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RF LOSES ITS MYSTERY

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By Janine Love, Contributing Editor

System-Level Simulation: RF Loses Its Mystery

Today's designers need tools that automatically bring RF blocks to be part of the main system design.

For years, radio-frequency (RF) simulation was typically performed separately and then ported into the system design. In contrast, today's designs require the RF blocks to be part of the main system design. While this change may have caused RF design to lose some of its mystique, system simulation has subsequently become much more complex. Fortunately, simulation software vendors are keeping pace.

RF and microwave simulation tools are evolving to consider the multiple effects inherent in highly integrated designs. In addition, they're offering options to interactively measure during simulation, reducing the need to wait for a final result before making design decisions. These features are combining to speed time to manufacturing. However, Ted Miracco, executive vice president and founder of AWR Corp., warns that we can no longer measure productivity simply by a simulator's solve time. Instead, Miracco argues that a measurement of productivity must encompass everything from schematic entry all the way through to design rule checking (DRC), layout versus schematic (LVS), and final manufacturing.

"Simulation needs to be tightly linked to the design environment and layout," observes Nebabie Kebebew, product marketing manager, Cadence. "Areas like modeling, synthesis, foundry kits, verification against wireless standards, layout, layout verification, links to test equipment, and links to other CAD tools are all part of the mix. This complete flow can be accomplished using a single toolset," adds Charles Plott, product marketing and planning manager, Agilent EEsof EDA Division, Agilent Technologies.

By way of encouragement, Markus Kopp, ANSYS® product manager, electronics, thinks that engineers should be aware of the vast improvements in the accuracy of simulations. "3D RF simulation can give absolute results that are as accurate as measurements," he observes. Kopp goes on to note that the state of the

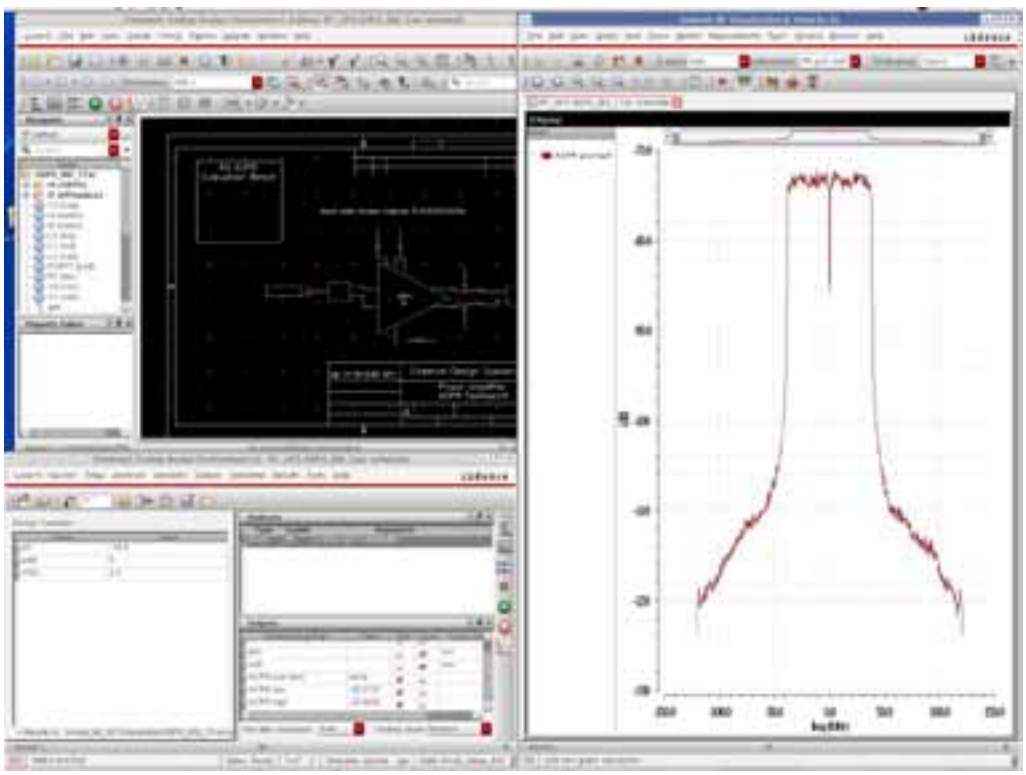

Figure 1: This screenshot is from Cadence's Virtuoso Accelerated Parallel Simulator RF for accuracy and productivity.

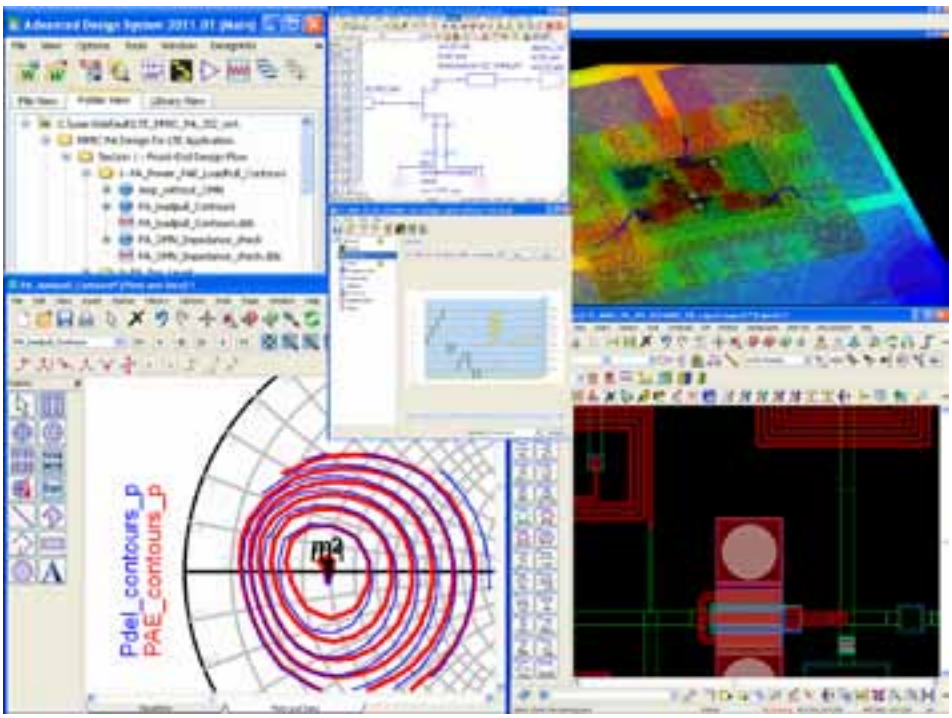

Figure 2: Agilent's ADS 2011 is optimized for functionality, usability, and multi-technology design.

art in simulation technology is no longer just modeling a component or circuit, but an entire system: "It is easily possible to model circuits that include 3D field simulations."

BIGGEST CHALLENGES

Given that RF simulation has grown to the system level, some of the biggest simulation challenges certainly include simulation speed and dealing with integration. Beyond that, 'RF simulation' is now encompassed into the larger system design. So some designers without RF expertise are being asked to model and design RF blocks. Making RF simulation easier while designs become more challenging has become a bit of a conundrum for simulation vendors.

"The biggest challenge today is making 3D full-wave electromagnetic (EM) simulations available to designers not versed in 3D modeling," agrees Kopp. He sees an increase in 3D simulation tools being used by engineers who aren't well versed in RF simulation technologies and concepts.

The impact of subcomponents in highly integrated designs is becoming more of a concern. "The biggest challenge is to do a full chip simulation and know what impact all of the subcomponents have on each other," says Cadence's Kebebew. "When I talk with designers, I find that often, they are not aware of the issues when they tape out. Then, it becomes a guessing game to pinpoint what the problem is."

Unfortunately, time isn't on the designer's side. So speed must be. To quickly achieve increasingly complex simulations, many engineers are taking advantage of multicore or high-performance-computing (HPC) cluster licenses to speed time to design. These new options allow quick and accurate results for multiple RF simulation needs, including linear, harmonic balance, transient, convolution, circuit envelope, data flow, planar EM, and full 3D EM. Agilent's Momentum product for EM simulation, for example, has been enhanced with new algorithms, multicore licenses, and compute farm licenses in order to accelerate simulation. And ANSYS HFSS has HPC options that enable parallel processing for complex models.

Beyond speed and integration issues, AWR's Miracco sees another problem looming for both commercial and aerospace/defense designers: thermal concerns. "Thermal simulations at the MMIC and module level are emerging as a critical simulation challenge. The need today is not only to simulate the junction temperatures of devices, but to make tradeoffs that might reduce temperatures and increase power-added efficiency and extend product MTBFs." Notably, AWR recently signed an agreement to integrate CapeSym's thermal-analysis software into its Microwave Office product.

LOOKING AHEAD

Kebebew sees a great deal of opportunity for RF functionality in the future, thanks to the growing worldwide adoption of 3G/4G protocols, home automation systems, and mobile connectivity. She sees this growing wireless market assisted by CMOS manufacturing supporting a "wireless transformation," where there will be a need to simulate more RF designs at the block level. "This will drive the need for more

automation, better accuracy, and comprehensive analysis in RF simulation that is closely linked to the design process from specification to layout."

ANSYS' Kopp sees future challenges growing out of the tablet market, requiring the simulation of new, thinner RF and microwave devices. "These small, thin devices will present design problems where electromagnetic, thermal, and mechanical issues will need to be addressed simultaneously. This will mean that RF engineers need to be able to include thermal-simulation capability directly into their models, and that mechanical engineers will rely on input from RF and thermal engineers."

Today's RF simulation tools take advantage of computing resources, have increased analysis capabilities, are closely linked with other EDA tools, and are integrated into the design flow. They can automate measurement setup and circuit extraction, and they include comprehensive libraries for wireless designs. Clearly, today's designers require all of these features in order to take the mystery out of RF design and bring it into the overall communications design flow. If history is any indication, we can expect RF simulation tool vendors to continue to anticipate and keep pace with changing needs.

SOME TOOLS FOR RF SIMULATION:

MENTOR GRAPHICS:

- **IE3D Signal Integrity:** Full-wave 3D EM design and verification for high-frequency IC, MMIC, package, and PCB designs
- IE3D plus Expedition Enterprise: Provides multiple designers the ability to co-design RF, analog, and digital circuitry on the same PCB

CADENCE:

- **Virtuoso Spectre Circuit Simulator RF:** RF simulation with comprehensive analyses; includes noise-aware PLL analysis and RF measurement library
- **Virtuoso Accelerated Parallel Simulator RF:** high-performance, post-layout, and multicore RF simulation (see Figure 1)

ANSYS:

- **HFSS:** 3D full-wave frequency-domain solver
- **HFSS-IE:** integral equation solver for large, unbounded simulations
- **Designer RF:** for design of microwave circuits and systems

AGILENT:

- Advanced Design System (ADS; see Figure 2)
- **EMPro:** 3D EM simulation
- **Genesys:** RF and microwave simulation software
- **Momentum:** 3D planar EM simulator
- **GoldenGate Software:** RFIC simulation software

AWR:

- **Microwave Office:** RF/microwave software
- **AWR Connected for CapeSym SYMMIC:** electrical-thermal tool combination (see Figure 3)

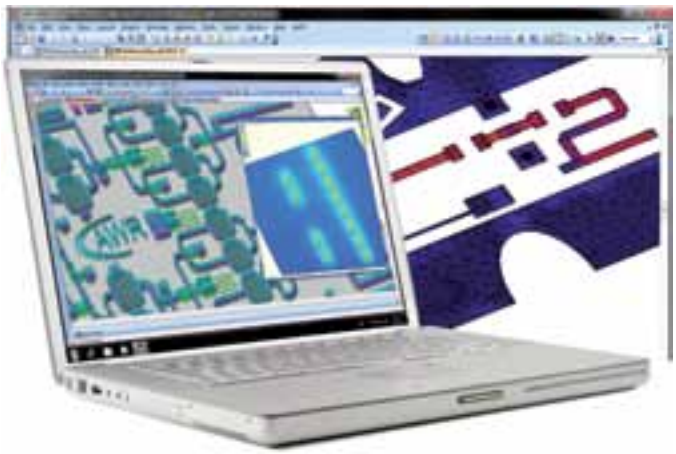

Figure 3: AWR's Microwave Office & SYMMIC target electrical-thermal simulation.

Janine Sullivan Love is a contributing editor and technical writer. Janine is a member of NASW and ACS and began working as a writer in the RF and microwave field more than 15 years ago.