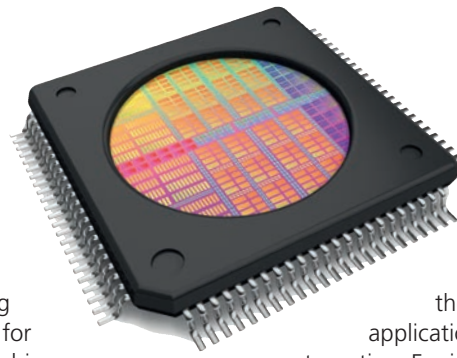


# Utilizing Multi Core CPUs with SIMPACK 9



With SIMPACK 9, not only were the data structures and Graphical User Interface completely redesigned, but also the architecture of the SIMPACK solver was updated and significantly improved. Apart from optimizations of the standard solver, a parallel solver was implemented which is significantly faster than a single core solver.

This reflects the paradigm shift in computer processor development. Previously, more speed and computing power was achieved by increasing the CPU frequency; today, more computing power is obtained by increasing the number of CPU cores on a processor chip.

Multi core CPUs can be used to speed up simulations either by running multiple independent simulations concurrently, or by running a single simulation with the

parameter studies, job runs can be automatically distributed using SIMPACK scripts. This is used, for example, to compute wind turbine dynamic loadcase scenarios (DLC) [1].

## PARALLEL SOLVER

Speeding up the simulation by using multiple CPU cores for a single solver run is more challenging. In this case, the solver must automatically distribute its computation tasks across the different CPU cores. For a set of equations which is loosely coupled or uncoupled, splitting the computations into different threads for simultaneous execution on different CPU cores is straightforward. And for large matrices, it is easy to use multiple CPU cores to speed up the matrix manipulation.

However, the equations of motion of an MBS model are often highly coupled and the matrices are typically small and densely populated. For these types of problems, no standard or readily available solutions exist to automatically take advantage of multiple CPU cores. This challenge is addressed by SIMPACK's new parallel solver which was introduced in its earliest version with SIMPACK 9.0.

The parallel solver automatically distributes solving the different parts of the equations of motion onto the available CPU cores. Sections that must be executed sequentially are automatically detected and evaluated in the proper sequence. The rest of the equations are executed in parallel with a strong focus on evenly distributing the workload on the available CPU cores. The results generated by single core and parallel solver are bit-identical.

SIMPACK 9.0 delivered an initial version of the parallel solver which brought significant speed-ups to certain applications. The focus of the subsequent releases (SIMPACK 9.1 through 9.4) was therefore to bring the speed-up

benefits to the complete application range: Automotive, Engine, Rail, Wind and General Machinery. Figs. 1 and 2 show performance gains with the parallel solver for different typical applications and SIMPACK releases 9.0 through 9.4 and for different number of CPU cores. The table also shows that the performance of the standard single core solver was significantly improved over the different SIMPACK 9 releases as well.

## CONCLUSION

SIMPACK's parallel solver was developed with today's typical multicore engineering workstations in mind which have 4–16 cores distributed across one or two CPUs and use a symmetric multiprocessing (SMP) approach. The best performance gains are achieved when all CPU cores used are on the same physical CPU. The chosen approach for the parallelization is unique to SIMPACK and goes far beyond the traditional approach of simply evaluating Force Elements in parallel. Performance gains with SIMPACK parallel solver have already led to significant simulation time reductions across the whole application range. Future versions of SIMPACK will further improve the speed-ups achievable with the parallel solver.

## REFERENCES:

- [1] S. Mulski, SIMPACK AG: *Wind and Drivetrain Conference 2012—Modeling Elements, Data-base Management, DLC Calculations* ([www.simpack.com/fileadmin/simpack/doc/papers/Wind\\_Drivetrain\\_Conf\\_2012/Harms\\_Mulski\\_Wind\\_Drivetrain\\_SIMPACK\\_congress\\_DLC.pdf](http://www.simpack.com/fileadmin/simpack/doc/papers/Wind_Drivetrain_Conf_2012/Harms_Mulski_Wind_Drivetrain_SIMPACK_congress_DLC.pdf))

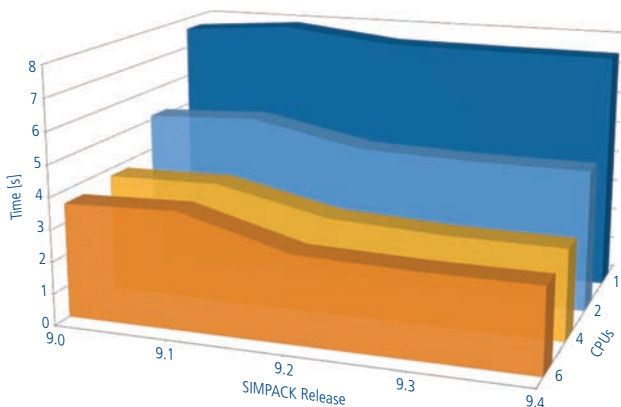


Fig 1: CPU comparisons — Rail simulation

parallel solver that utilizes multiple CPU cores. Whether a parameter study of a model needs to be completed as quickly as possible, or a single solver run should be executed with maximum speed, the user has the choice to employ either approach.

## PARAMETRIC STUDIES

Parametric studies best utilize the CPU cores if, for each parameter setting, a single core solver run is performed (single core meaning that the solver run only uses a single CPU core). In this scenario, the CPU cores can all be used without requiring any special solver. Speedups that can be achieved scale almost linearly with the number of CPU cores. For

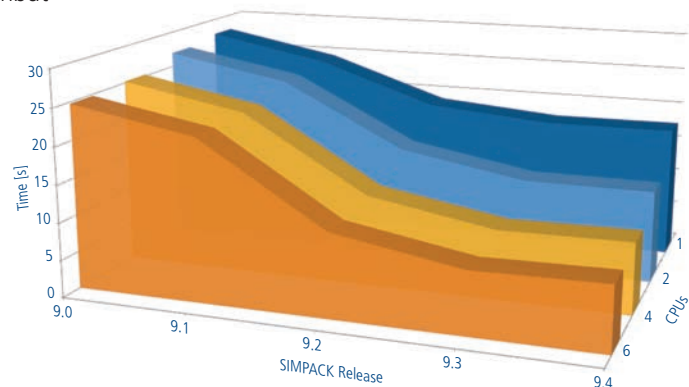


Fig 2: CPU comparisons — Automotive simulation