APPLICATION **NOTE**

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Using Parallel and Remote Schematic Simulation and Optimization to Reduce Design Time

This application note overviews the options for high-performance electromagnetic (EM) computing for circuit simulations based on remote and parallel simulations within Cadence® AWR Design Environment® software, specifically the Cadence AWR® AXIEM® 3D planar and Cadence AWR Analyst™ 3D finite element method (FEM) solvers.

Design Overview

The increasing complexity of integrated monolithic microwave integrated circuit (MMIC), radio frequency integrated circuit (RFIC), and cross-fabric designs requires the support of powerful computational software beyond the limits posed by a single central processing unit (CPU). The ability to distribute circuit and EM simulations across multiple processors on a single computer or across external remote compute farms can dramatically reduce the overall simulation time for resource-intensive problems. Leveraging parallel computing enables design teams to verify the performance of large-scale systems (chip, package, and board assemblies) and to fully explore design options through optimization routines that may require hundreds if not thousands of iterations.

Parallel computing supports simulation of more than one job (simulation document such as a circuit schematic, EM structure, data file, netlist, etc.) on the same computer at the same time, for instance, an eight-core laptop running eight simulations in parallel on that one laptop. Remote computing, on the other hand, allows simulations to run somewhere other than the user's computer, such as if the user has access to a server farm with six machines to run. These two actions can also be combined for further speed advantages.

Evolution of Remote/Parallel Simulation in AWR Software

To provide designers with access to more compute power for complex designs, AWR software has evolved to support various remote/parallel simulation features. Remote computing allows users to set up an EM simulation in the AWR AXIEM or AWR Analyst solver on a local computer and simulate the structure on a different computer. By setting up dedicated, remote computers for resource-intensive simulations, designers can use local computers to continue working on other design tasks or perform smaller simulation problems.

Remote and parallel computing for circuit-based simulations was introduced to address growing design complexity. Circuit simulations usually take considerably less simulation time than EM simulations, often on the order of seconds. However, with the increasing size of RF/microwave intellectual property (IP) integration at both the IC and module packaging levels, it is often necessary to simulate these circuits with large embedded S-parameter models comprising of hundreds to almost a thousand input/output (I/O) ports over many frequency points. Networks containing these large broadband S-parameter files can take a much longer time to simulate.

Simulation Times for Different Configurations

Figure 1 illustrates the length of time it takes to run a simulation job with the four different options: local, local parallel, remote, and remote parallel. The timeline illustrates how simulation time can be cut dramatically from almost an hour to six minutes, depending on the configuration used.

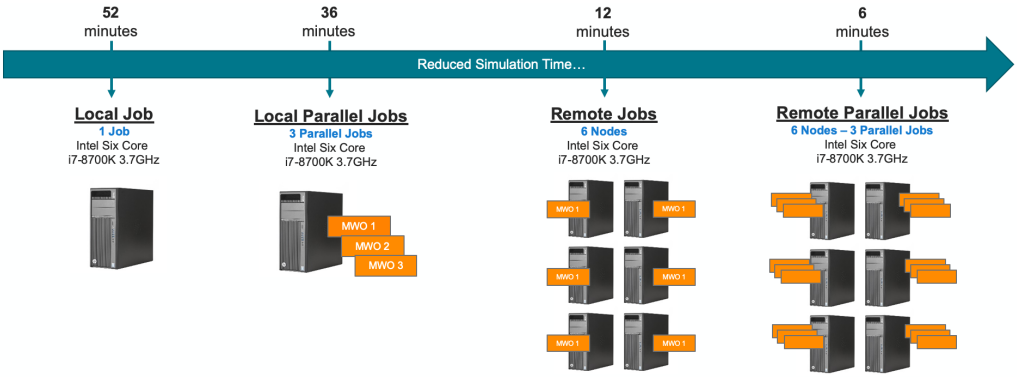

Figure 1: Comparison of simulation times depending upon which computing configuration is used

In this one example, running a circuit simulation as a local job took 52 minutes. Parallelizing it to run three jobs locally on a multi-core computer reduced the simulation time to 36 minutes. To further shorten simulation time, six different remote computers can be used with one job each, taking just 12 minutes. If the parallel and remote jobs are combined to run three parallel jobs on each of six remote computers, the simulation takes only six minutes. In addition to the time savings, this enables designers to share high-end hardware resources and multitask while continuing to work locally as the simulations run elsewhere. This capability enhances productivity by freeing the designer to consider more variants for improvements to the end product. Table 1 shows several user examples and the time it took for particular simulations.

Decomposition Type	Local	Local Parallel	Remote	Remote Parallel
Swept EM Simulation	105 min (1,1)	88 min (1,2)	20 min (6,1)	18 min (6,2)
Multiple Circuit Schematics	44 min (1,1)	48 min (1,3)	10 min (6,1)	9 min (6,3)
Circuit Schematic Optimization	52 min (1,1)	38 min (1,3)	12 min (6,1)	6 min (6,3)

Table 1: User examples for different simulation types

Looking at the swept EM simulation, our example reflects a reduction in simulation times from 105 minutes down to 18 minutes. The number of remote machines and the number of parallel machines respectively are shown in parenthesis. For example, the circuit schematic optimization (6,3) test case refers to a simulation that ran on six different remote machines, each running three jobs each, for a total of 18 jobs. The simulation time was cut from the local simulation time of 52 minutes to six minutes using the remote parallel approach.

In general, most of the run times in this chart decreased with the addition of remote and parallel computing. However, under certain configurations, the run times increased. This is the result of not having enough memory resources on the local computer, which is why running remotely offers a distinct speed advantage. Simulation speeds will be impacted by problem type.

Parallel Optimization

Figure 2 illustrates how a parallel optimization is run on one computer in AWR software.

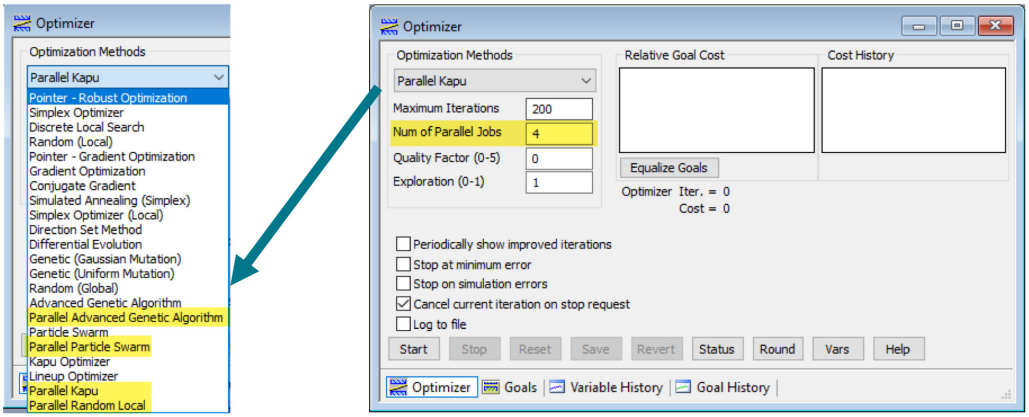

Figure 2: A parallel optimization simulation being run in AWR software

Open the optimizer window and choose one of the four parallel optimizers from the optimizer list. Then set the maximum number of parallel jobs per node for the project. For example, using a four-core computer, the number of parallel jobs would be set to four.

Remote Plus Parallel Simulation

The configuration for a remote plus parallel simulation in AWR software is shown in Figure 3.

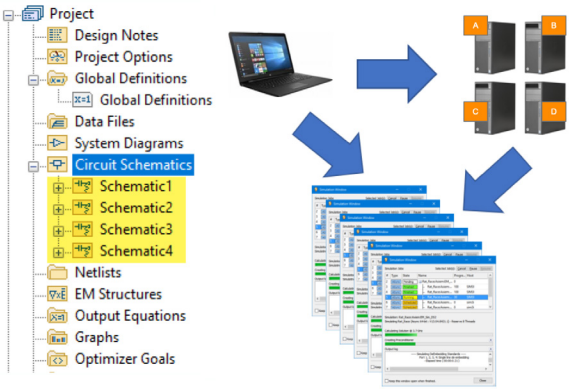

Figure 3: Remote plus parallel simulation configuration

If the designer wants to run multiple schematics, each will take about five minutes to run on a single machine. Alternatively, schematics 1 through 4 can run on remote machines A through D by having schematic 1 go to remote machine A, schematic 2 to remote machine B, etc., which will run considerably faster. If there are 16 schematics to be run simultaneously, they can be sent to machines A through D, each running four jobs in parallel. Figure 4 shows how this configuration is set up in AWR software.

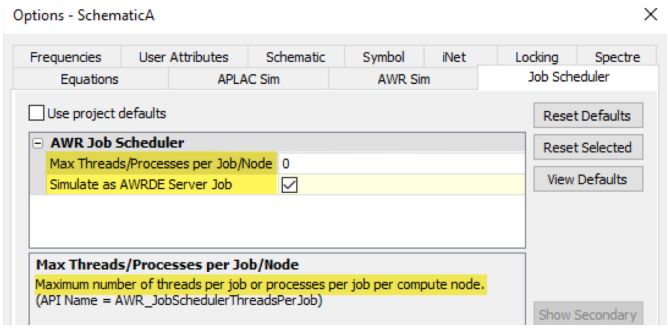

Figure 4: The AWR job scheduler is used to set the maximum processes per job per computer node

Conclusion

Highly integrated RFIC, MMIC, and multi-technology modules are developed through powerful design software that benefits from distributed computing in order to reduce simulation run times and streamline optimization. This application note has demonstrated how the use of the latest high-performance remote and parallel computing features in AWR software can shorten schematic simulation times considerably through remote, parallel, and remote/parallel configurations. Table 2 reveals how parallel computing has been enhanced over prior releases.

Feature	V13	V14	V15	V15.0x
Multiple EM Docs	X	X	X	X
Swept EM Docs	X	X	X	X
Multiple Circuit Schematics		X	X	X
Swept Circuit Schematics		X	X	X
Optimization		X	X	X
EM Extraction			X	X
Yield				X
System Diagrams				X

Table 2: Timeline of AWR software remote/parallel simulation features