The logiRECORDER device injects four channels of video recorded by the test car's four video cameras furnished with integrated wide-angle (fish-eye) lenses, via a GMSL2 serial interface. The Surround View Parking Assistance ECU corrects the input video and stitches it together to provide a full 360° view

Stimulate to accumulate

How flexible HIL data injection is breaking down simulation boundaries between the synthetic and the real world

by **Gordan Galic**, technical marketing director, Xylon

Direct HIL data injection provides automotive developers with the freedom to indefinitely repeat any corner-case traffic situation until the control algorithms are fully perfected. HIL simulations offer better controllability and a full check-up of ECU responses through more economical testing that requires fewer test-driven miles.

HIL injection stimuli comprise either road-recorded or synthetically modeled sensory data. Raw road data is invaluable in simulations of weather conditions, real-car installations and complex road scenarios sensed by a heterogeneous sensory system. The artificial stimuli enable a workaround of direct HIL limitations by enabling interactive and precise variations of 'what-if' simulation scenarios.

Each HIL simulation rig needs an interface to connect the simulator to real ECUs. The interface must overcome one of the biggest HIL challenges – it must break boundaries between the synthetic world built in the simulator and the real world of ECUs. Road data must electrically and logically clone the original vehicle's sensors, and synthetic data also requires constant translations between virtual and physical domains.

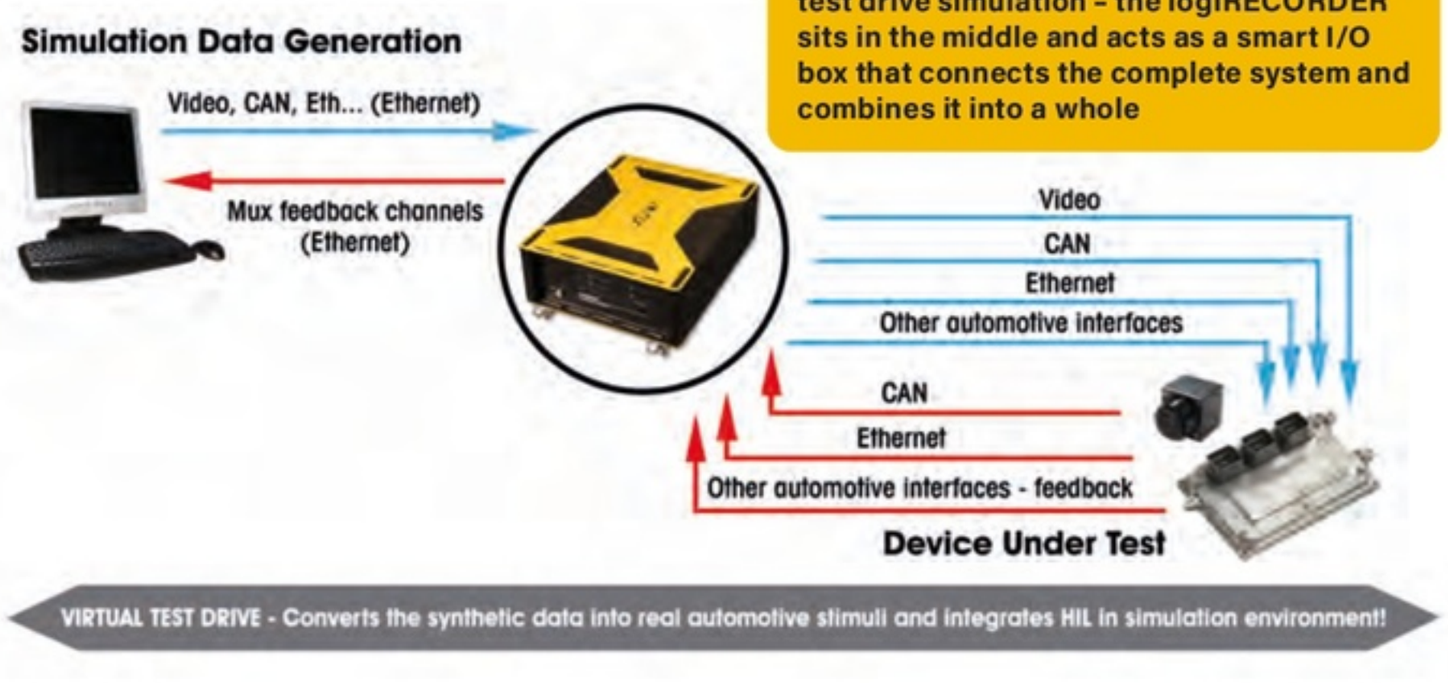
ADAS and AV automotive systems combine many heterogeneous sensors, such as high-bandwidth radar, lidar and video cameras with legacy low-bandwidth sensors and automotive networks. Any type of HIL injection simulation requires a flexible and multichannel interface for the attached hardware.

A customizable solution

Xylon has designed its logiRECORDER Automotive HIL Video Logger to support all HIL use cases and interfaces. It is modular and enables users to adapt the hardware platform's interfaces by choosing from more than 20 interface I/O module types.

The device is a single box solution with recording and playback capabilities. In the logging mode, it non-intrusively records raw data through native automotive interfaces and in industry-standard formats, such as MDF4, ROS, PCAP and others.

Below: Data paths in a complete virtual test drive simulation – the logiRECORDER sits in the middle and acts as a smart I/O box that connects the complete system and combines it into a whole



When in the direct HIL mode, Xylon's datalogger injects harvested road data through the same interfaces and perfectly clones physical signals expected by the DUT. It can simultaneously record ECU responses through automotive interfaces, such as FPD-Link III, GMSL, CAN or Ethernet, and process industry-standard TAPI data in real time.

This level of flexibility is possible because of the device's architecture, which is based on programmable FPGA chip technology. The logiRECORDER is designed from scratch, and each of its hardware and software parts can be fine-tuned. It enables Xylon's developers to fulfill any customer requirements and work around typical limitations set by PC architecture-based solutions. The same applies to software offerings that include the standard datalogger dashboard user interface for full recording and playback controls, and a complete software development kit (SDK) for flexible integration with different simulation rigs.

The most sophisticated virtual test drive simulations use both synthetic and realistic stimuli. A great advantage of this simulation type is its interactivity. While the direct HIL records only ECUs' feedback on prerecorded data sequences, virtual test drives can modify stimuli based on real-time ECU responses. Simulation rigs for simulations at such complexity levels must overcome many challenges and provide an acceptable real-time performance level and flawless data conversions between virtual and physical domains.

In virtual test drive HIL simulations, the logiRECORDER inserts as a smart I/O module between the simulation environment and ECUs that can work in a production firmware mode, which additionally increases the realism of the simulation.

The only interface between the device and the simulator is the 10GbE link for multiplexed synthetic and real test data encapsulated in Ethernet frames. The datalogger de-encapsulates test data and formats it to match the ECUs' automotive interfaces. It simultaneously receives ECU responses and sends them toward the simulator. It aligns stimuli based on received time stamps, and time stamps ECU responses in a return loop.

Real-time and high-precision simulation is ensured by the datalogger's configurable buffering that compensates Ethernet traffic bursts or delays, and its integrated flawless and low-latency data type conversions.

A single-point 10GbE interface simplifies the overall system software architecture, removes the need for multiple driver changes, and simplifies the integration with different simulators and simulation rigs. ‹