Bentley – Simulation for Luxury Vehicles

- Innovations for Bentley's new Continental GTC
- Bentley relies on dSPACE HIL solutions
- Driver-in-the-loop simulation with MotionDesk

For developing and testing the new Continental GTC, Bentley Motor Cars Ltd. relies on hardware-in-the-loop (HIL) systems from dSPACE. By using a simulated vehicle, Bentley can evaluate and validate all the electronic systems dynamically prior to eventual signoff at the test track. For example, a new approach for the GTC Tyre Pressure Monitoring system (TPM) required a HIL solution that provided a quick, low-cost and fault-free dynamic test capability to get new features on the road faster.

The Continental GT Convertible is the latest member of the Bentley Continental family. As a manufacturer of luxury vehicles, our development and production facilities are set up for low-volume but high-value cars. Although such niche cars have correspondingly limited development budgets, the customers of luxury vehicles expect reliability and quality standards to exceed those of more mass-produced vehicles. That is why we at Bentley rely on extensive HIL tests to achieve quality and reliability for the customer.

▲ *MotionDesk visualized driving maneuvers during driver-in-the-loop tests.*

Testing Focus

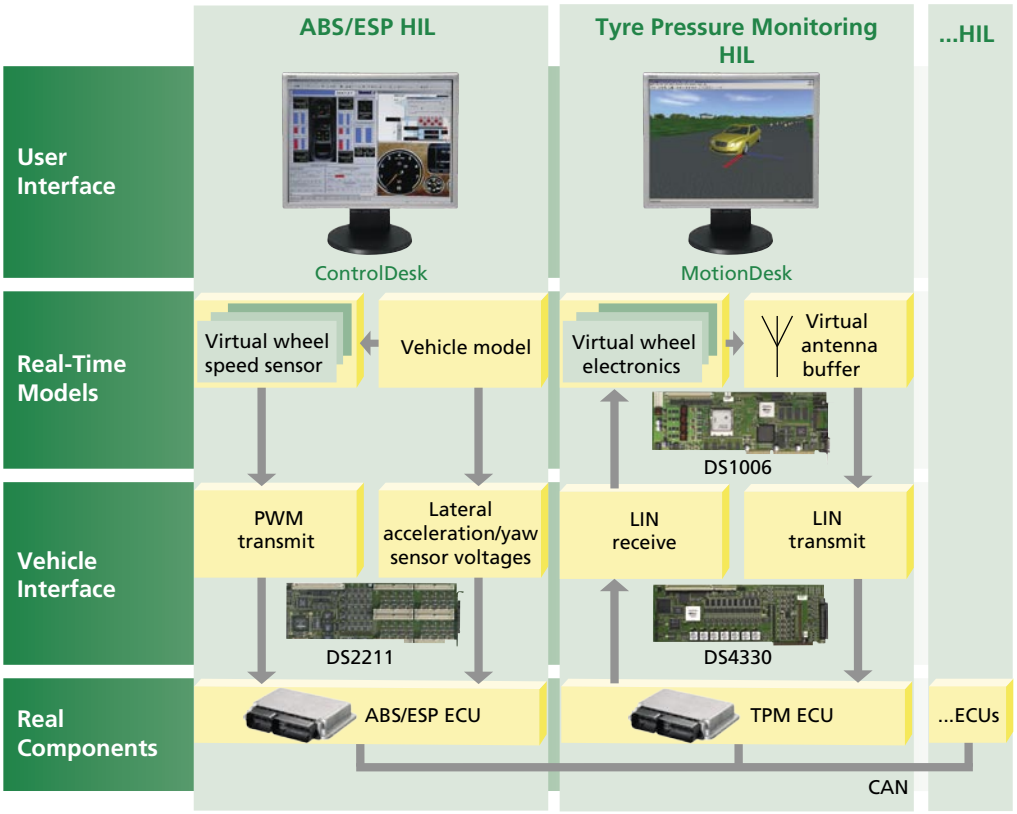
As the development of comprehensive new models is prohibitively expensive, model-year updates are necessary to incorporate the latest technologies. These additional features require an integrated test approach, which means we focus the testing and test tools where the most significant deviations have been made. For example we have introduced additional functionality in safety-critical systems such as the Tyre Pressure Monitoring (TPM) system and electronic parking brake. Bentleys have no speed limiter fitted and can easily go over 300 km/h. With our HIL system we are able to perform the majority of these potentially dangerous tests within the laboratory, requiring vehicle tests on the road only for final signoff when we are sure the systems are robust and fully functioning.

▼ *The Continental GTC by Bentley.*

HIL in Action

The TPM system was recently improved to use a Local Interconnect Network (LIN) solution comprising LIN-based trigger units in each wheel-arch and a centralized LIN antenna to receive the responses from the in-wheel electronic sensor units. This solution allowed us

to implement an HIL interface using the DS4330 LIN Interface Board for connection with real LIN components. The added customer-visible functionality included not only tyre pressure/temperature information but also a matrix of speed/pressure warnings to warn the driver if the tyres were not suitably prepared for very high-speed motoring. With the HIL solution in place, the test engineer can now 'drive' the simulated vehicle to the desired speed and then perform a variety of tests in ControlDesk from dSPACE. These include verifying the threshold performance at accurately controlled vehicle speeds, simulating synchronized tyre punctures/deflations and creating LIN communication errors so that subsequent repeat data requests etc. can be monitored. Key real-world problems such as slow deflations at high speed are extremely time consuming (tyres must be allowed to cool etc. after each test), but this LIN-based virtual solution allows all permutations to be tested at a fraction of the time/cost.



▲ *Schematic overview of the hardware-in-the-loop tests.*

Driver-in-the-Loop Simulation

In addition to HIL simulation, our proving phase also covers driver-in-the-loop simulations. MotionDesk, enabling 3-D animation in a virtual world, is used to allow virtual test-drives to be replicated in the laboratory. Together with our Volkswagen Group colleagues, we have digitally recreated the VW test facility Ehra-Lessien and exported this to MotionDesk with additional scenery etc., so that the test engineer can drive the same routes as our real prototype vehicles. This visualization tool allows key vehicle parameters to be evaluated, and changes in calibration can be immediately assessed at the overall vehicle response level. The virtual vehicle model and visualization also allow rapid conceptual changes to be easily validated.

"By using the dSPACE HIL system for the Continental GTC tyre-monitoring development, we reduced our software development time by 50% compared to previous projects."

Tom Fussey, Bentley

Test Automation

The challenge we now face is to enable the test quantity and depth to be increased in line with system complexity. Therefore we have solutions in place to control all major driver inputs remotely, including throttle pedal actuation, steering-wheel angle, ignition switch status and gear lever position. CAN messages are also manipulated via the dSPACE Real-Time Multi-Message Blockset. As part of our test automation solution we use AutomationDesk to allow test engineers to efficiently create and monitor simple test scripts, primarily for our mobile automated failure insertion unit.

By using the dSPACE HIL system for the Continental GTC tyre-monitoring development, we reduced our software development time by 50% compared to previous projects.

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