Altair | HyperWorks®

FEKO

Comprehensive Electromagnetic Solutions

High Performance Computing

Introduction

A key feature of FEKO is its wide spectrum of numerical methods and hybridisations. Each method or hybridisation is suitable for a specific range of applications and model sizes. Collectively, the methods can solve a wide variety of applications with models ranging from electrically small to electrically large. In many cases standard desktop computers are able to solve large or complex models by selecting the optimal numerical method. Still, computationally expensive problems exist where high performance computing (HPC) is essential. Numerous HPC solutions are available.

- Private cloud computing via HyperWorks Unlimited™ allows unlimited software usage on the device
- HyperWorks Unlimited™ - Virtual provides convenient and on-demand access to HPC-driven computer-aided engineering (CAE), regardless of location
- Computation acceleration via graphics processing units (GPUs)
- Parallelisation of calculations using central processing unit (CPU) technology via multi-threading, Message Passing Interface (MPI) and Open Multi-Processing (OpenMP) parallelisation
- Optimal resource use via specialised coding techniques

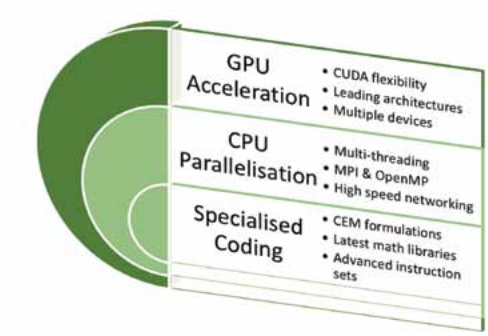
HyperWorks Unlimited(TM)

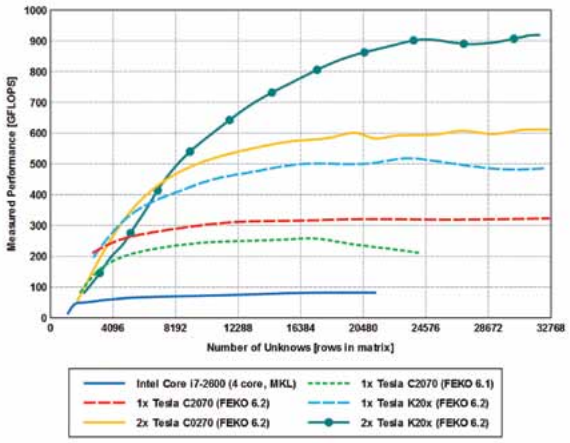
HyperWorks Unlimited™ (HWUL) is a state-of-the-art private cloud solution with fully configured hardware and software, offering unlimited use of all Altair software within the appliance. Altair is the only company to offer best-in-class application software, HPC workload management tools, and industry leading licensing and business model to fit your growing simulation needs. HWUL provides users with:

- Infinite exploration: Contains unlimited HyperWorks Unit (HWU) licenses for usage within the device for massive virtual exploration.
- A single vendor: Reduced operational expenses in setting up and supporting HPC infrastructure and software.
- Innovative pricing model: Conveniently leased to customers, shifting HPC investments from capital expense (CapEx) to operational expense (OpEx).
- Fully integrated, plug and innovate HPC cluster: Delivered as a turnkey system, loaded with Altair's software applications and HPC tools for simplified deployment. Installation takes hours vs. days or weeks.
- Third party solver support: Open architecture allows for third party solvers to be fully integrated for a monthly fee on a BYOL (bring your own license) model.

HyperWorks Unlimited™-Virtual is a public cloud solution, bringing software, platform and infrastructure as a service to Altair customers within a single and intuitive portal. It leverages Altair's patented licensing system, providing access to a selection of the HyperWorks products and a modern, scalable HPC infrastructure through a secure and efficient web-based platform.

Graphics processing unit (GPU)





Performance improvement of the MoM LU decomposition acceleration via GPU

GPU Acceleration

FEKO supports the use of GPUs for simulation acceleration using the compute unified device architecture (CUDA) framework from NVIDIA. The computational phases targeted for execution on CUDA-based GPUs show a significant speedup when compared to standard CPU-based execution. Support for the latest generation of CUDA devices and multiple GPU configurations further improves performance.

CPU Parallelisation for Shared and Distributed Memory Systems

In FEKO, true distributed computing and "farming" parallelisation of simulation are two distinct concepts. Farming assigns individual optimisation iterations to separate CPU cores, while not distributing the solution of the iterations. With true distributed computing, any particular solution (for example, a single frequency) can be parallelised across multiple nodes. This is achieved via rigorous MPI-based parallelisation for clusters and shared memory computers. The efficiency of the parallelisation is improved by limiting the MPI interaction between processes. For example, the multilevel fast multipole method (MLFMM) in FEKO features parallelisation efficiency in excess of 80%.

Efficiency in FEKO is further boosted by integration for different high speed networking technologies such as Gigabit Ethernet, Infiniband and NumaFlex through SGI MPT. OpenMP technology is used for distributed parallelisation across multiple cores of a single CPU. For clusters or shared memory multi-CPU servers, select memory blocks are copied between processes. Communication is reduced and simulation time decreased, but a penalty is paid in terms of memory efficiency. In contrast, the cores of multi-core CPUs address the same memory block much faster than in shared memory multi-CPU systems. OpenMP parallelisation of FEKO for multi-core CPUs make use of this fact to reduce memory requirements. MPI and OpenMP distributed parallelisation methods are hybridised in FEKO to harness the strengths of both schemes.

Specialised Coding

The FEKO developers code software in an efficient way to ensure maximum HPC performance. Existing code is regularly reviewed and reworked to incorporate innovative thinking. Examples of such coding practices are found in both the solver routines and in the specialised hardware supported by the FEKO solver. The MoM LU decomposition algorithms use advanced vector extension (AVX) instructions supported in the latest Intel and AMD based 64-bit processors. Support was added for Intel Xeon Phi math co-processor technology.

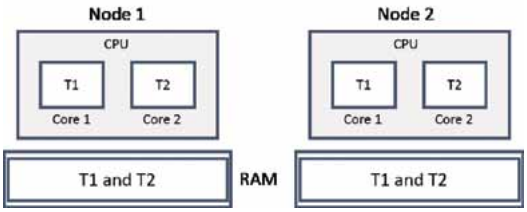
Certifications and Industry Partners

The effort invested by FEKO developers in programming for HPC environments reflects in the strong industry partnerships and certifications that have been achieved. FEKO is Windows Server 2012 certified and integrates seamlessly into the Microsoft job scheduler. Recognition for FEKO development efforts resulted in Altair Development S.A. (Pty) Ltd. awarded the status of "Microsoft Certified Partner". FEKO is certified as Intel Cluster Ready. This implies that FEKO customers can purchase an Intel cluster system with confidence knowing that FEKO is qualified for this computing environment and will work straight out of the box.

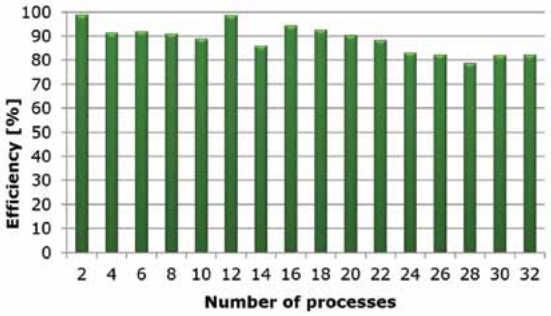
In cases where customers require large scale on-demand computing resources for FEKO runs, partnerships are formed with leading HPC service providers. This ensures the installation of FEKO on the partner's hardware, ready for customer use.

Conclusions

HPC is an ideal solution to demanding CEM simulations. Strategic industry partnerships as well as the adoption of the latest HPC technology ensure that FEKO customers receive optimal value for money invested in HPC hardware infrastructure.



Hybrid distributed / shared memory parallelisation in FEKO



MPI parallelisation for MLFMM

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