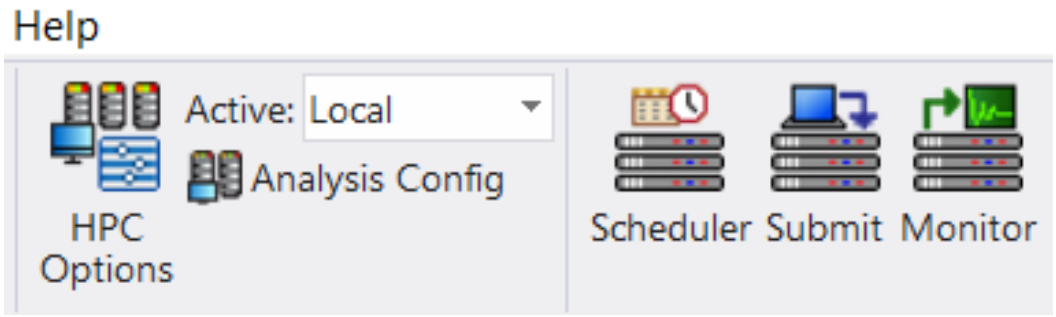
Ansys HFSS Getting Started LE7

Module 7: Optimetrics and High-Performance Computing (HPC)

Release 2020 R2

Outline - High Performance Computing (HPC) and Optimetrics

- DDM and SDM
  - Domain Decomposition Method (DDM)
  - Spectral Decomposition Method
- HPC Settings
  - HPC Setup Up Add Edit
  - Use Automatic versus Manual Settings
- Optimetrics
  - Parameter Sweep with
  - Tuning with Analytic Derivatives
  - Optimization

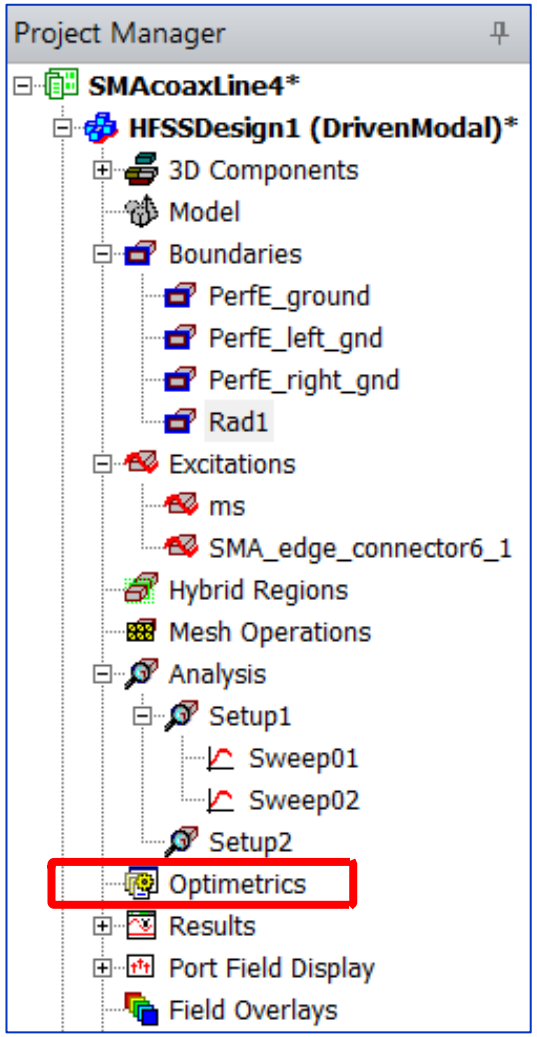


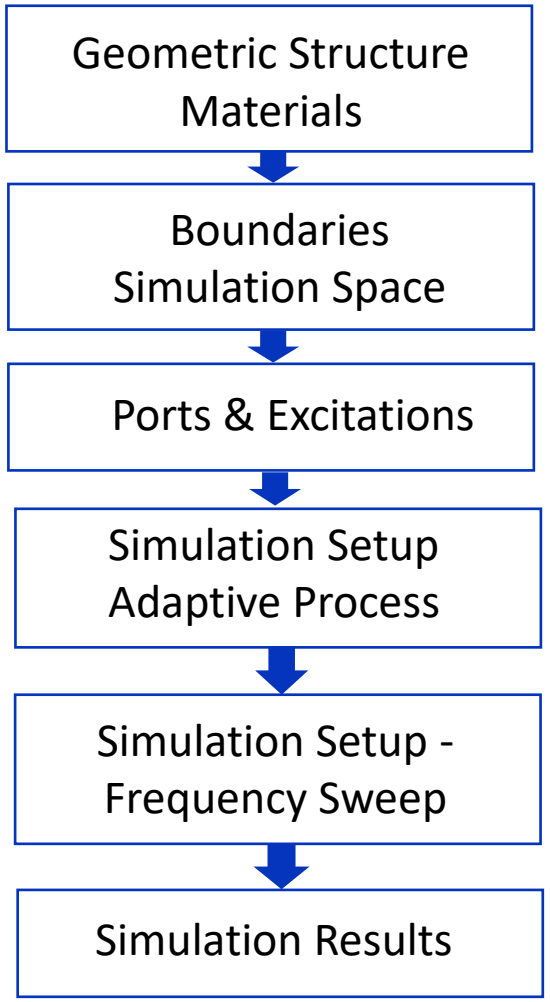
HPC refers collectively to features that access additional computing resources to either allow larger HFSS simulations or improve the simulation speed of a given HFSS simulation.

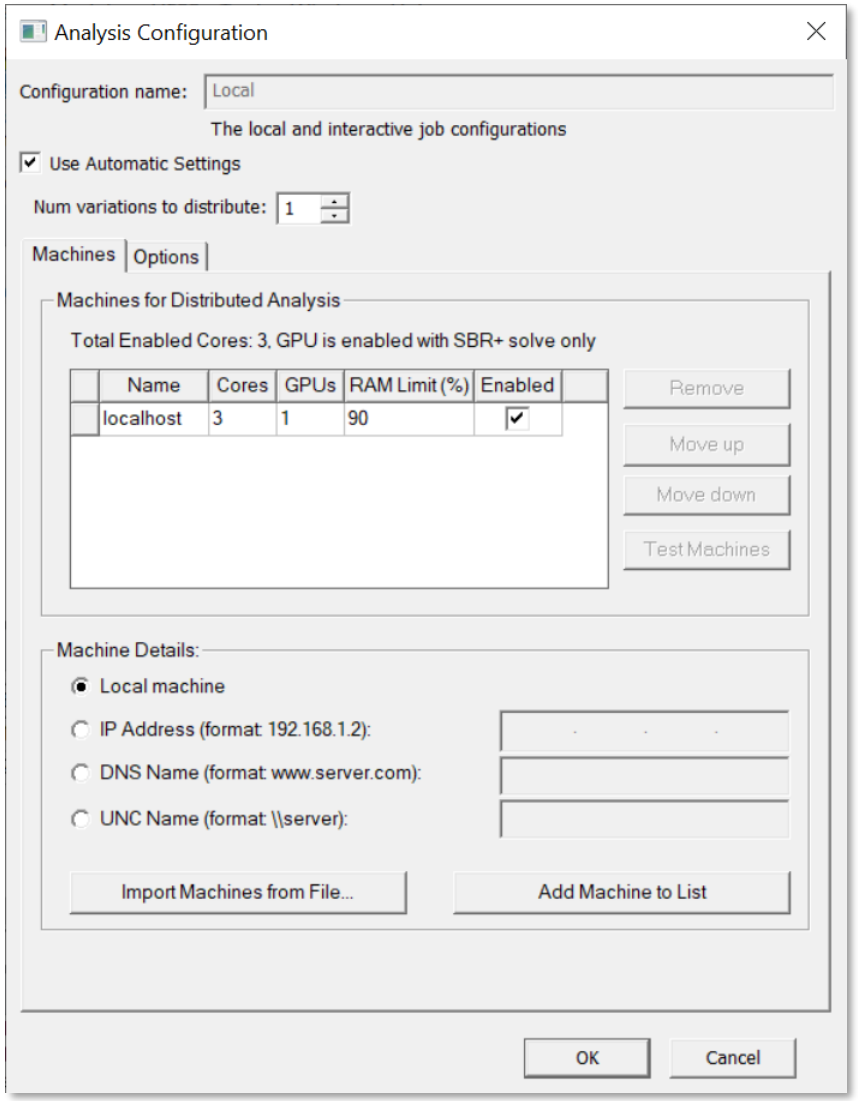
Additional detailed information on ***Optimetrics*** is available in the Help document ***HFSS.pdf***. See chapter on ***Optimetrics***.

The document ***An Introduction to HFSS***, is available in the installation directories ***/Help/HFSS/GSG***.
See Chapter 4 ***HFSS Solution Setup > HPC and Analysis Options.***

Optimetrics and HPC in the HFSS Simulation Workflow







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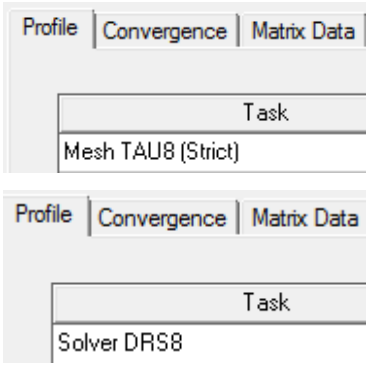
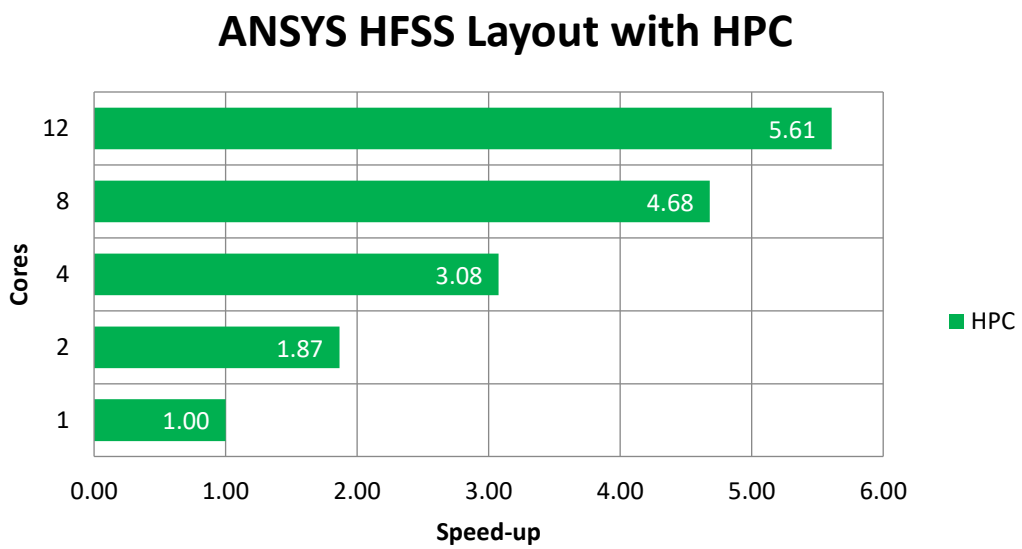
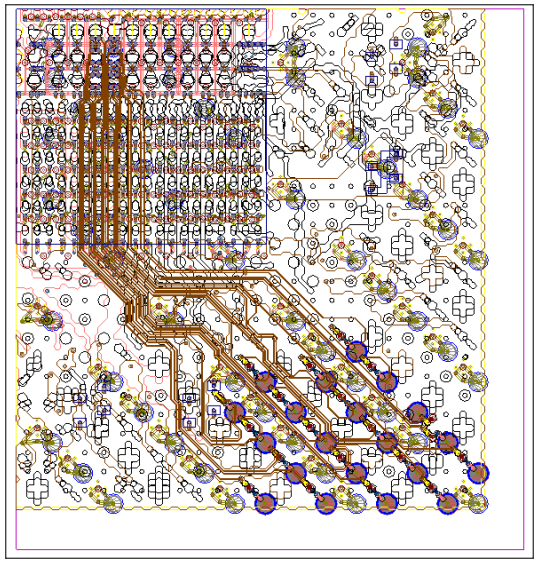
HPC: Multi-Threading (MT)

Multi-Threading (HPC-MT)

- Single workstation solution
- Many tasks of the solution process
  - TAU Initial Mesh Generation
  - Direct Matrix Solver
  - Iterative Solver
  - Field Recovery
- Available in HFSS, HFSS 3D Layout and HFSS-Transient design types



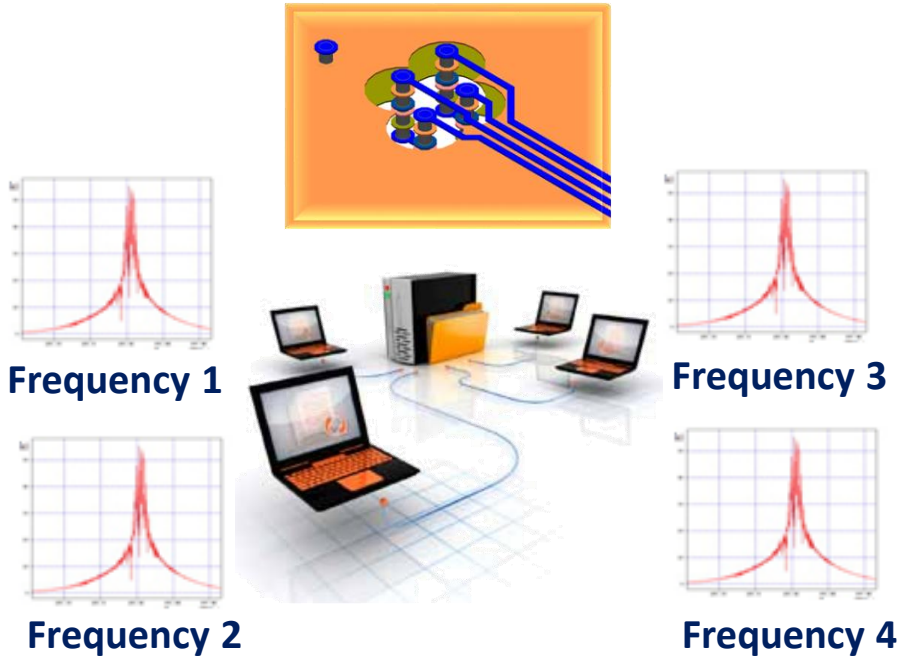


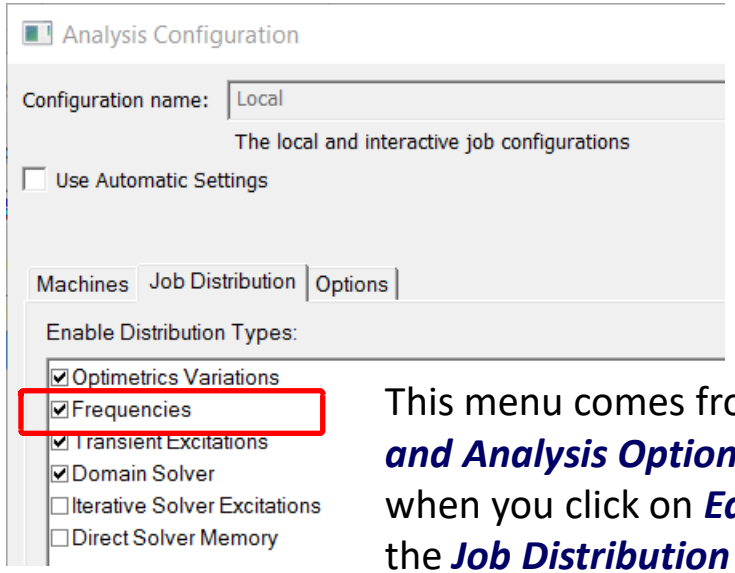


HPC: Distributed Frequency Solutions - DSO

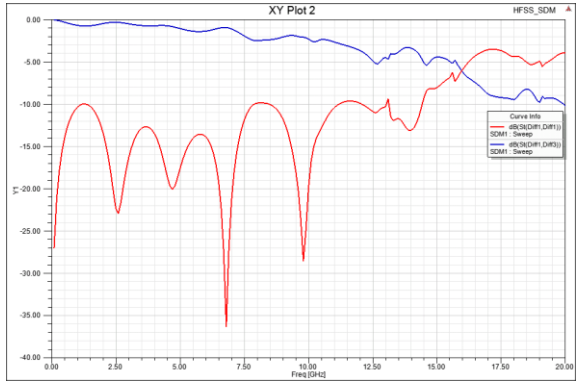
Distributed Frequency Solutions

- Distributes frequency points in frequency sweeps across a network of processors or on a single computer.
  - Uses MPI (message passing interface)
- Scalable to large numbers of cores
- Available in HFSS and HFSS 3D Layout design types





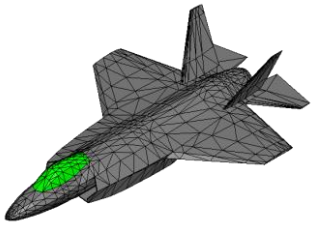
This menu comes from the ***HPC and Analysis Options*** dialog box when you click on ***Edit*** and choose the ***Job Distribution*** tab.

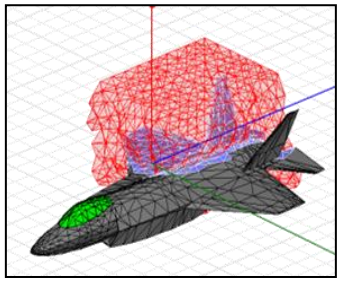


DDM (Mesh Based) - Domain Decomposition Method

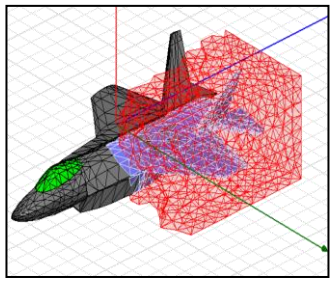
HFSS can partition a design into domains simulating different parts of the overall mesh separately

- A large problem domain is partitioned into small sub-domains. (A large mesh is broken down into small sub-meshes.)
- Each sub-mesh or sub-domain is solved in a separate core or a set of shared cores on a single computer or spread across multiple computers in a network.
- An iterative procedure combines the separate results into a single solution that gives the complete response for the entire model.

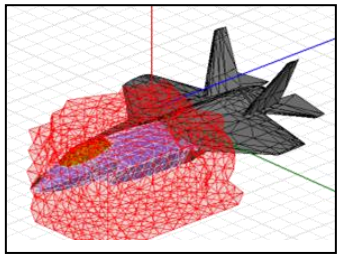




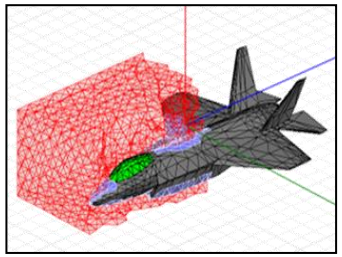
Domain 2



Domain 3



Domain 1

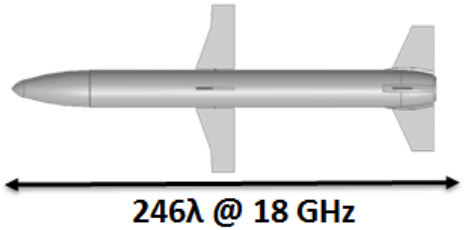


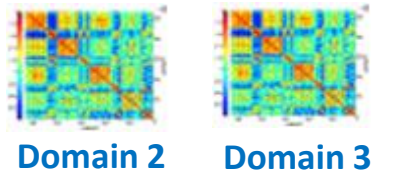
Domain 4

For DDM context and introduction, see ***HFSS.pdf***, chapter on ***Specifying Solution Settings > Setting Adaptive Analysis Parameters for HFSS > Enable Domain Decomposition***.

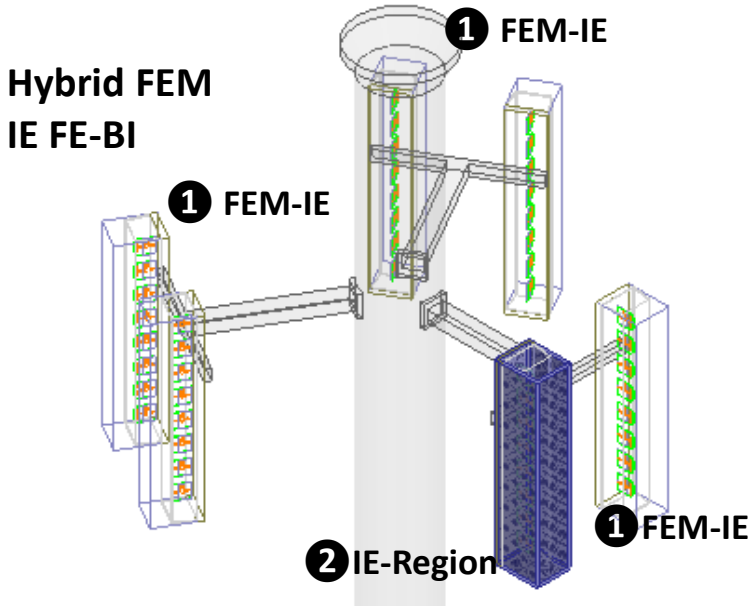
DDM with IE Regions, Finite Arrays, and Hybrid Regions

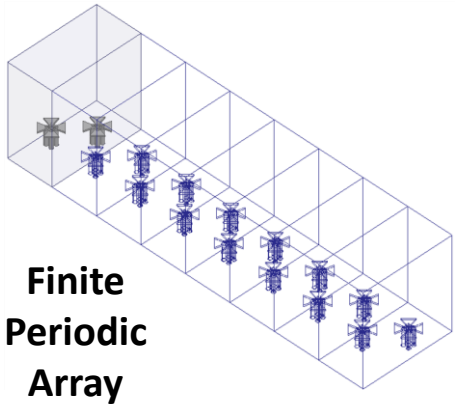
- Domain Decomposition Method: Matrix Based (Integral Equation Solver)
- Domain Decomposition Method for Hybrid Solve (e.g. FEM/IE/FEBI)
  - FEM volume can be sub-divided into multiple domains.
  - IE Domains and FEBI boundaries will be distributed to separate nodes when they become large.
- Periodic Domain Decomposition Method for Finite Array Antennas (FADDM)
  - Automatic generation of domains
  - Available in HFSS 3D with Model Array defined





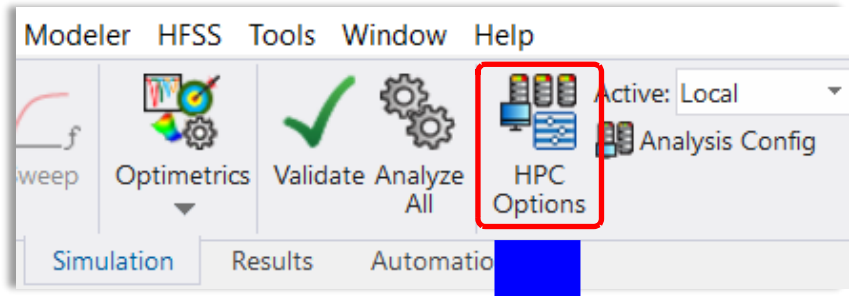
Matrix-based for IE

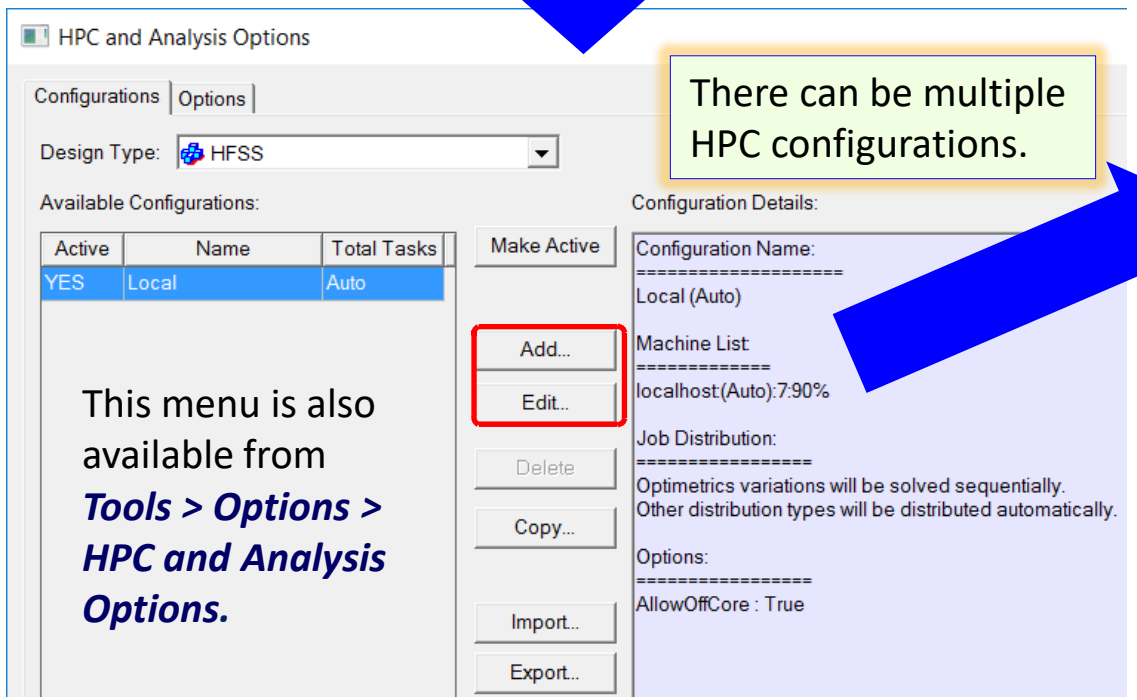




For more information, please see ***HFSS Online Help > Specifying Solution Settings > Setting Adaptive Analysis Parameters for HFSS > Enable Domain Decomposition.***

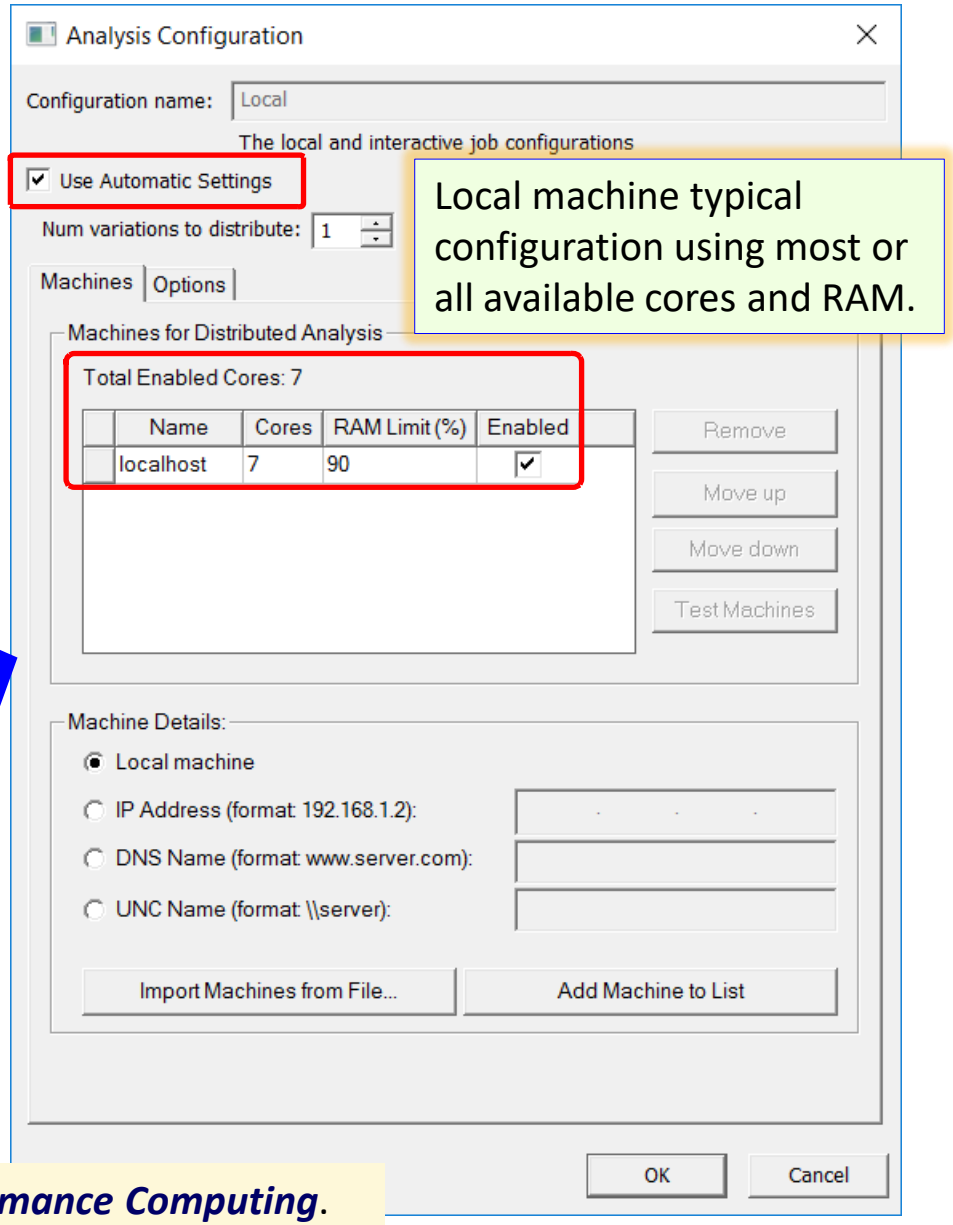
HPC Setup - Add Edit Buttons





There can be multiple HPC configurations.

This menu is also available from ***Tools > Options > HPC and Analysis Options.***



Local machine typical configuration using most or all available cores and RAM.

See also the online Help document ***HFSS.pdf*** chapter 6 ***High Performance Computing***.

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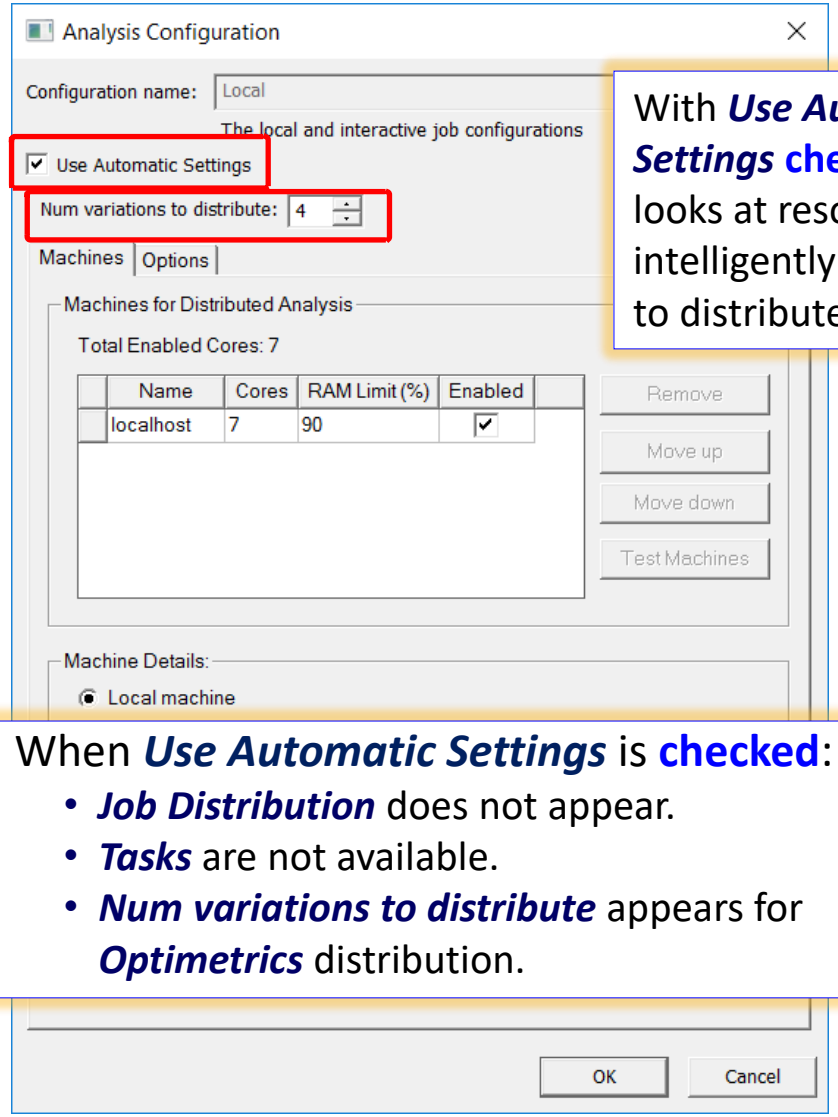
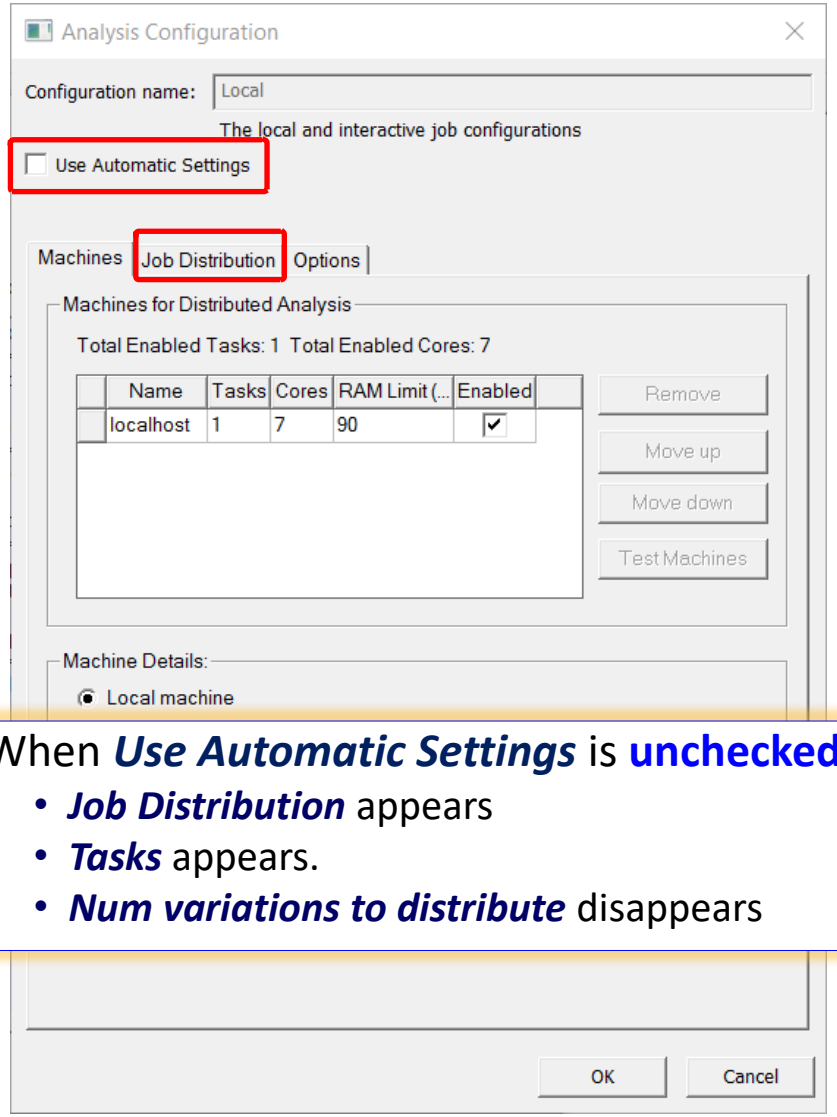
Analysis Configuration: Manual vs. Automatic



With ***Use Automatic Settings*** **checked**, HFSS looks at resources and intelligently choose how to distribute simulations.

When ***Use Automatic Settings*** is **checked**:

- ***Job Distribution*** does not appear.
- ***Tasks*** are not available.
- ***Num variations to distribute*** appears for ***Optimetrics*** distribution.



When ***Use Automatic Settings*** is **unchecked**:

- ***Job Distribution*** appears
- ***Tasks*** appears.
- ***Num variations to distribute*** disappears

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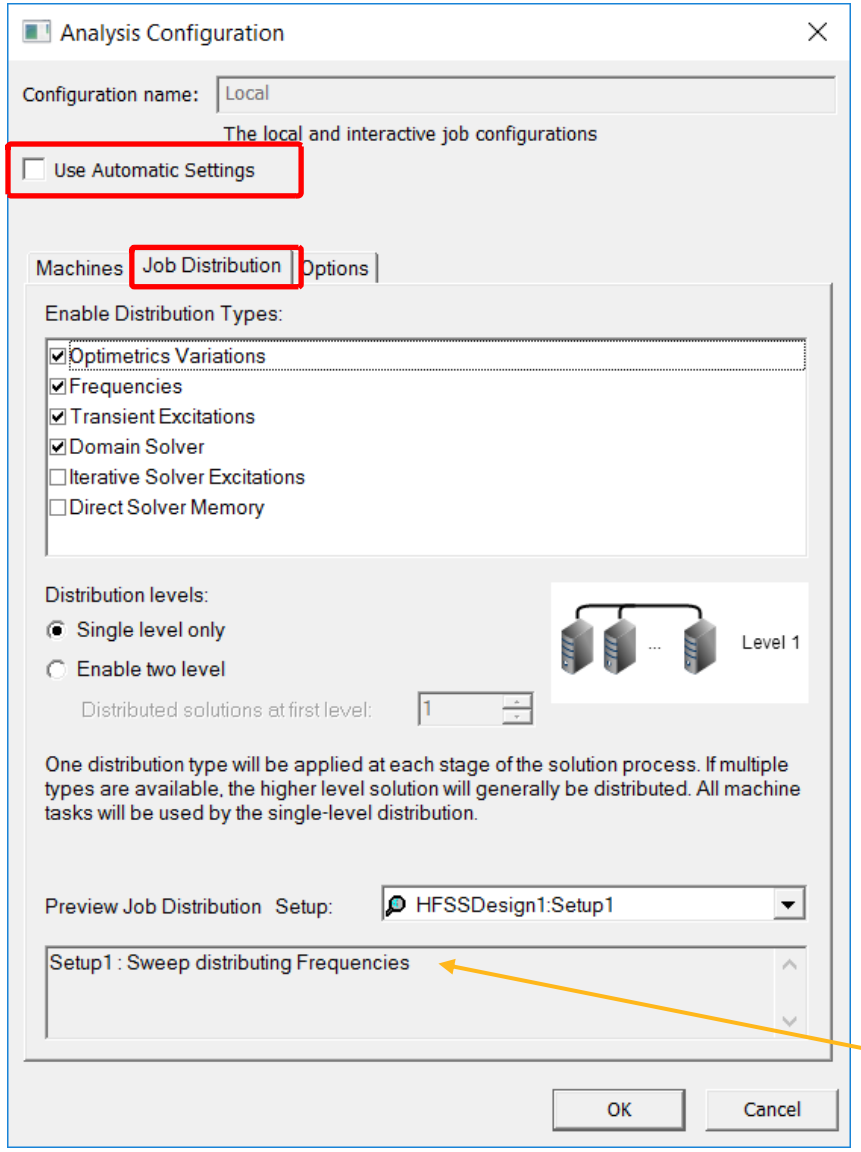
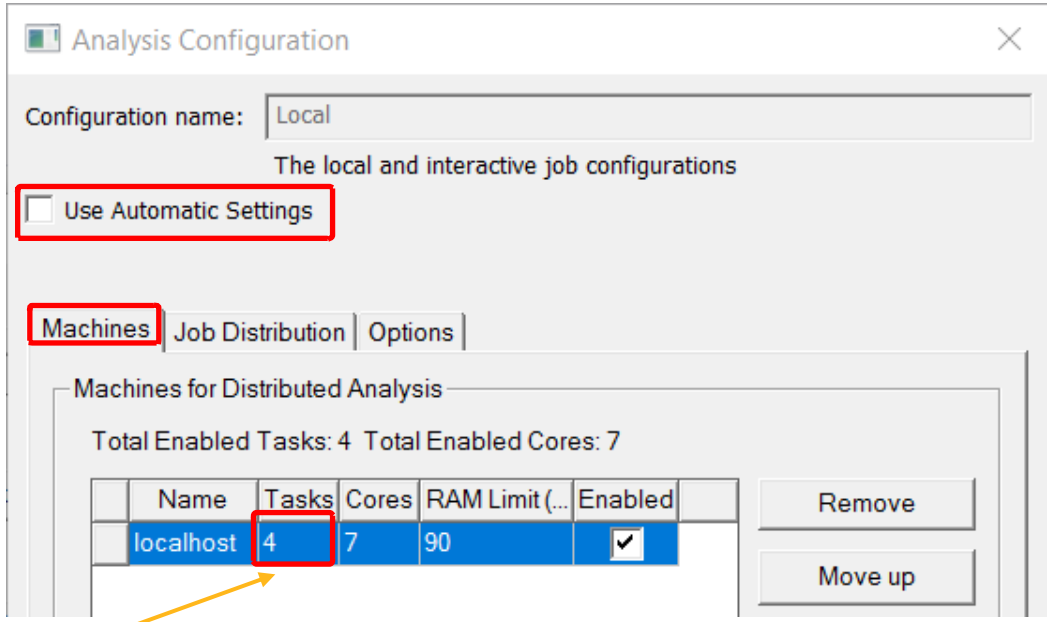
For Job Distribution…Uncheck *Use Automatic Settings*



– Many settings under ***Job Distributions***
  - ***Use Automatic Settings*** needs to be ***unchecked***.
  - A number of ***Tasks*** above 1 must be specified in ***Machines*** tab.
  - This menu on left indicates frequency distribution.



If ***Tasks*** under ***Machine*** tab is left at **1**, then one won't see distribution here under Job Distribution tab.

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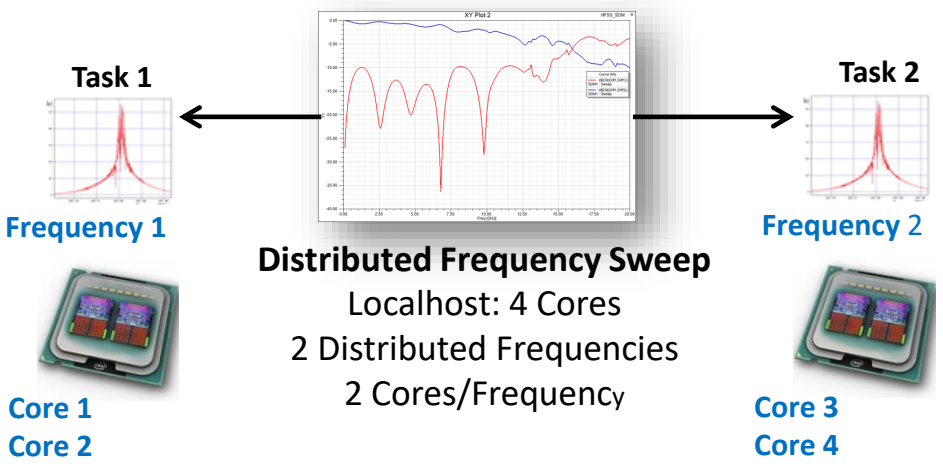
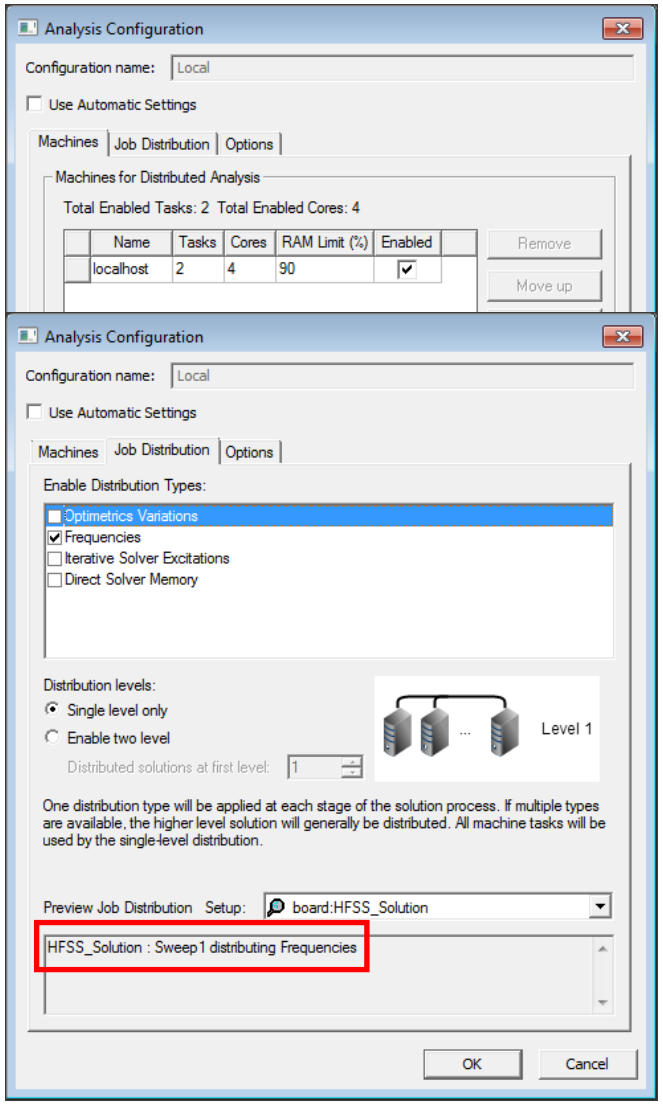
HPC Frequency Sweeps - Adaptive Mesh on One Machine

HPC for Frequency Sweeps

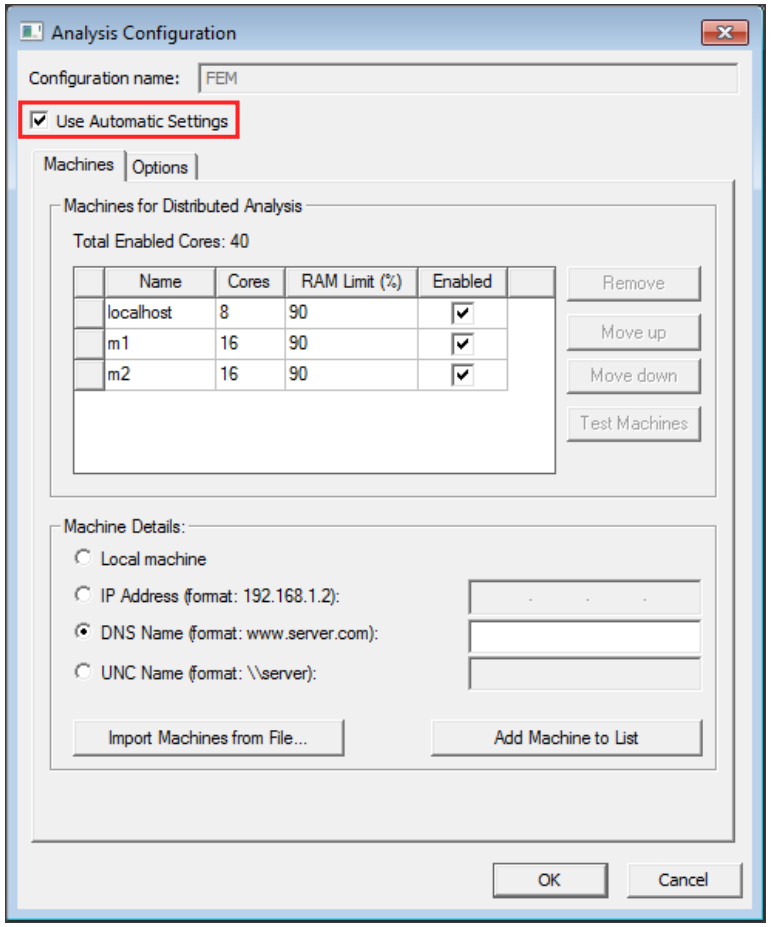
- Machine Details:
  - Cores: Total number of cores on the machine
  - Supports multiple machines
- Job Distribution:
  - Tasks: how many distributed frequency points will be launched per machine
  - If ***Tasks*** < ***Cores***, the remaining cores will be used to accelerate the solver
  - Distribution Type: Frequencies.
- Adaptive Mesh Process
  - Since the ***adaptive mesh process only supports a single machine***, the solve will automatically be run on the first machine in the list. All the available cores on that machine will be used for multi-threading during adaptive process.



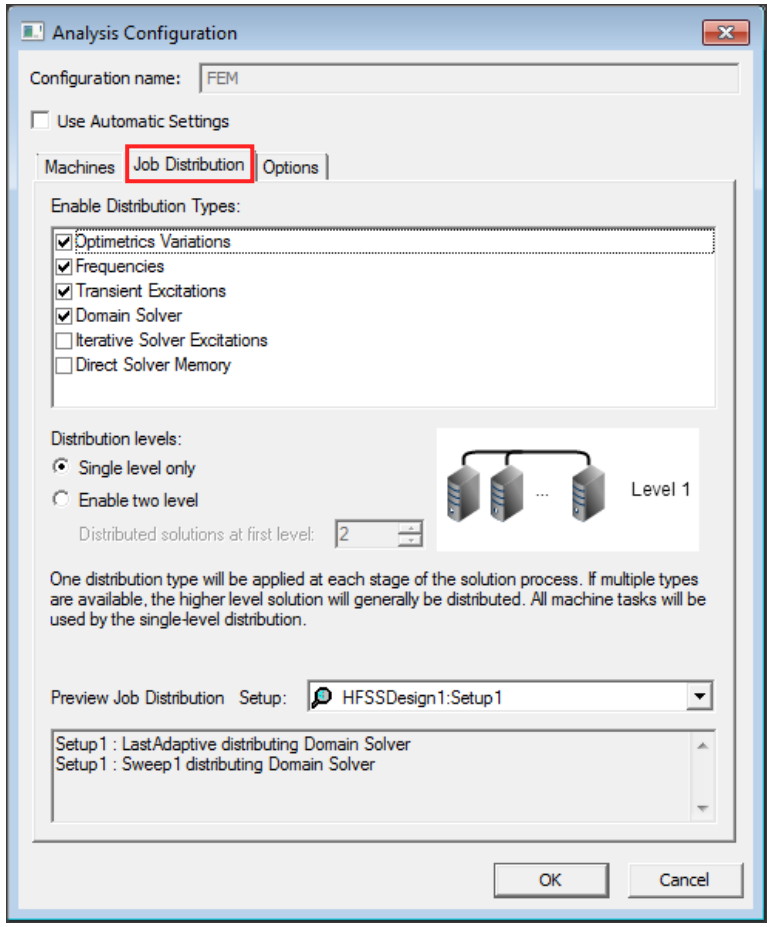


Analysis Configuration: Manual vs. Automatic

- Automatic Settings of Analysis configurations
  - Indicate machines and total number of cores per machine to use in simulations
  - HFSS decides how to distribute tasks.



- Default Settings of Analysis configurations
  - Indicate machines, tasks and total number of cores per machine to use in simulations
  - Indicate ***Job Distribution***



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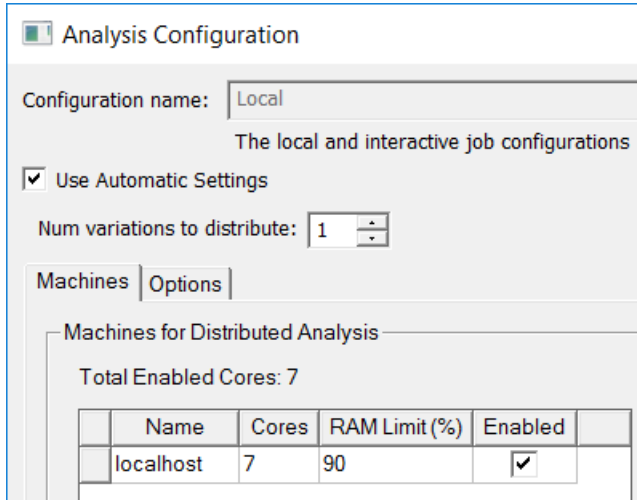
Num Variations and Job Distribution

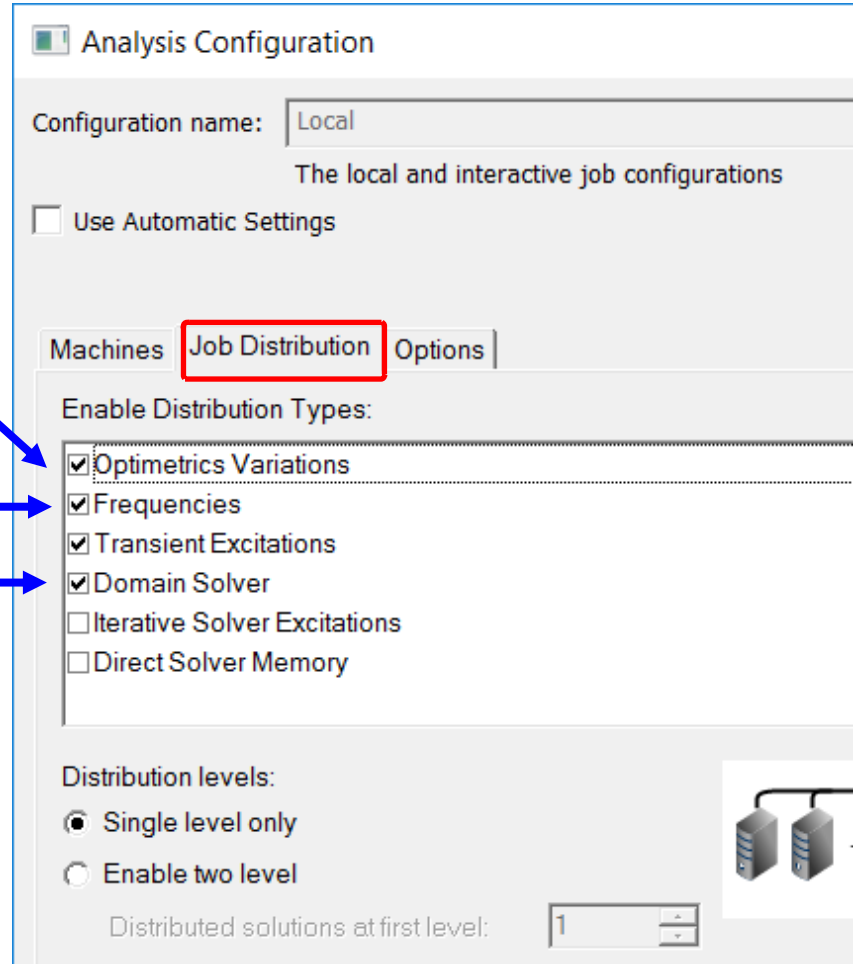


Num variations, when ***Use Automatic Settings*** is checked, only refers to parametric studies (within ***Optimetrics***).

Optimetrics Variations include parametric, sensitivity, and optimization parallel tasks. This uses ***DSO*** - Distributed Solve Option.

SDM - Spectral Decomposition

DDM variations (depending upon what is being solved)



DSO - a licensing option - refers to multiple instances. ***DSO*** is what allows a user to choose ***Num variations*** above 1.

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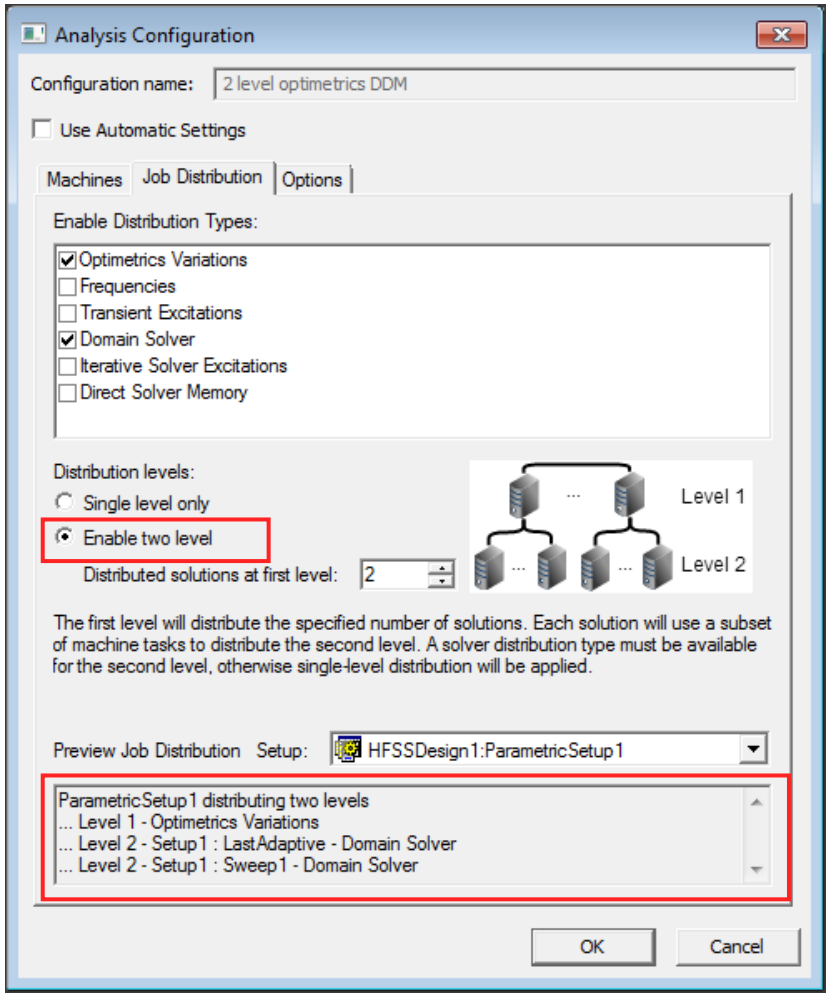
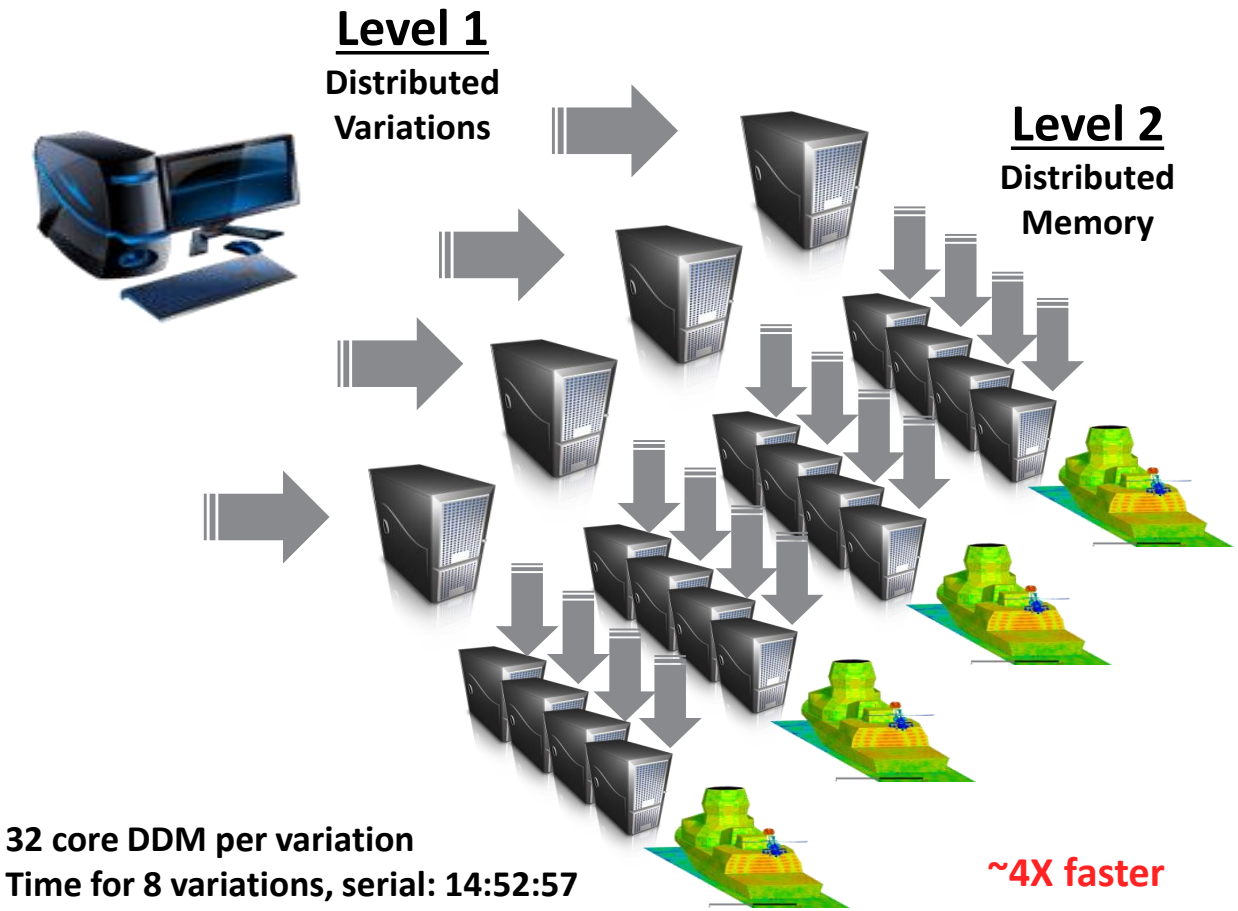
Multi-level HPC for Speed *and* Scale





32 core DDM per variation
Time for 8 variations, serial: 14:52:57

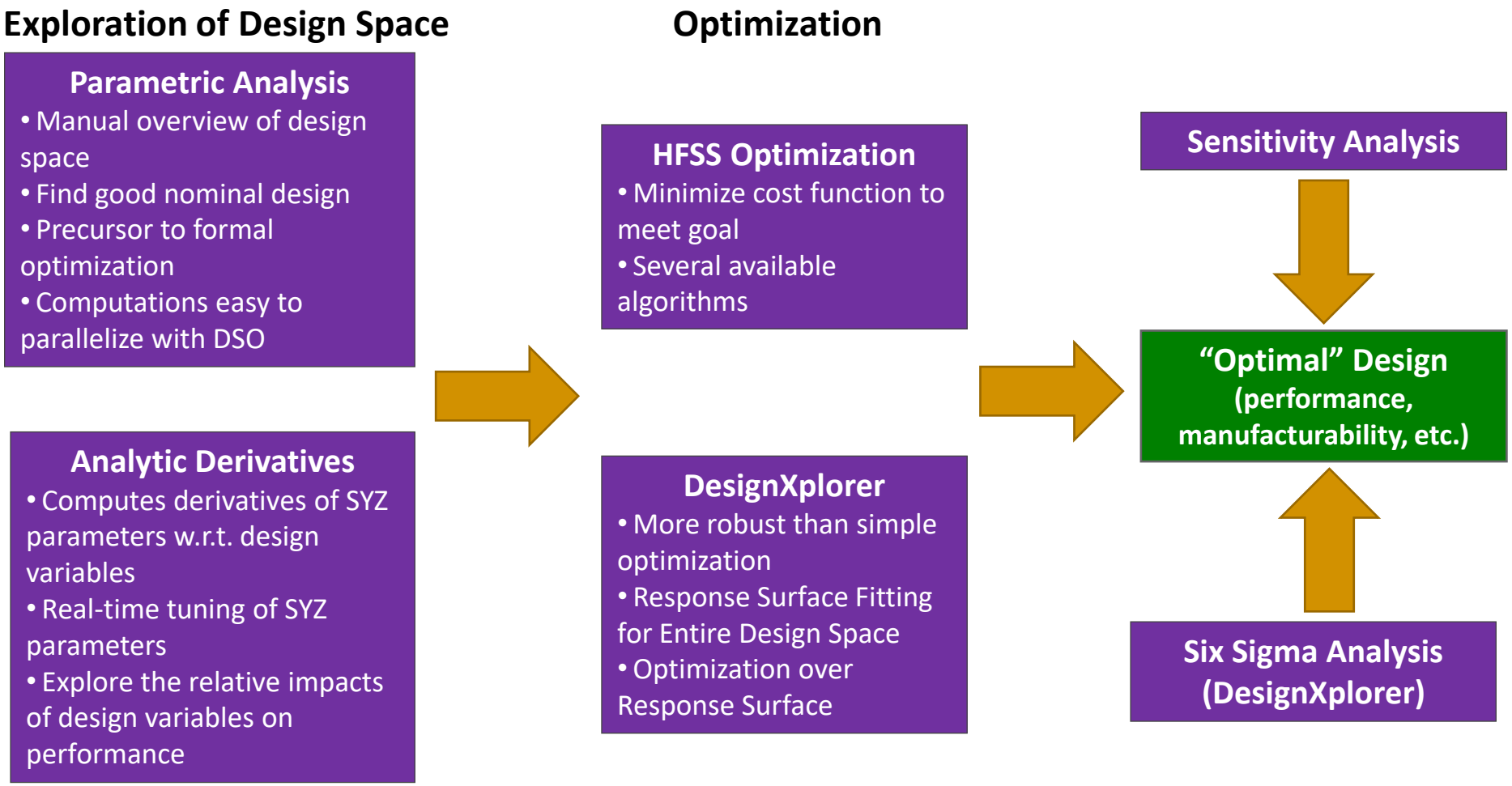
128 core 'two level', 32 core DDM per variation
Time for 8 variations, four variations in parallel: 3:39:38

~4X faster

Optimetrics Introduction

- Optimetrics is now included with all premium and enterprise licenses.
  - Parametric
  - Optimization
  - Sensitivity
  - Statistical
  - Tuning
  - Analytic Derivatives
  - Enables ANSYS DesignXplorer Link
- Optimetrics allows centralized control of design iterations from one common interface
- Optimetrics allows the user to:
  - Automate parametric sweeps
  - Perform real time parameter tuning using Analytic Derivatives
  - Identify performance specifications to optimize
  - Perform sensitivity and statistical analysis on optimized model
  - Link to DesignXplorer for
    - Optimization via a Surface Response using Design of Experiments (DOE)
    - Six Sigma Analysis

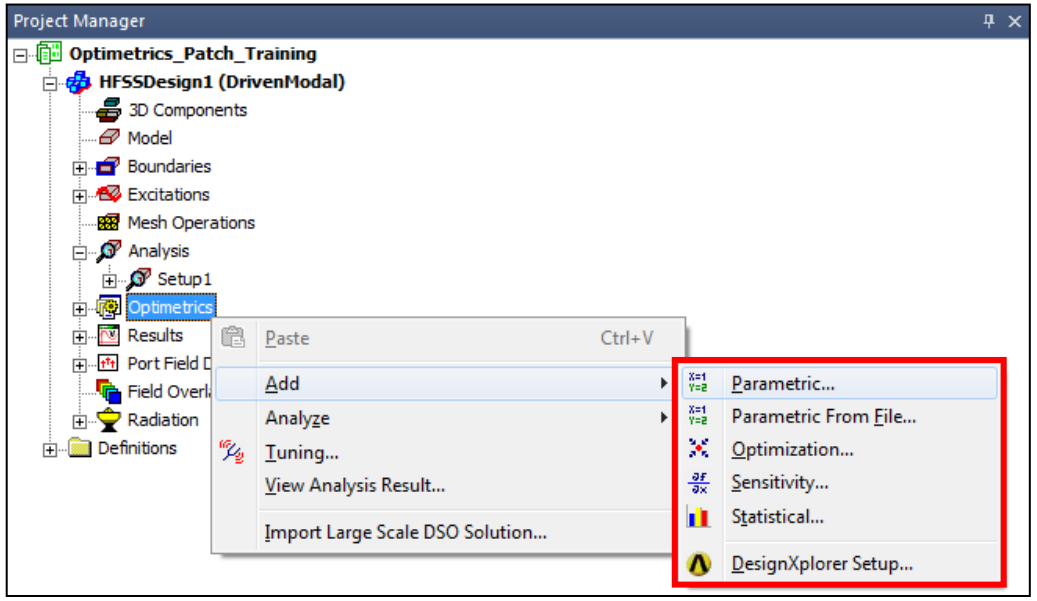
Robust Design using Optimetrics Tools



Robust Design is MORE than simple optimization: it is the ability for a user to systematically explore an entire design space so as to arrive at an optimal design.

Using Optimetrics

- Process
  - Create parameterized model
  - Define design parameters to vary
  - Model geometry, material properties, etc.
  - Perform analyses
- Where can Optimetrics be used?
  - User may apply parameterization at all modeling stages
    - Geometry (size, shape, orientation, quantity, etc.)
    - Materials (lossless, complex, anisotropic, etc.)
    - Boundaries (impedance/conductance boundaries, linked boundary scan angles, symmetry or mode cases, etc.)
    - Solution setup
    - Post Processing Quantities (Port magnitude/phase, De-embedding, etc.)
  - Once model is parameterized, optimization can be performed toward an extensive array of cost functions
    - Circuit parameters (S, Z, or Y-parameters)
    - Antenna patterns (Directivity, gain, axial ratio, etc.)
    - Emissions
    - Derived field quantities (radiated power, etc.)



End of Presentation