HIL without compromises

Precision, speed, configurability, cost-effectiveness and improved safety are all key requirements for videologgers used in hardware-in-the-loop testing

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

An automotive video camera exchanges various manufacturer-defined metadata, such as product codes, frame numbers, timestamps and error correction codes, with the ECU that controls it. Metadata is merged with a sensor's video data, usually by embedding dedicated video lines within a single camera frame. The ECU recognizes such data and extracts it from the video.

This convenient camera control mechanism might become an obstacle in hardware-in-the-loop (HIL) validation setups that inject synthetically generated video from simulation environments or even previously recorded raw video data into the ECU under test. The most demanding HIL simulations that enable automotive functional safety (FuSa) testing require the ECU to run in the production firmware mode, instead of running in fault-tolerant debugging modes. Video generated within advanced simulation environments often includes fixed or even incomplete video camera metadata, while videos from test vehicles include metadata recorded and 'frozen' at a certain time in the past.

When stimulated with a video containing metadata that doesn't correspond to the ECU's expectations based on issued control sequences, for example, missing video brightness adjustments or a wrong frame number, the ECU under test can quickly encounter an invalid state and the HIL simulation will fail.

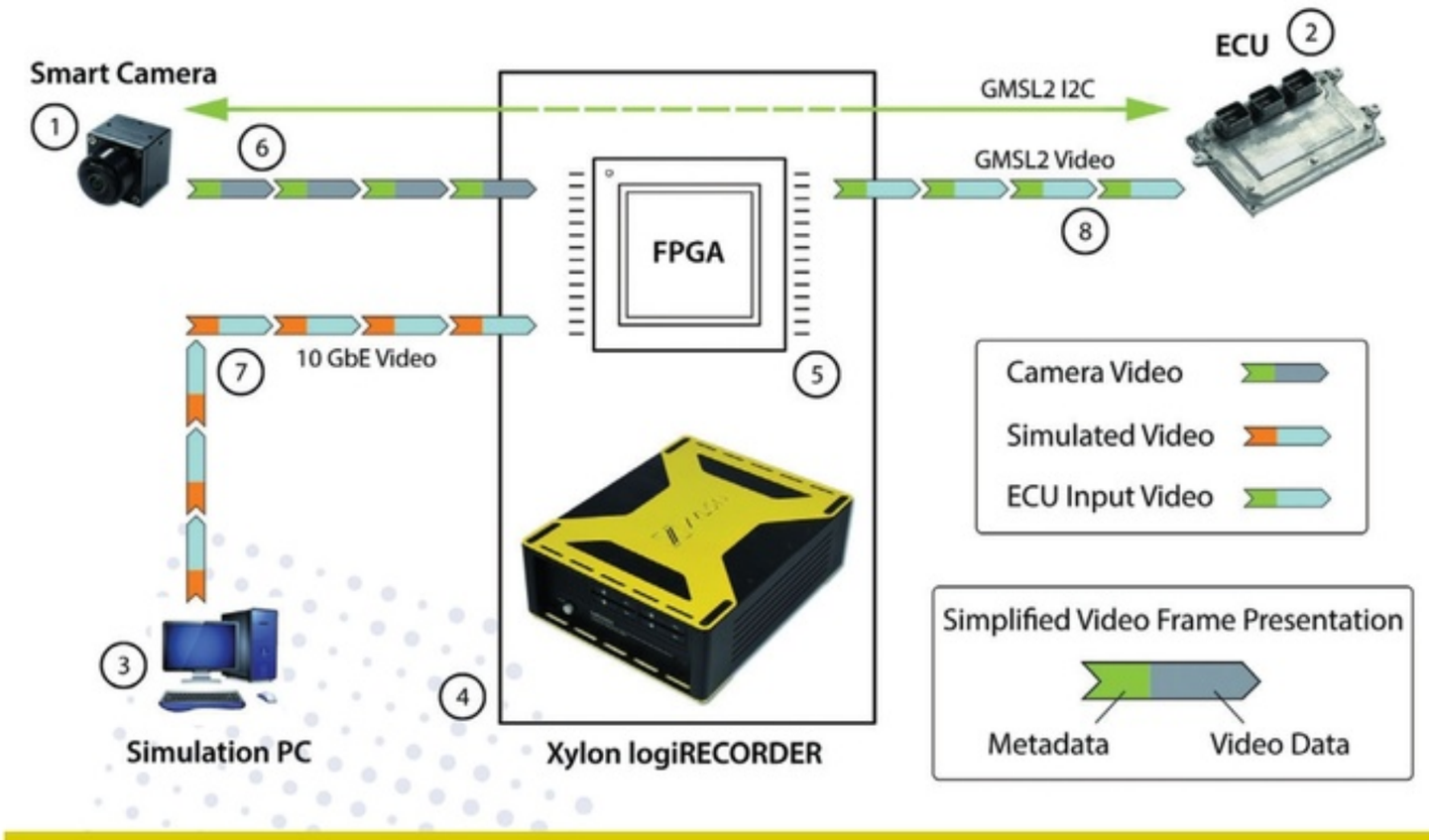
Xylon's logiRECORDER Automotive HIL Video Logger (4) used in the HIL mode with streaming data can overcome this problem by injecting simulated video data (7) merged with the interactive metadata from the real video camera (1) into the ECU (2). The ECU usually controls the video camera over the I2C bus tunneled via the LVDS that routes through the logiRECORDER. Such a setup enables the ECU to continuously 'talk' to the camera in real time and with an extremely low latency.

The logiRECORDER integrates programmable FPGA chips (5) with hardware accelerators developed in-house that merge the real camera's metadata with the simulated video streamlined from the PC (3) via a 10GigE datalink (7).

Before both can be merged, the camera video streamlined via a high-speed LVDS (6) serial link and the simulated video packaged in Ethernet packets must be decoded and synchronized. With both video links working in the gigahertz frequency range, it is obvious that such precise data manipulation exceeds software performance levels and that only customized hardware accelerators make it possible. Real-time modified video input (8) to the ECU combines real video camera metadata with inserted simulated data from the simulation PC. Data latency through the logiRECORDER HIL box is minimal and does not interfere with the ECU's regular operation.

Additional data manipulation is also possible. While the test rig is reconfiguring, for example starting a new simulation scenario, the logiRECORDER can continuously repeat a video frame with inserted modification that will prevent the ECU from stalling due to a frozen or missing video input. This feature enables automated HIL test rigs that run 24/7 and speed up testing and validation. The logiRECORDER can also be used for controlled error injections and ECU testing in all possible corner-case scenarios.

Xylon's solution is highly configurable and can support different video links, such as GMSL2 and FPD-Link III. Through design services, the demonstrated HIL mechanism can be quickly adapted for specific manufacturer metadata. ‹



FuSa-level HIL ECU testing with synthetic video generated from the simulation environment. The setup includes a real video camera that responds to the ECU's commands and prevents HIL stalls. The ECU receives the video input with the expected metadata and simulated video data, fused together within real-time FPGA hardware accelerators in the logiRECORDER unit

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