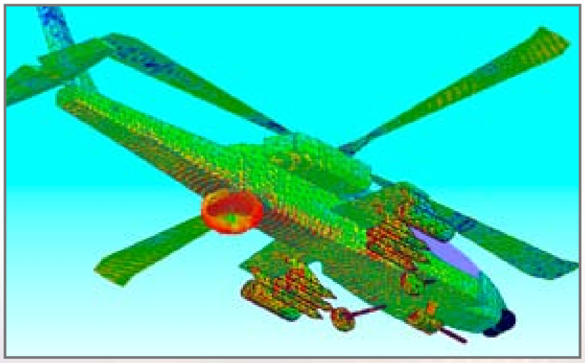
HFSS™ v12

HFSS™ is the industry-standard simulation tool for 3D full-wave electromagnetic field simulation. HFSS provides E- and H-fields, currents, S-parameters and near and far radiated field results. Intrinsic to the success of HFSS as an engineering design tool is its automated solution process where users are only required to specify geometry, material properties and the desired output. HFSS will then automatically generate an appropriate, efficient and accurate mesh for solving the problem using the proven finite element method. With HFSS the physics defines the mesh; the mesh does not define the physics. Using HFSS in your design flow reduces engineering costs, mitigates risk and reduces time to market.

HFSS KEY INNOVATIONS

The power of HFSS comes from many research and development innovations. These breakthroughs have made HFSS the most widely used software for solving 3D full-wave electromagnetic field simulations.

- Tangential vector basis functions enabled the highly accurate finite element method for electromagnetic field solution
- Transfinite element method for fast and accurate multi-mode S-parameter extractions
- Automatic mesh generation and adaptive refinement for reliable, repeatable and efficient results



900 MHz simulation of monopole antenna mounted on the underside of a helicopter displaying surface currents on airframe and overlaid far field gain pattern.

NEW IN HFSS

Domain decomposition method
A new optional high-performance computing (HPC) capability is available for HFSS. Ansoft's breakthrough implementation of the Domain Decomposition Method (DDM) allows efficient and highly scalable parallelized simulations across a network of machines using all of their available memory.

Volumetric meshing
A new highly robust volumetric meshing technique results in even more efficient and higher-quality meshes that reduces memory and simulation time.

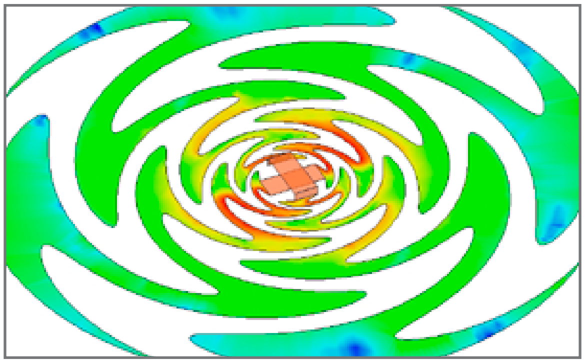
New element technologies

- Curvilinear elements – State of the art element technology that increases the fidelity of solutions for curved geometries by providing a precise representation of the electromagnetic fields on "true" surfaces.
- Mixed Element Orders – Built upon and leveraging hierarchical basis functions, HFSS automatically and judiciously applies the appropriate element order based on geometry and electromagnetic requirements.

Adjoint derivatives
Adjoint derivatives provide a direct calculation of the derivatives of S-parameter with respect to variations in geometry, materials and boundary conditions. A new feature in the Optimetrics™ add-on module, these derivatives delivers insight into design sensitivity and the performance effects of manufacturing tolerance variations. This derivative information also accelerates the SNLP optimizer in Optimetrics.

HFSS KEY FEATURES

- Pushbutton Solution Data:
  - S-parameters (single-ended, differential, de-embedded, renormalized)
  - Y and Z matrices
  - Port mode and impedance calculation by 2D-eigenmode solver fields
  - E and H fields, current densities, material losses, Q factors, radiation losses
  - Radiated-field calculations (directivity, gain, beam width, side-lobe levels, axial ratio, etc.)
  - SAR calculation
- Accurate broadband frequency sweeps with rigorous treatment of dispersive ports, materials and skin effect
- Direct and iterative matrix solvers (32 and 64-bit)
- Floquet ports for antenna arrays, frequency-selective surfaces (FSS) and other periodic structures
- Eigenmode matrix solver (32 and 64-bit) including periodic boundary conditions for traveling wave and electromagnetic band-gap structures
- Strong CAD integration capabilities including model healing and automatic feature recognition with mesh resolution control
- Full-Wave SPICE™ Model extraction option for integration with Nexxim®, HSPICE®, Spectre® RF and MATLAB®



HFSS can accurately solve for the surface currents on a sinuous antenna.

HFSS FOR MICROWAVE AND RF APPLICATIONS

HFSS' automation for accuracy, capacity and performance allows engineers to design high-frequency components found in communication systems, radar systems, satellites and cellular telephones confidently in the computer. With the new High Performance Computing (HPC) option in HFSS 12.0, engineers can leverage the full power of enterprise compute clusters to solve large-scale electromagnetic field simulations with the rigor and accuracy of HFSS including:

- passive components such as couplers, multiplexers, filters, ferrite circulators
- antennas such as horn-, slot-, patch-, Vivaldi-, and reflector antennas
- multi-band antennas, e.g. for wireless communication device;
- phased-array antennas
- antenna feed networks
- advanced electromagnetic structures such as frequency-selective surfaces (FSS) electromagnetic band-gap (EBG) structures and meta-materials
- RF coils for MRI
- shielding to reduce electromagnetic interference (EMI) and satisfy electromagnetic compatibility (EMC) requirements
- platforms with reduced radar cross section (RCS)

Antenna Systems

Engineers design, optimize and integrate antennas with HFSS, automatically computing standard antenna metrics such as gain, directivity, input impedance, efficiency, and near- and far-field radiation patterns. HFSS can incorporate field data between separate 3D models to capture the antenna response in its actual environment. Dynamic co-simulation with Designer RF allows antenna engineers to perform rigorous analysis of the antenna system including state-of-the-art feed networks and transceivers coupled to the radiating elements.

RF/mW passive component design & optimization

The performance of RF/mW passive components such as connectors, couplers, filters, and waveguides is directly coupled to materials and physical geometries. Optimetrics is a smart parametric and optimization engine that works with HFSS to explore possible design trade-offs through parametric, optimization, sensitivity and statistical analyses. Furthermore, engineering teams can employ HPC technology with the Distributed Solve option to accelerate the solve time of all parametric design studies. Distributing parametric instances across an unlimited number of computing machines provides greater design insight in a fraction of the time.

HFSS FOR SIGNAL INTEGRITY APPLICATIONS

With HFSS' automation for accuracy, capacity and performance, engineers can easily design and evaluate signal integrity and electromagnetic interference in connectors, transmission lines and vias on printed circuit boards (PCBs) and high-speed components used in computer servers and storage devices, multimedia PCs, entertainment systems and telecom systems. HFSS performs the 3D full-wave characterization needed to capture accurately the behavior of:

- on-chip passive components such as spiral inductors and critical interconnects
- advanced IC packages, including ball-grid array (BGA) packages, multi-chip modules (MCM), low-temperature co-fired ceramic (LTCC) devices, and RF System in Package (SiP)
- critical parts of printed circuit boards (PCBs), e.g. vias, lands, transmission lines, gridded power and ground planes
- connectors
- back planes

High-speed Components

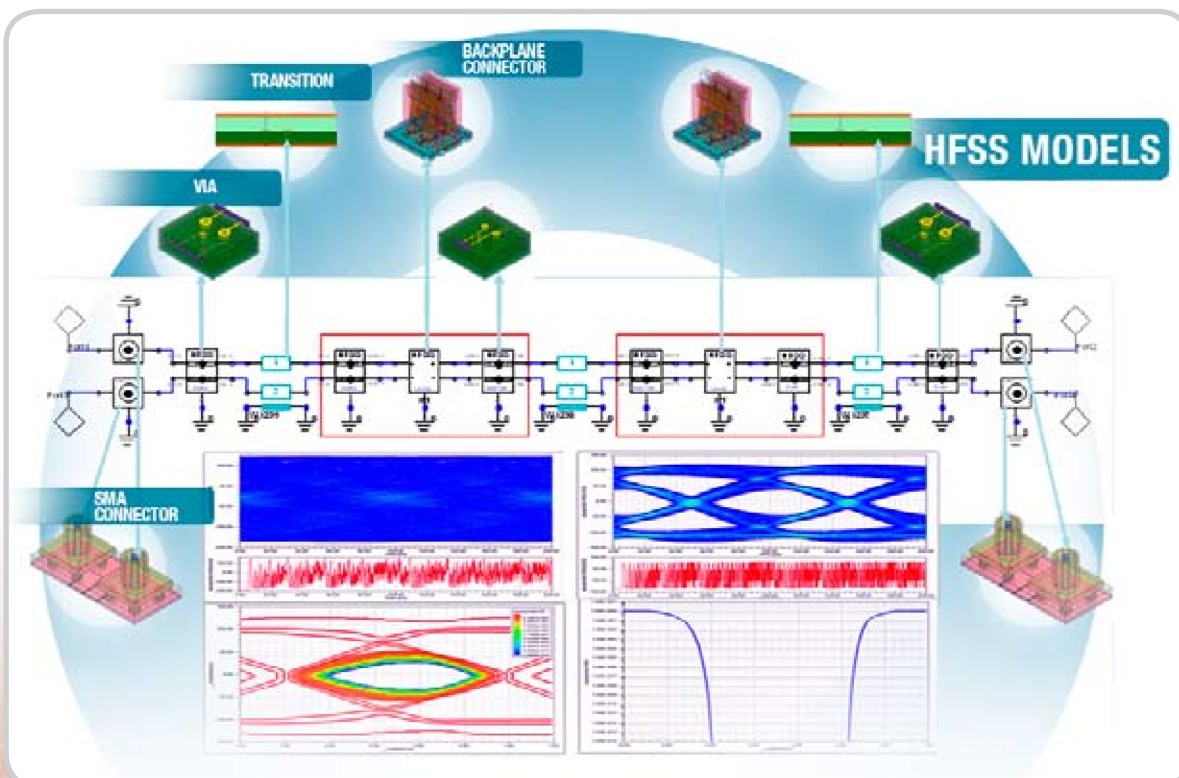
For components operating beyond 1 GHz, S-parameters provide the best representation of the electrical characteristics of high-speed interconnects. HFSS provides GHz-accurate S-parameter and Full-Wave SPICE™ models for complex trace routing, vias and transitions, connectors and IC packages.

PCB Circuit Design and Communication System Verification

Increasing component densities and board layers leads to unexpected signal coupling that requires parasitic extraction and overall system/sub-system verification. Neglecting these proximity effects could lead to a host of problems such as frequency shifts and spurious oscillations. HFSS captures the component to component interaction, transmission line coupling, and electrical behavior of structures such as via transition or interconnects that dominate PCB performance. Powerful handshaking between HFSS and Designer SI transient circuit simulation ensures accurate predictions of PCB signal- and power-integrity.

SiP/SOC package and MCM co-design

Integrating multiple die and embedded passives into a single package or module requires accurate characterization of all package parasitics and any off-chip passive components. Circuit/EM co-simulation is needed to optimize the impedance match between package interconnects and the RF CMOS, SiGe and/or GaAs ICs. Together, HFSS and Designer SI accurately predict package interaction with the nonlinear behavior of the IC including load/source pulling from non-ideal impedance terminations. Uncertainty is eliminated as transistor-level IC blocks are combined with accurate 3D full-wave EM models of the complex passive components and advanced packages generated by layout tools such as Cadence Allegro® PCB Design, Allegro® Package Designer or SiP Digital Layout.



HFSS provides GHz-accurate S-parameter and Full-Wave SPICE models of components used in high-speed serial channels.

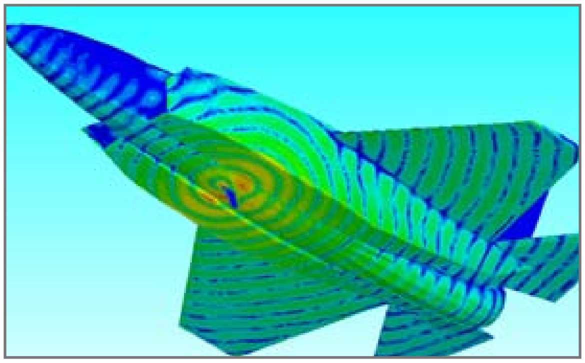
HIGH-PERFORMANCE COMPUTING OPTIONS

The HFSS High-Performance Computing (HPC) options enable intra- and inter-machine parallel solving and processing by:

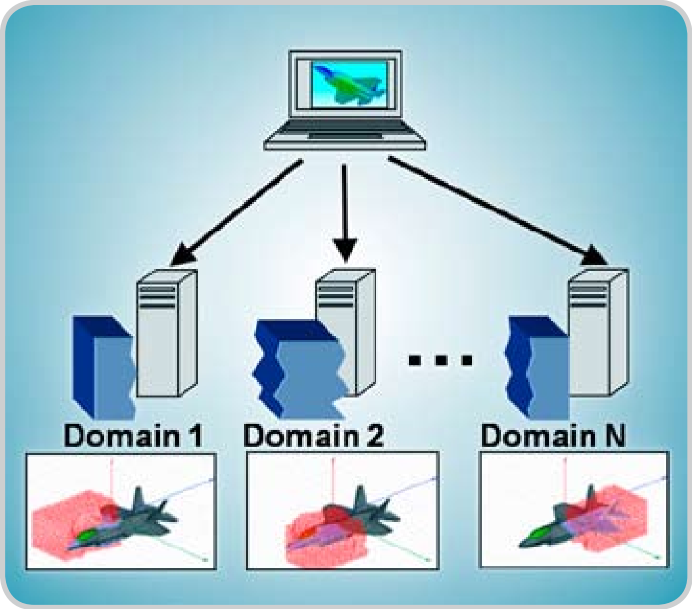
Domain Decomposition Method (DDM)
DDM enables the simulation of very large models by accessing the memory of a network of machines. DDM splits the finite-element mesh of your geometry automatically into a number of smaller mesh sub-domains. HFSS determines the optimum number of domains, depending on the mesh size and the number of computers and processors available. The domains are analyzed separately on a single machine or on a network of machines, after which an iterative procedure on the domain interfaces reconstructs the full solution. This network memory access allows the simulation of very large models for which one machine might not have enough memory. It also reduces simulation time and overall memory load, offering in some cases better than linear speed up with each additional processor.

Multiprocessing (MP)
The multiprocessing option is used for solving models on a single machine with multiple processors or multiple cores which share RAM thus reducing the simulation time.

Distributed Solve Option (DSO)
The DSO option allows users to distribute parametric sweeps to explore variations in geometry, materials, boundaries and excitations. Additionally, users can distribute frequency sweeps to generate responses over a broad frequency band of interest. This time-saving capability splits multiple pre-defined parametric design variations and/or frequency points, solves each simulation instance on a separate machine and then reassembles the data. This dramatically accelerates parametric studies and design optimization.



Antenna on an aircraft simulated using the domain decomposition method. Using 16 cores, the speed-up in solution time was greater than 17x, with overall memory reduction or 30%.



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