DRD TECHNOLOGY

ANSYS HFSS HPC Usage

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DRD

Agenda

1 HFSS Solver Technologies

2 Types of Solve Distribution

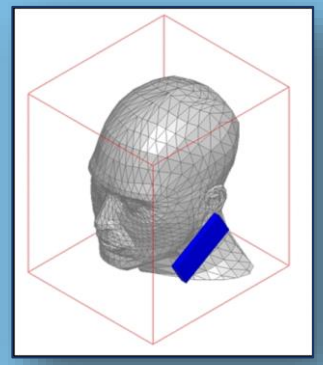
3 AEDT HPC Best Practices

4 HPC Licensing Choice

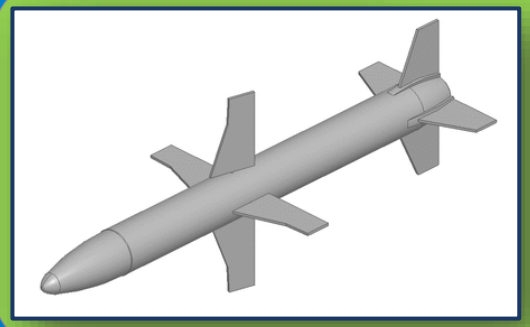
5 AEDT UI Usage

HFSS Solver Technologies

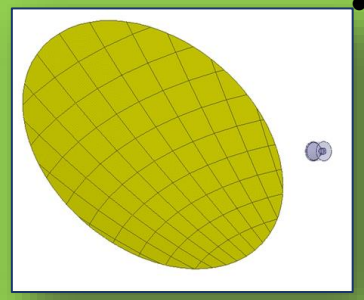
Hybrid Solutions



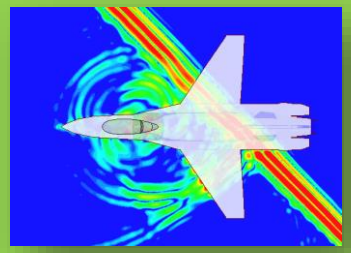
- **Finite Element Method**
  - Enabled with HFSS
  - Efficiently handles complex material and geometries
  - Volume based mesh and field solutions
  - Fields are explicitly solved throughout entire volume
  - Frequency domain solution



- **Integral Equations (HFSS-IE)**
  - Enabled with HFSS
  - Efficient solution technique for open radiation and scattering
  - Currents solved only on surface mesh
  - Efficiency is achieved when structure is primarily metal

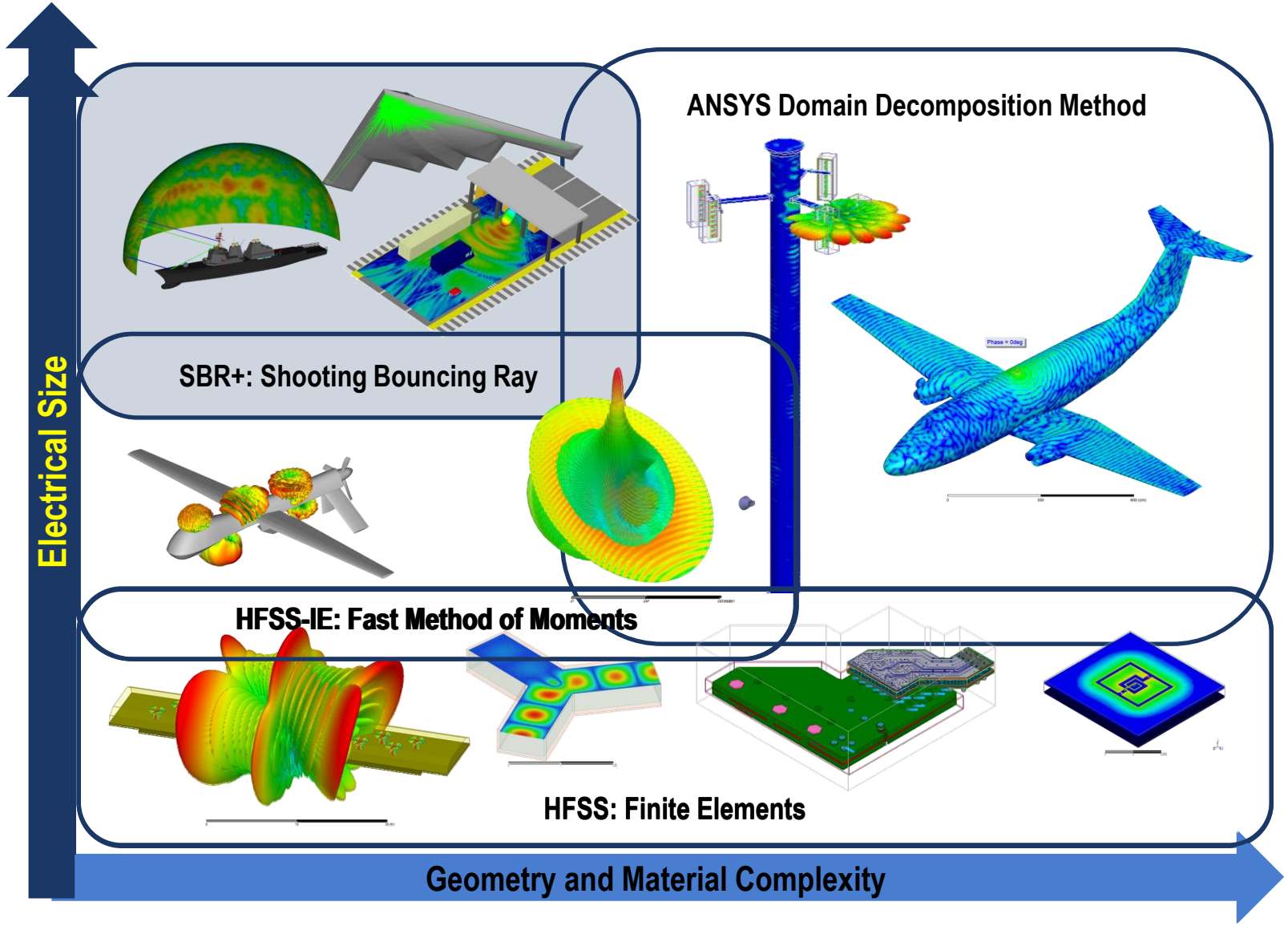


- **PO/SBR+**
  - Enabled with SBR+ Solver
  - High frequency approximation
  - Ideal for electrically large, smooth objects
  - 1st order interactions



- **FEM Transient**
  - Enabled with HFSS
  - Ideal for fields that change versus space and time; scattering locations
  - Time domain solution

A Solution for all Ranges of Electrical Size

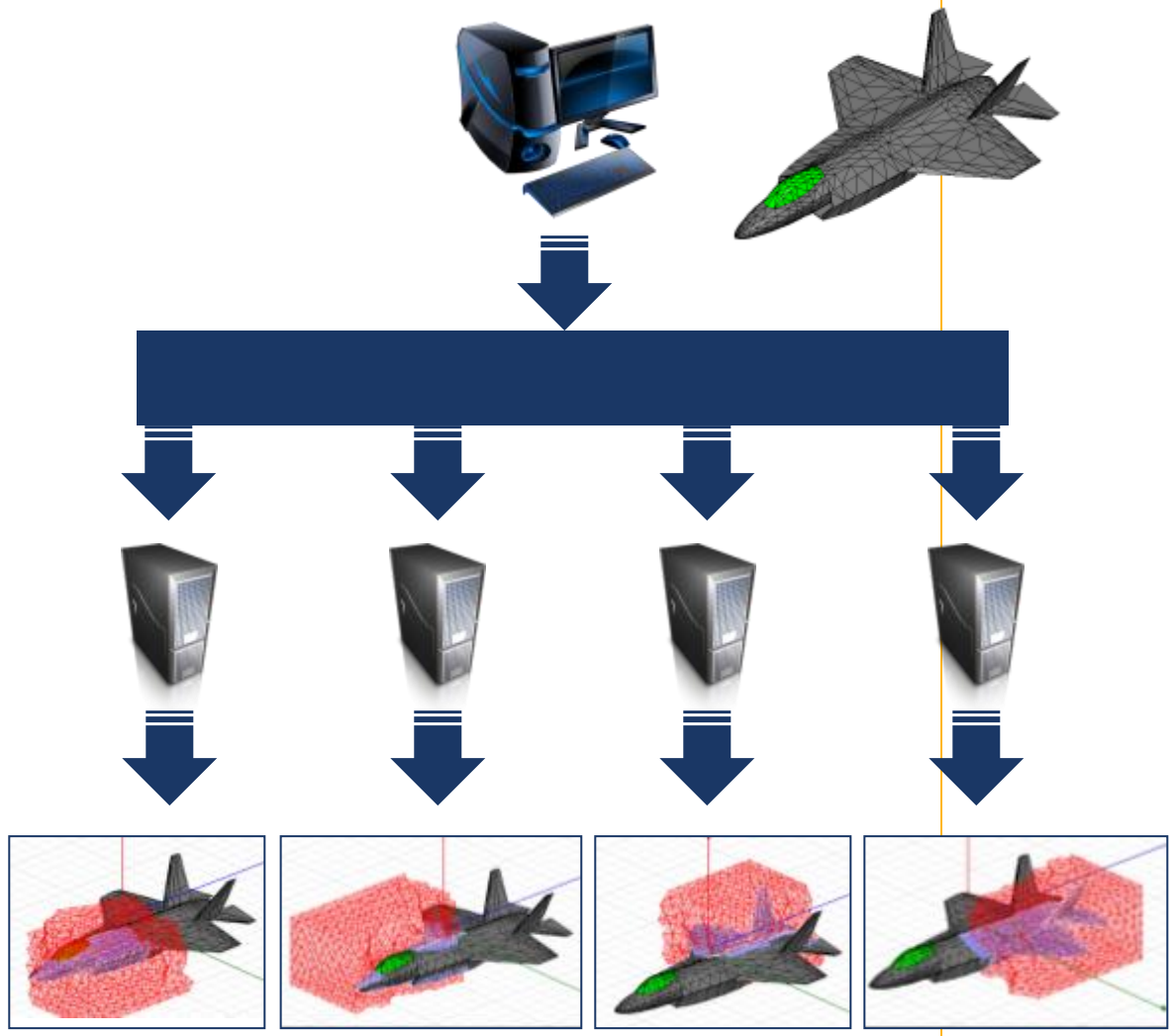


Different Parallel Processing Methods

- HFSS has 3 different methods for parallel processing:
  - Multi-processing of FEM, MoM, or SBR+ matrix algebra
    - Colloquially referred to as “distributed solve”, “HPC”, etc…
  - Parallel processing of frequency sweep points
  - Parallel processing of parameterized study run points
- All these approaches can be employed in the same simulation run
  - Must have appropriate licensing availability (HPC licensing)
  - Must have appropriate hardware
- Distribution over multiple cores/machines is referred to as “remote solve management”

Distributed Solve/HPC

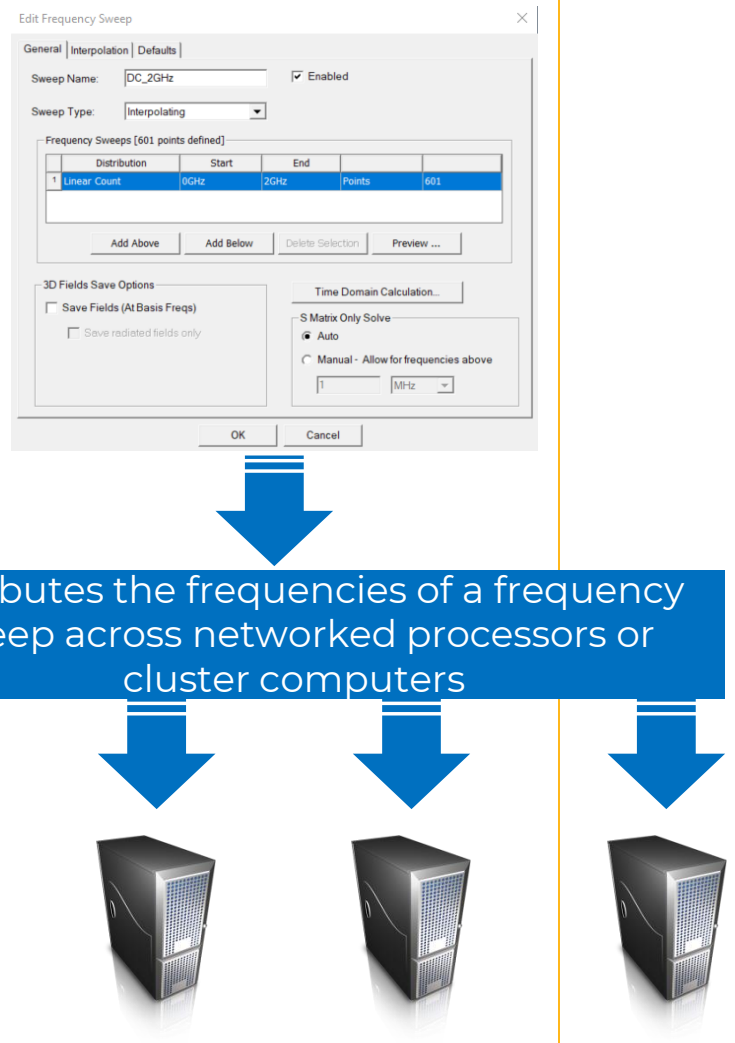
- Distributed memory parallel solver technique
- Distributes mesh sub-domains to network of processors
- Significantly increases simulation capacity
- Highly scalable to large numbers of processors
- Automatic generation of domains by mesh partitioning
  - User friendly
  - Load balance
- Hybrid iterative & direct solver
  - Multi-frontal direct solver for each sub-domain
  - Sub-domains exchange information iteratively via Robin's transmission conditions (RTC)



Frequency Sweep Parallel Processing

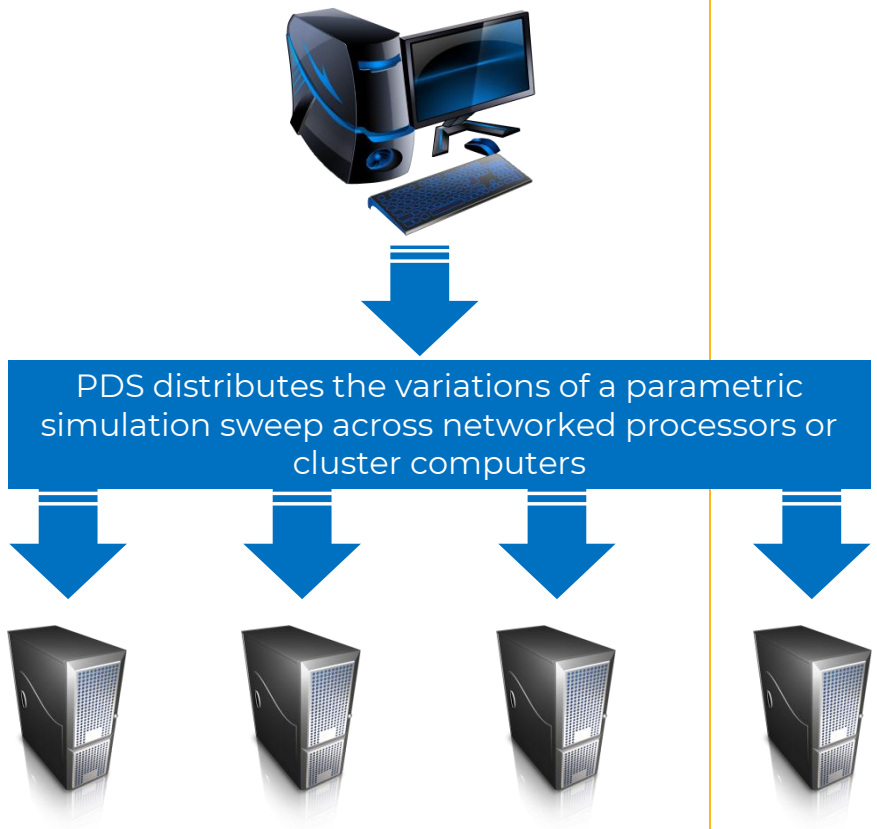
- A “Frequency Sweep” in HFSS is essentially a series of HFSS (frequency) solutions using a common mesh with different frequency of solution

- HFSS can solve the various frequency points in a parallel fashion either on different processors, or on different computers (or both)



Parametric Distributed Solve

- Expands performance of Optimetrics
  - Enable via HPC licensing (pool or pack)
- Optimetrics Distributed Solve enables a user to solve a parametric sweep substantially more efficiently
- The user can distribute the individual variations over many cores of a local computer or many computers of an external cluster



- **Applications**
  - What-if studies
  - Design of experiments (DOE)
  - Dynamic circuit model generation
  - Design for Six Sigma (DFSS)

HPC Best Practices

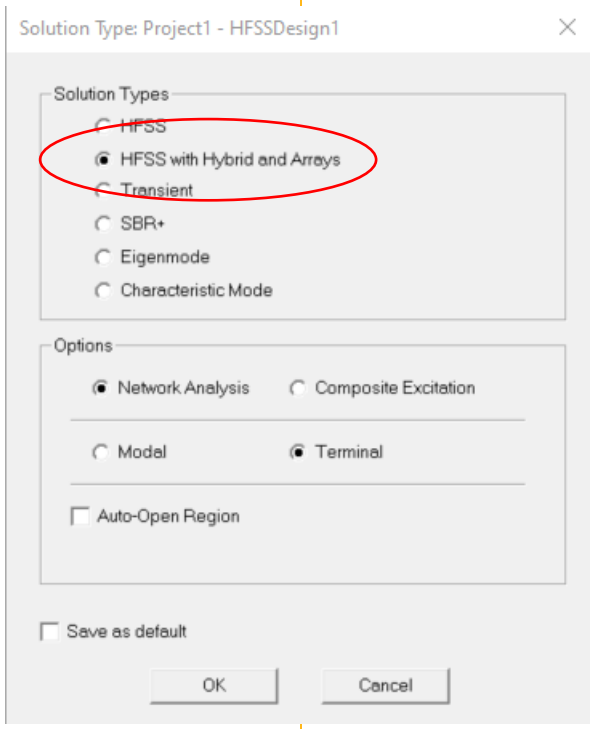
- Overarching Statement:
  - *Cluster computing is not synonymous with FAST computing!*
- A common expectation is that more processors=faster
  - This is incorrect!
- Cluster computing is a paradigm for solving very large computation problems in a reasonable time
- The computing resources applied to a given problem need to have parity with the problem being solved
  - A computationally small problem will actually run slower when distributed over multiple processors/computers as compared to a single machine run
    - Overhead associated with domain decomposition

HPC Best Practices

- A word about computationally large problems…
  - *Do not* start out solving a problem using a cluster computer
  - *ALWAYS* start with a simplified version of a problem that will solve on a single machine
    - Reduced part count
    - Lowered frequency
    - Increased convergence criteria
  - Using a fast-solving form of your model can significantly speed up model synthesis time
    - Deduce appropriate application settings
    - Deduce if parts will mesh or not
  - Start “small” and build up in complexity in a sequential fashion
    - Will be performing a sequence of solutions, each with more accurate state and approaching the final form of the model
    - Success at a one iteration but failure at the next quickly elucidates the reason for the failure
    - Some may view this as unnecessary expenditure of time…***THIS IS FALSE***

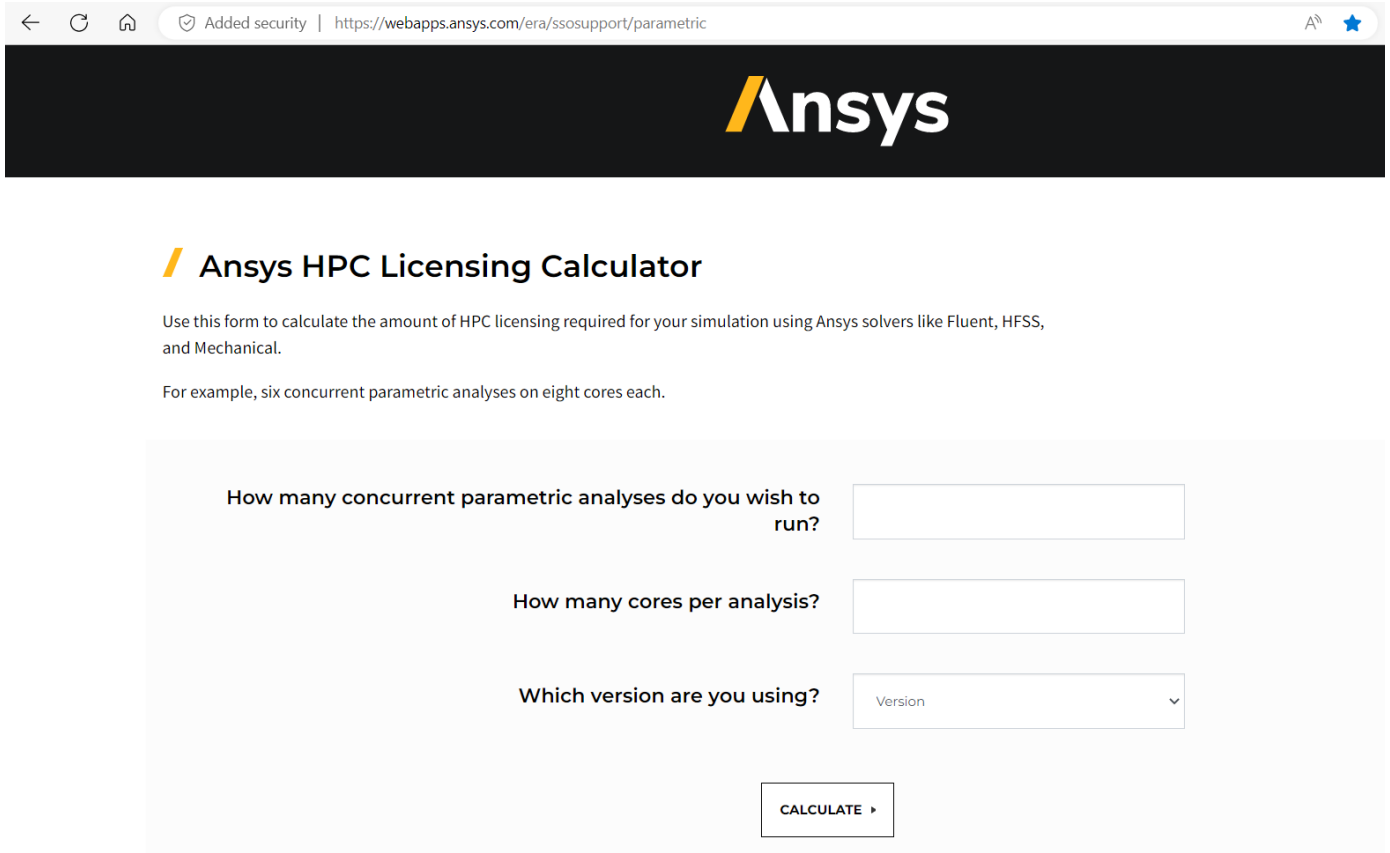
HPC Best Practices

- A word about solver usage when you don't know which one to use…
    - In general, ANSYS recommends using a solver until it "runs out of gas" and then switching to the "next up to bat"
        - When HFSS FEM runs gets too cumbersome, switch to using IE/MoM.
        - When IE/MoM gets too cumbersome, switch to SBR+
        - Keep in mind the "Hybrid" methods



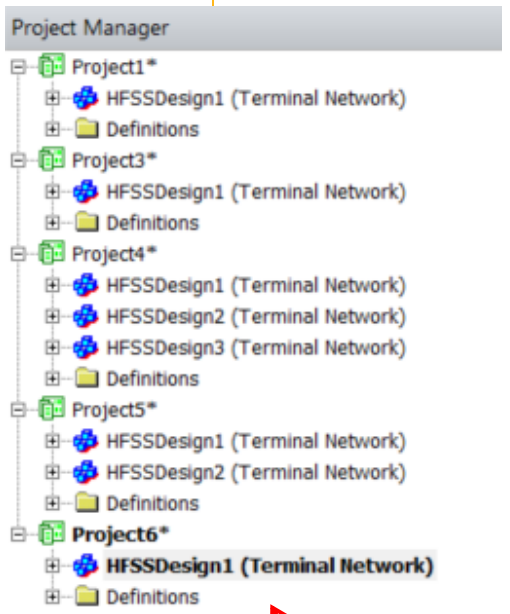
HPC Licensing Choice

- Think about what you are doing and if you are doing a parametric study, use this web utility to deduce if HPC Pack or Pool licenses are appropriate:
    - Ansys HPC Licensing Calculator

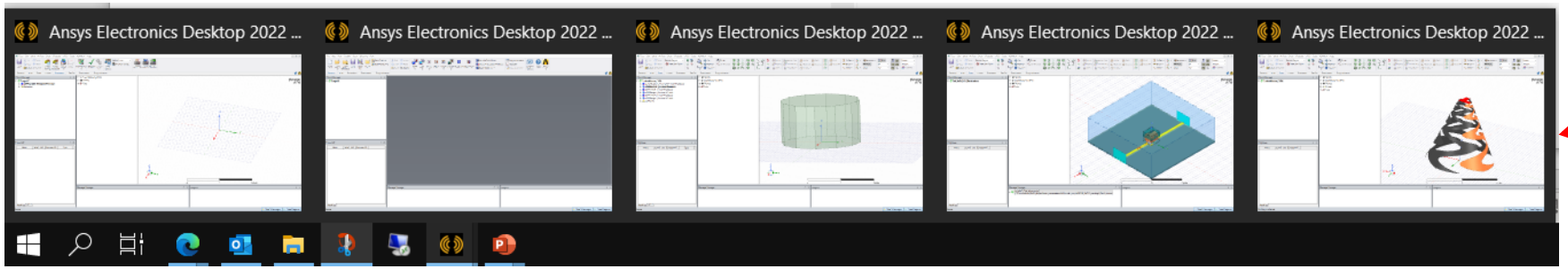


AEDT GUI Instances

- A word about AEDT GUI instances…
  - The AEDT GUI also functions as a project manager
    - Multiple projects can be opened in a single AEDT GUI instance
      - Only one AEDT GUI license is checked out
  - A common habit is to have multiple AEDT sessions started…
    - Would not recommend doing this
    - An additional AEDT GUI license is checked out for each instance
      - Will skew your license usage statistics



Better!



Not Good!

Discussion

- Questions?
- Comments?