown in Figure 1 on page 2.

As seen with the ripples on a pond, waves reflect when they encounter obstacles and interfere with each other, slowly weakening the initial wave. In our communications channel, the discontinuities would be the obstacles; the channel can also resonate when the signal is at a certain frequency, hence interfering with proper transmission.

At Dell EMC, we want to provide our customers with the highest performance and the highest quality products, and thus we strive to innovate new signal transmission techniques with each generation. For example, at the launch of the DDR4 memory technology standard, Dell EMC servers achieved some of the highest three DIMM per channel speeds among Intel x86 servers. This in turn allows our customers to run their workloads faster.

Turning concept into reality

Once we develop a concept for a server that addresses customer workloads, we need to understand if the concept turned into reality will function, and particularly if all the communications channels will allow

operation at the targeted speed. Designing a channel requires us to build accurate mathematical models of each element of the channel, and simulate the signal traversing the channel many *billions* of times. We perform those simulations on PowerEdge servers.

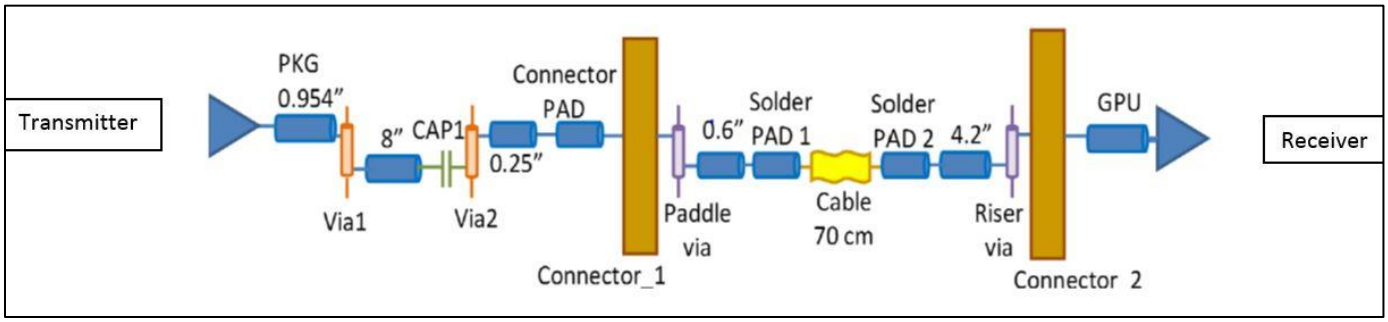

Figure 1: Example of a communications channel

Simulating reality

For us to be sure that every one of the millions of servers we sell will operate at the advertised speed for years to come, we have to simulate several conditions. In the case of memory, for example, these conditions include not only the various memory configurations that are orderable, but also all of the manufacturing tolerances in the silicon of the CPU and the memory chip, and the tolerances of connectors and circuit boards. All of the combinations that represent the manufacturing life of a product can run into the hundreds of thousands of simulations for each sub-system.

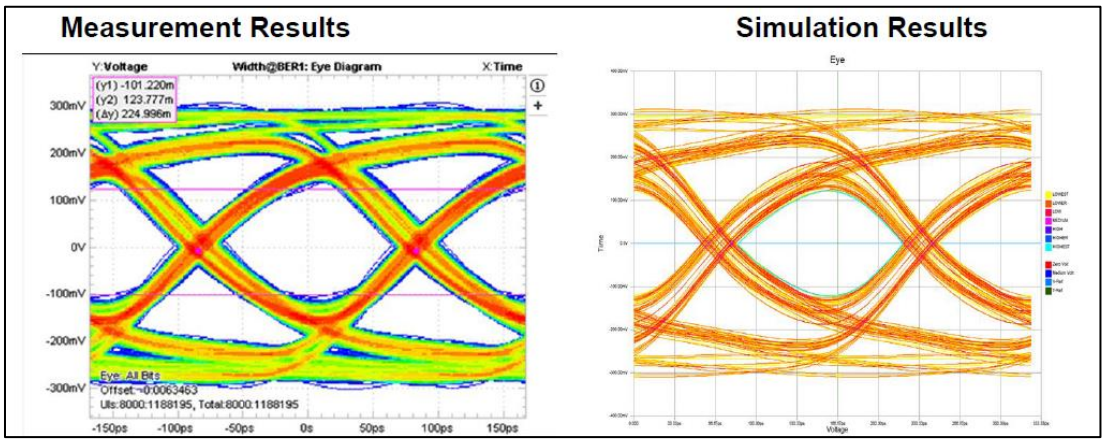

Figure 2: Accuracy of Dell EMC simulations (right) relative actual measurements (left)

Dell EMC engineers, several with doctoral degrees in advanced mathematics and electro-magnetic engineering, design the mathematical algorithms that we convert to software that ultimately runs millions of simulations for each product generation. All of this research also yields many innovations that lead to patents filed by our engineers every year.

In Conclusion

Running millions of simulations does more than create the highest quality products and deliver the highest possible performance. By simulating speeds that are expected in the future, we can produce flexible server platforms today that can be upgraded many years into the future. This gives PowerEdge servers a lengthy lifecycle, helping customers to protect their IT investments, attain superior total cost of ownership (TCO) and enhance their return on investment (ROI).