

Quad Power

Performance boost for HIL simulation with new DS1006 Processor Board



dSPACE has upgraded the DS1006 Processor Board – the heart of dSPACE real-time systems – with a Quad-Core AMD Opteron™ processor. The board now has even more power to meet the growing demands of hardware-in-the-loop (HIL) simulations. Large, processor-intensive models can be distributed easily across the processor cores and executed synchronously.

Simulation Needs Performance

HIL simulation is always hungry for greater computing performance. There are countless examples, such as the HIL simulation of electric motors for hybrid drives. These require high computing speeds because some tasks necessitate very short cycle times, for example, to allow oversampling even at high switching frequencies. Gasoline engines with variable valve timing and valve lift are another example. The usual mean-value models no longer suffice for these; more precise and therefore more processor-intensive models are required. The same applies to diesel engines with in-cylinder pressure measurement.

The new DS1006 supplies the performance needed for all these application cases and still has enough in reserve for further tasks. Various performance tests have shown that the new DS1006 is up to 60% faster than its predecessor in multiprocessor systems.

The Solution: Multi-Core Processors

For a long time, the usual method of boosting processor speed was to increase the clock rate. This method is coming up against its physical limits, however, as the heat build-up it causes is becoming unmanageable. The second common way in which speed is boosted is to im-

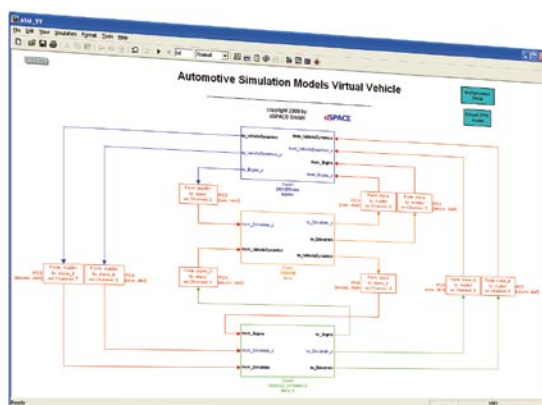


Figure 1: Example of distributing a model across several cores of the DS1006. An ASM virtual vehicle consisting of three submodels (Drivetrain, Engine (with Soft_ECU_Gasoline) and Vehicle-Dynamics) is distributed across three of the four cores of a DS1006 and interconnected via 9 IPC blocks.

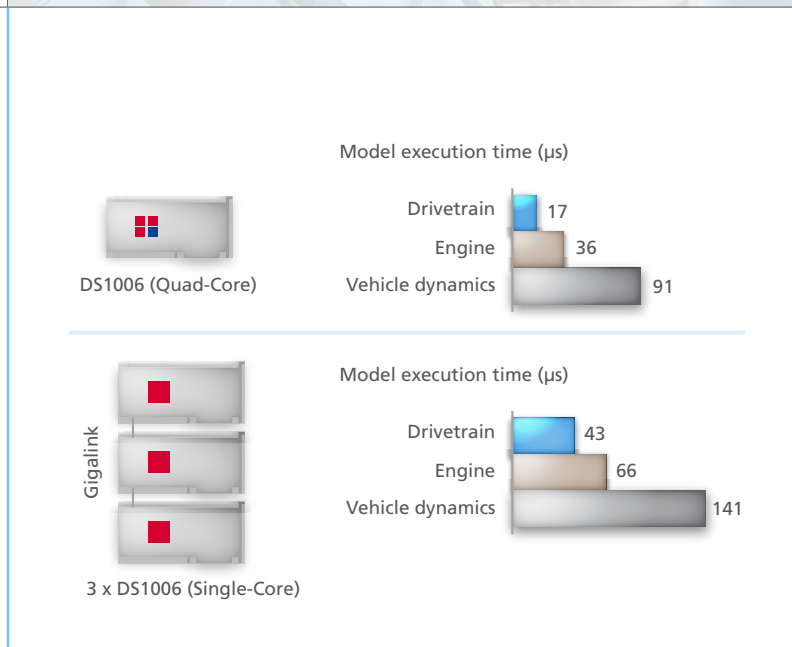


Figure 2: Performance of the quad-core DS1006 2.8 GHz compared with its predecessor DS1006 2.6 GHz (each without I/O). Three submodels of the ASM virtual vehicle run simultaneously on three cores of the quad-core DS1006: drivetrain, engine and vehicle dynamics.

prove processor architecture, but here too, there is very little room for further improvement. Multi-core processors, i.e., ones with several CPU cores, are the way out of this dilemma. Each of the CPU cores has greater performance than earlier single-core processors, and the rapid data communication between the cores is a real bonus. The challenge of harnessing the great power of multi-core processors for real-time simulation therefore lies in thinking out how to handle all the different tasks, in other words, how to most usefully distribute and parallelize them, and how to organize communication between them.

Made-to-Measure Power

Where several DS1006 single-core boards used to be necessary in the past, only one single quad-core DS1006 Processor Board will often be needed in the future. This not only makes HIL simulators more cost-effective, it also provides greater flexibility for extensions. Naturally, multiprocessor systems can also be built in the usual way by connecting several new quad-core DS1006 processors together. Users can tailor the computing power to specific requirements in this way – whether they “only” want to process CPU-intensive models, or need the modularity of multiprocessor systems to

build a virtual vehicle from the test systems for individual ECUs or vehicle domains.

Graphical Control via the Real-Time Interface

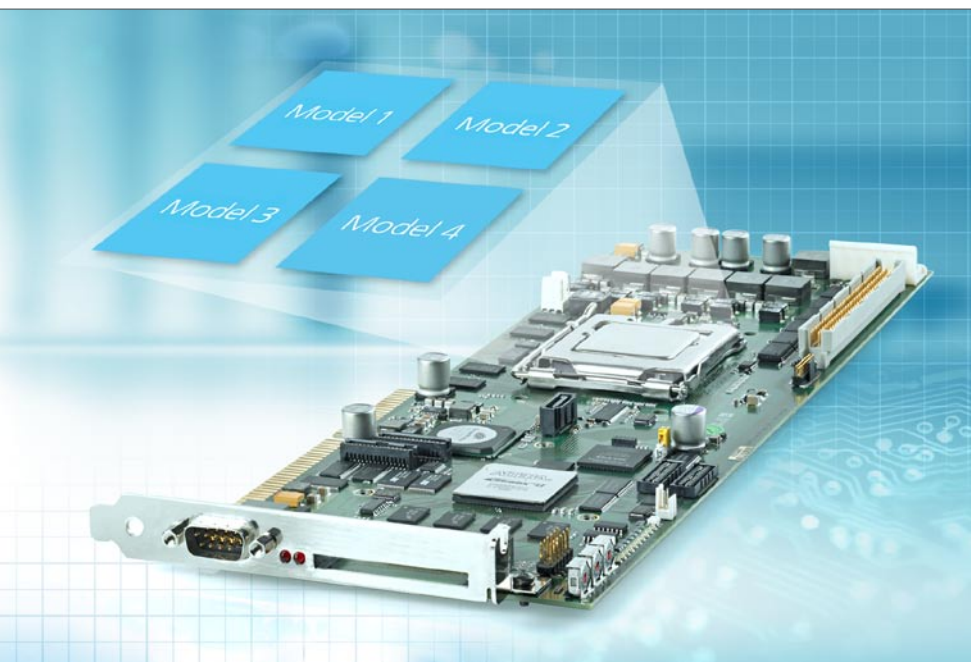
The Real-Time Interface for Multiprocessor Systems (RTI-MP) is an implementation tool that supports users when they scale large, processor-intensive models on their systems. Users can perform all the necessary steps on this one user interface, whether they want to use a single quad-core DS1006 board or build a system from several boards. RTI-MP lets users partition the models to ensure optimum utilization of the processor cores, and define and specify the communication channels for data transmission between the cores of the quad-core DS1006 in the same way as for multiprocessor systems. The communication parameters can be defined via interprocessor communication (IPC) blocks. This is done independently of how communication is actually performed physically, i.e., whether there are internal Gigalinks between several processor cores or optical Gigalinks between different processor boards. The cores of the new quad-core DS1006 not only compute several tasks synchronously, they can also execute several unsynchronized models at once.

Comparison: The New DS1006 and Its Predecessor

The performance of the new quad-core DS1006 board is clearly shown when various dSPACE Automotive Simulation Models (ASM) are computed (figure 2 and figure 3), with each submodel running on one core of the board. The cores are all connected via internal Gigalinks. With the predecessor board, the single-core DS1006, each ASM model runs on its own board. The single-core DS1006 boards are connected via external Gigalinks.

Profile of the New DS1006 Processor Board

- Quad-Core AMD Opteron™ processor, 2.8 GHz
- 512 kB L2 cache per core; 6 MB L3 cache
- 1 GB local memory for executing real-time models
- 128 MB global memory per core for data exchange with the host PC
- 2 MB on-board boot flash memory
- Optional application flash memory on a CompactFlash board for automatic, host-independent booting of real-time applications



Without connected I/O (figure 2), the time saving is between 35% and 60%, depending on the model being computed. This is largely due to the bandwidth of the internal Gigalink connections, in addition to the higher clock rate and the improved processor architecture. Even with connected I/O (figure 3), the new board is faster, despite the fact that I/O access to both DS2211s runs via a common pro-

cessor interface. The reason is the high speed of the internal Gigalink connections in the quad-core DS1006 – even though the number of signals transmitted here by no means uses the Gigalinks' full potential. ■

Conclusion

With the new Quad-Core AMD Opteron™ processor, the new DS1006 Processor Board provides considerably more performance than its predecessor. Various tests showed that it achieves up to 60% more speed than its predecessor in multiprocessor systems, depending on the model. As with other dSPACE boards, several of the new DS1006 Processor Boards can be used to build multiprocessor systems that increase performance even further. The HIL simulation of electric motors for hybrid drives, gasoline engines with variable valve timing, and diesel engines with in-cylinder pressure measurement are typical examples of applications that require greater computing performance. Users can conveniently partition all the computing tasks with the Real-Time Interface for Multiprocessor Systems (RTI-MP) software, whether they are handling a single DS1006 or a system made of several boards.

Figure 3: Performance data of the quad-core DS1006 2.8 GHz compared with its predecessor DS1006 2.6 GHz (with I/O boards). Each main component of an ASM virtual vehicle, in this case the basic gasoline engine and vehicle dynamics, runs on one core of the quad-core DS1006.

