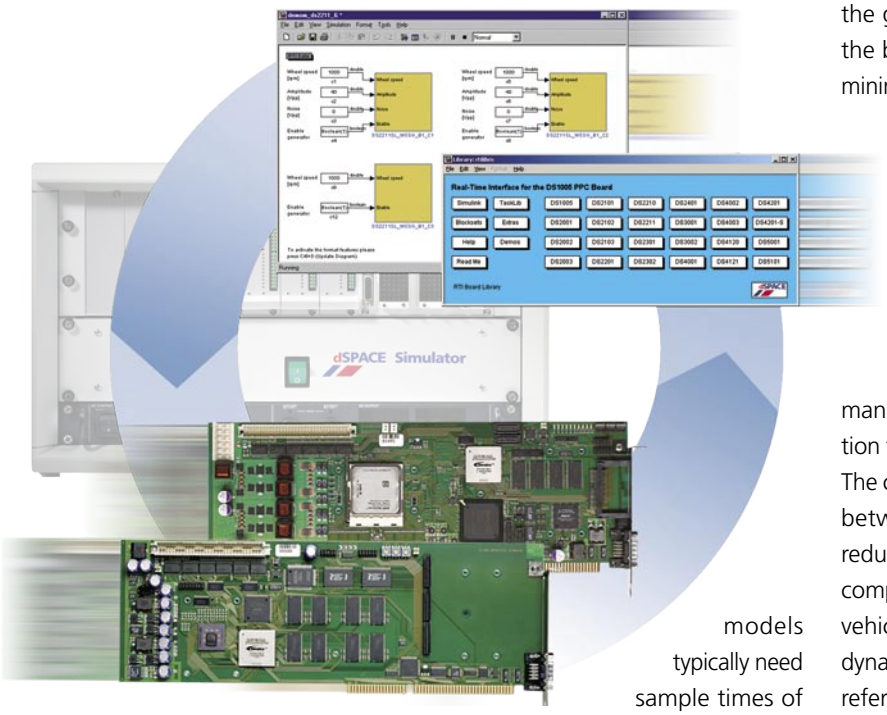
Real-Time Without Pitfalls

- High processing power
- Fast I/O performance
- Perfect scalability

Your real-time applications need more than just processing power. That is only one of the preconditions for meeting future challenges. The others are high-speed I/O-to-processor communication, system scalability, and a comprehensive software environment. Real-time systems from dSPACE provide all this, giving you optimum conditions for real-time applications.

Present Trends in Real-Time Hardware

Hardware-in-the-loop (HIL) simulation with complex, precisely detailed simulation models requires enormous real-time computing power. Common automotive HIL



models typically need sample times of 1 ms or less to meet real-time requirements. In Formula One applications, engine and vehicle dynamics simulations are usually performed with sample times of 0.5 or 0.25 ms. The size of HIL models continues to increase rapidly, and with it the need for more processing power. dSPACE regularly upgrades dSPACE Simulator and boosts the speed of its real-time hardware to meet future challenges.

Upgraded Processor Boards

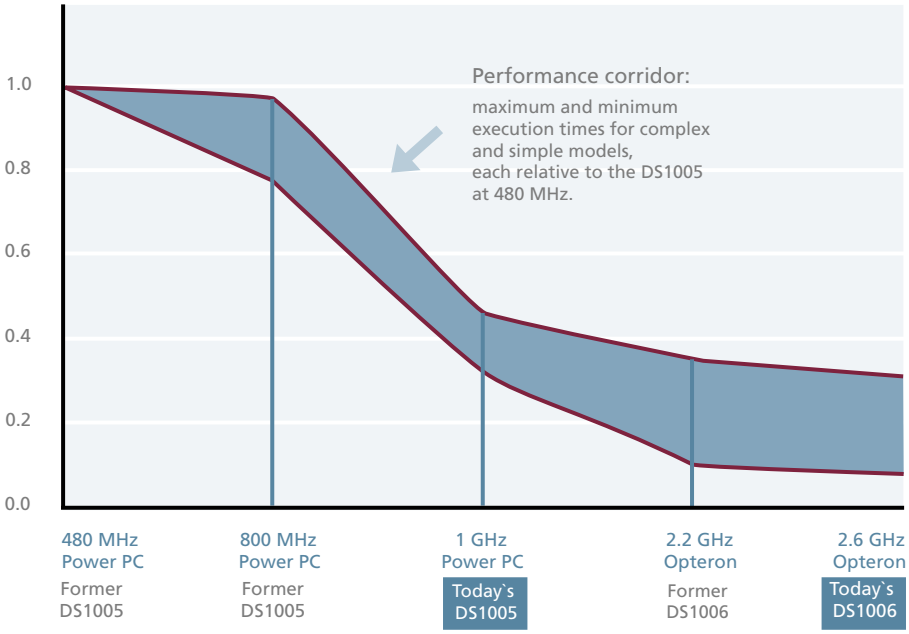
dSPACE Simulator's current flagships are the DS1006 Processor Board, now running at 2.6 GHz, and the DS1005 PPC Board with 1 GHz processing power. Designed for use in laboratories, the DS1006 has the greater computing power, while the DS1005 is the board of choice wherever I/O latencies must be minimized, and for in-vehicle applications such as rapid control prototyping (RCP). For example, the turn-around time for an F14 Simulink® demo model (without I/O) running on the DS1005 is less than 1.2 µs. Combining the DS1005 with the new DS2004 High-Speed A/D Board (see also article on page 18) produces sampling rates of up to 275 kHz for a PID control loop, including I/O.

The diagram on page 15 illustrates the performance increase of dSPACE processor boards in relation to the former DS1005 PPC Board with 480 MHz. The corridor shown in the diagram indicates the range between the maximum and minimum achievable reduction in processing time, which depends on the computed model and the I/O communication. Large vehicle models without I/O, and engine and vehicle dynamics models with comprehensive I/O, are used as references. The larger the computational load of the model (not counting I/O), the greater the advantage of the powerful AMD Opteron™-based DS1006. You can calculate large and complex HIL models on the DS1006 in a single task, without having to split them.

Low I/O Latencies

When designing the DS1006, dSPACE chose the AMD Opteron™ instead of an Intel® CPU because of its HyperTransport™ capabilities. The HyperTransport bus allows

fast access to the Opteron processor itself. The I/O-to-processor communication of the DS1006 is performed via HyperTransport and the peripheral high-speed I/O bus (PHS). As the PHS bus is especially designed for real-time applications, this guarantees fast I/O access times. There is no software overhead caused by extensive transfer protocols. In contrast a solution with PCI I/O would be significantly slower than the HyperTransport connection. HyperTransport is 12 times faster than PCI-X, for example. Excellent processing power plus fast and deterministic access to I/O hardware with minimum latencies make dSPACE processor boards considerably faster than solutions based on commonly available PCs.



▲ *Performance increase: reduced processing time per processor board relative to the DC1005 at 480 MHz.*

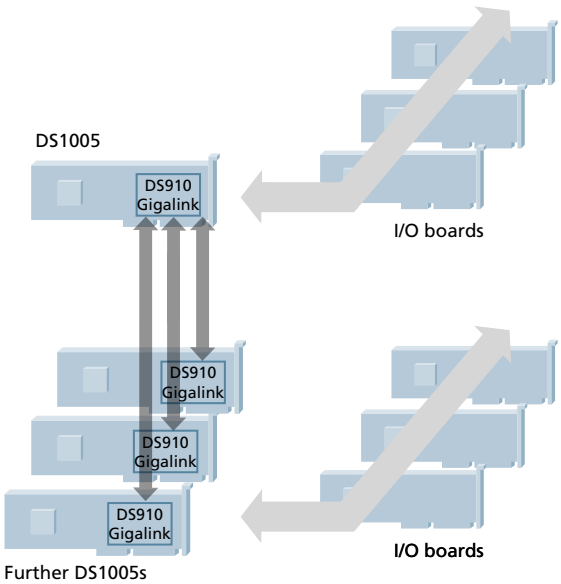
System Scalability

Our customers often start running HIL simulation in one application, typically testing engine controllers, vehicle dynamic controllers, or body electronics separately. Then as control functions are increasingly distributed across several ECUs, HIL component testers have to be networked to test the interaction between ECUs that were previously tested separately. This requires flexible multiprocessor systems and comprehensive software which handles complex task synchronization automatically. dSPACE processor boards give you the ability to build scalable multiprocessor systems.

We offer you scalability in terms of increasing performance and/or spatial distribution. Our multiprocessor systems achieve a net transfer rate of more than 600 Mbit/s (after deducting the protocol overhead) with the help of 1.25 Gbit/s optical fiber technology. You can connect up to 20 processor boards in one system and over distances exceeding 100 meters.

Our customers never have to worry about losing earlier investments, as their systems are always expandable. It is even possible to couple an older DS1005 running at 480 MHz with the current DS1005 running at 1 GHz.

The dSPACE Real-Time Interface (RTI) software makes it easy to configure each dSPACE board in Simulink and to generate the code for your real-time hardware automatically. You can use RTI-MP to define the multiprocessor structure in Simulink, including the communication channels between the processors.



▲ *Building multiprocessor systems with dSPACE boards.*

Conclusion

Processing power on its own does not guarantee a successful real-time application. When you plan your real-time system, you should also look for low I/O latencies, scalability, and a comprehensive software environment. All four factors need to be just right to produce a powerful and efficient real-time system.