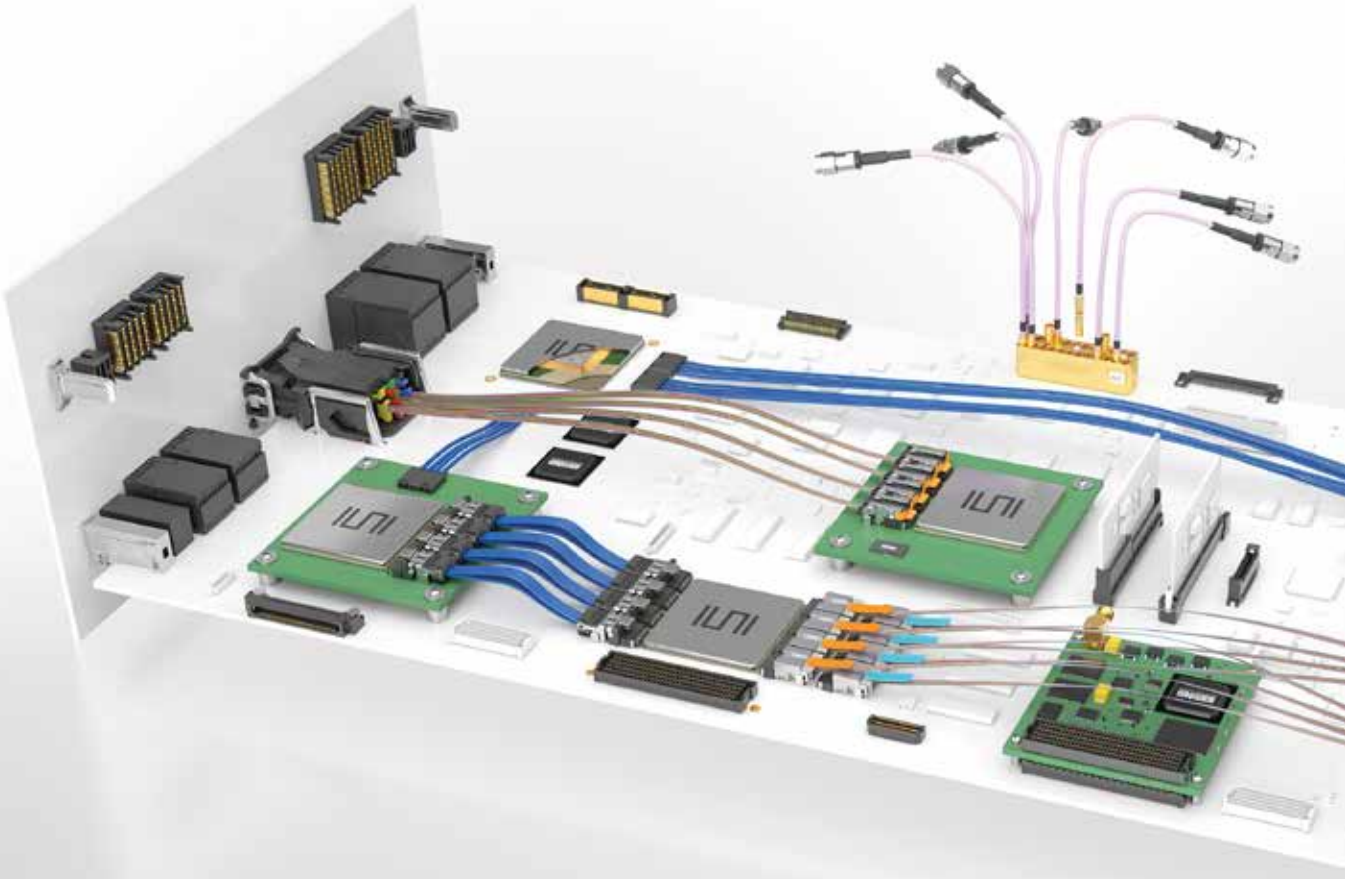

Deep Channel Analysis for High-Speed Interconnect Solutions

Data center servers, storage and networking equipment communicate over copper and optical cable assemblies joined by ever-faster connectors. Samtec leverages a comprehensive suite of simulation software from ANSYS to design and optimize next-generation, high-performance interconnect solutions across the entire signal channel.

By **Scott McMorrow**, CTO, Signal Integrity Group, and **Matt Burns**, Product Marketing Manager, Samtec, Inc., New Albany, USA

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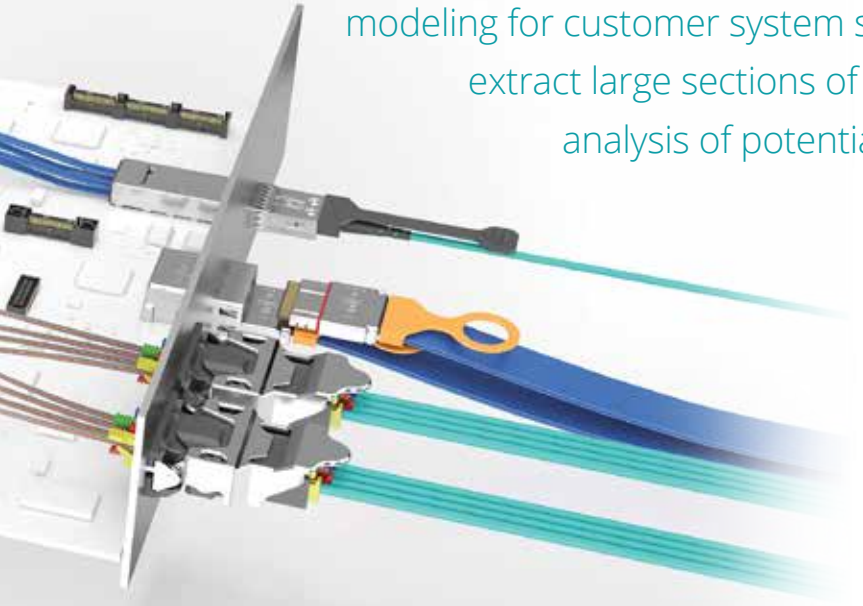


Data. Data. Data. Consumers demand real-time access to personal and professional data no matter where they are or what the time of day. Twenty-first–century consumers and workers are untethered, so mobile data is expected. At the end of 2016, global mobile data traffic reached 7.2 exabytes per month (an exabyte is one billion gigabytes). That number will exceed 49 exabytes per month by 2021 [1].

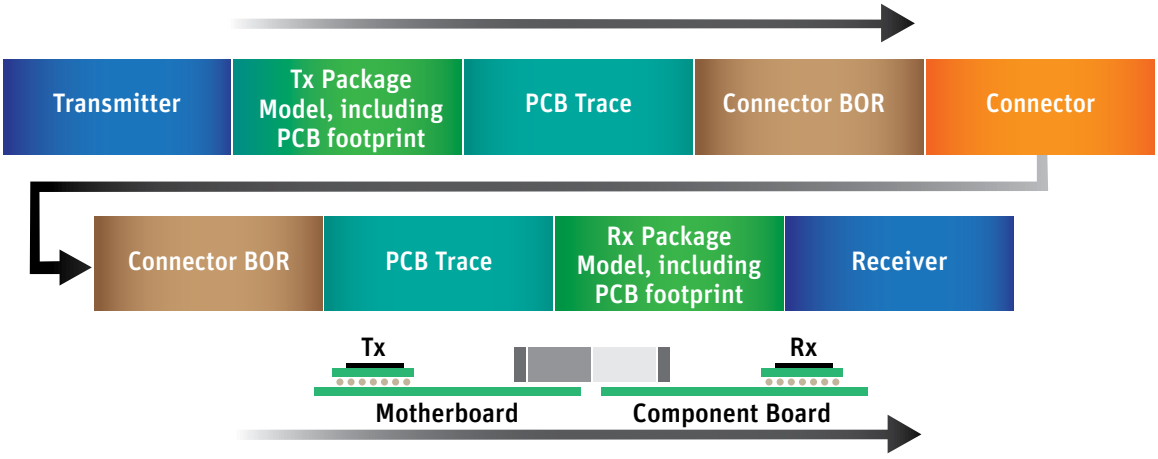
The demands of easily accessible mobile data via cellular and fixed networks (via Wi-Fi and low-power cellular base stations called femtocells) places increasing demand on data centers and backbone networks. Data center equipment — servers, storage, communications and networking — are constantly upgraded to support higher data rates.

Data center equipment OEMs must keep up with demand. Current-generation solutions typically support data rates of 10 Gbps to 15 Gbps. Next-generation solutions will operate at 28 Gbps/56 Gbps and beyond. Routing high-speed signals throughout a system presents many design challenges. While legacy design decisions were made at the component level, engineering 28 Gbps systems requires a deep analysis of the entire channel from IC to IC via packages, PCBs and interconnect solutions. How does Samtec — the service leader in the electronic interconnect industry with full-channel system support from the IC to the board and beyond — support deep analysis throughout the high-speed channel?

Designing a High-Speed Signal Channel

Next-generation, multigigabit-per-second designs require a holistic approach for the signal channel path. Developers cannot focus on just one component, but must analyze and optimize the interaction of all components across the entire channel.

Each component in a channel has design variables that affect the performance of others across the path. Connector variables such as insertion loss, return loss,



Components that typify a simple, standard 28 Gbps high-speed channel

crosstalk and impedance must be considered. PCB design decisions include placement, routing, material/laminate selection, trace lengths and impedance matching — all of which can enhance or adversely affect the performance of the high-speed serial channel. The breakout region (BOR) of PCB traces from the connector is often overlooked, yet it can break a design.

Designing and optimizing the high-speed channel requires two basic steps. Engineers must model each particular component in the channel. The channel model is created from the concatenation of these component models to form a complete system. The system model can then be simulated, modeled, analyzed and tested at data rates of 28 Gbps and beyond.

Modeling Complex 3-D Components

Channel components, especially connectors and cable assemblies, are complex 3-D mechanical structures that typically are mechanically modeled in industry-standard MCAD tools. Samtec's engineers port the mechanical models into the ANSYS HFSS software tool to analyze and optimize 3-D structures with high-frequency electromagnetic fields.

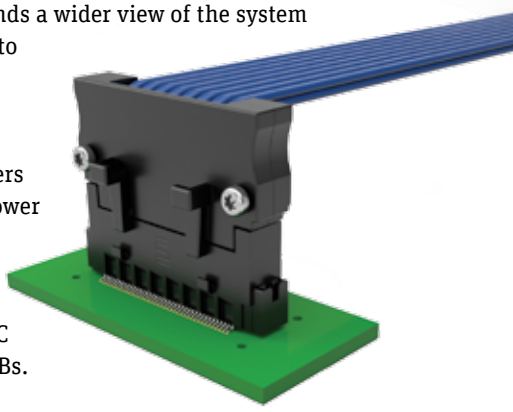
The flexibility of the state-of the-art 3-D full-wave solvers in HFSS allows Samtec to target subcomponent modeling as well. Modeling 3-D structures of PCB traces, cables, RF launches and the complex transitions between PCBs, the package and multichip modules (MCMs) expand channel optimization capabilities.

The accuracy of ANSYS HFSS also enables improved channel optimization. Solver accuracy can reach error levels well below manufacturing tolerance, which allows virtual prototyping. When combined with the speed and capacity of high-performance computing (HPC), Samtec leverages HFSS accuracy to offer predictable correlation to measurements at frequencies up to 70 GHz. Driven by system inputs, Samtec can fine-tune channel variables, like the connector BOR, via placement, trace type, manufacturing variability and other factors to drive accurate analysis and simulation across the channel. In addition, advances in HFSS solver technology for hybrid planar/3-D designs in HFSS 3-D Layout have enabled Samtec engineers to rapidly prototype complex interactions between components and PCBs, compressing the time to solution from weeks to days, and from days to hours.

HFSS 3-D Components
ansys.com/HFSS-3D

Optimizing IC Packages and PCBs

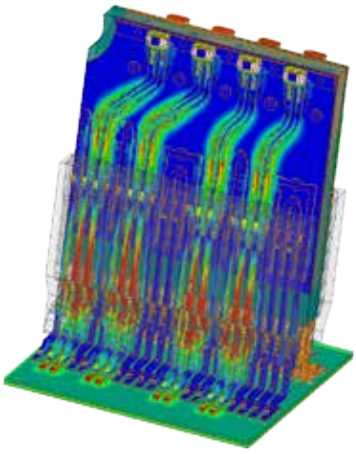
Optimizing the signal channel requires optimizing large integrated circuit (IC) packages and PCBs found within the channel. These components present unique design challenges as well. Optimizing larger structures demands a wider view of the system and, in addition to high-frequency electromagnetic simulation and analysis, engineers must consider power integrity, signal integrity, crosstalk and EMI analysis of IC packages and PCBs.



MCAD 3-D rendering of Samtec MEC5-DV connector and cable assembly

> “The company continues to leverage the capability of ANSYS software to shorten product design cycles and expand its capabilities to provide next-generation products to tech industry performance leaders.”

Samtec uses ANSYS SIwave software to model and analyze large planar PCB and IC package high-speed channels and complete power delivery networks (PDNs). Using SIwave, Samtec can design current flow pathways, eliminate current crowding and minimize IR voltage drops virtually in internal connector test boards and customer-specific applications. Samtec can also model resonances, reflections, inter-trace coupling, simultaneous switching noise, power/ground bounce and DC voltage/current distributions, and near- and far-field radiation patterns in connector breakout regions, packages and PCBs. Using what Samtec terms “deep modeling technology,” SIwave models entire buses and packages using S-parameters with hundreds or thousands of ports in hours so that Samtec designers and customers can identify critical signal integrity / power integrity issues without guesswork. Problems that could not be solved five years ago are now readily solved with SIwave running in a high-performance computing (HPC) environment.



ANSYS HFSS-modeled electric field within Samtec MEC5-DV connector and cable assembly

Circuit Simulations Across the Channel

Once the channel has been modeled and characterized electromagnetically with ANSYS HFSS and SIwave, the remaining step is circuit simulation across the channel. Samtec uses ANSYS Nexxim time-domain circuit simulation engines to perform full-channel simulations of a high-speed interconnect.

Industry-standard IBIS-AMI drivers and receivers act as signal transmitters and receivers across the channel signal path. When used in combination with IBIS-AMI, the Nexxim circuit simulator represents the industry’s leading solution for high-speed communication channel design. The ANSYS Nexxim circuit solver combines IBIS-AMI models with the channel performance model to provide SerDes circuit and timing analysis. This approach provides virtual time-domain compliance to the Samtec design team.

ANSYS High-Performance Computing Options

Simulating, analyzing and optimizing the entire high-speed channel signal path across multiple components can be time intensive. Samtec leverages the HPC capabilities of the ANSYS tools to increase problem size and complexity while minimizing time-to-solution. Engineers can increase product performance while reducing the overall design cycle.

Samtec has developed the appropriate IT infrastructure to fully leverage the HPC features from the ANSYS tool suite. Leveraging the HPC capabilities of ANSYS tools is necessary to harness bigger, faster and higher-fidelity simulations. Like many companies, Samtec has engineering and signal-integrity resources located in many places with multicore servers and multiple scalable computing clusters to fully unlock the HPC capabilities of the ANSYS tools across the world.

For ANSYS HFSS and SIwave applications, Samtec leverages highly parallelized clusters running HFSS to achieve full-wave solve times accelerated by 10 times to 100 times. Engineers can perform large connector modeling for customer system simulations and extract large sections of packages with thousands of ports for deep analysis of potential issues.

Conclusion

The combination of Samtec’s SI capabilities for 28 Gbps (and faster) channels with ANSYS tools provides data-center equipment OEMs a platform for deep channel analysis. Samtec is currently developing a 112 Gbps connectors, package and interconnect design, using ANSYS software to shorten product design cycles and expand its capabilities to provide next-generation products to tech industry performance leaders.

Reference

[1] Cisco Visual Networking Index: Global Mobile Data Traffic Forecast Update, 2016–2021 White Paper