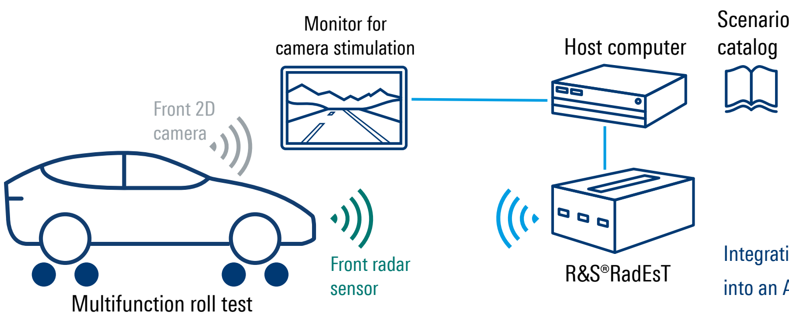
MORE FREEDOM, LESS COMPLEXITY: VEHICLE IN THE LOOP TESTING REINVENTED

Flexible, scalable and cost-effective

The R&S®RadEsT automotive target generator and car learning to act (CARLA) open-source driving simulator enable realistic radar and camera simulation in an open-source setup – free from the constraints of proprietary solutions.



Integration of R&S®RadEsT and CARLA into an ADAS/AD VIL functional test stand

Your task

Advanced driver assistance systems (ADAS) and autonomous driving (AD) functions require extensive real-world testing to ensure safety, robustness and regulatory compliance. As sensor fusion and algorithmic complexity grows, so does the need for controlled, reproducible and cost-effective validation environments.

Vehicle in the loop (VIL) systems have become a powerful solution by combining real sensors and actuators with virtual driving scenarios. However, traditional VIL setups often depend on proprietary simulation platforms and complex hardware in the loop (HIL) configurations. These systems are typically expensive, difficult to configure and hard to transfer between different roller test benches – particularly when integrating with existing chassis dynamometers or end-of-line (EOL) systems.

A key challenge in this context is radar sensor validation. Electronically generating realistic, synchronized radar echoes that accurately represent moving vehicles and their surroundings is essential. Without these echoes, meaningful testing of detection, tracking and decision-making algorithms is nearly impossible.

Application

In a typical setup, the ego vehicle is placed on a chassis dynamometer (also known as a roller test bench or dynamic vehicle tester) while a simulation environment generates dynamic traffic scenarios to stimulate both radar and camera sensors. Radar target data is sent in real time to the R&S®RadEsT radar target simulator, which produces over-the-air (OTA) echoes precisely aligned with the virtual scene. Simultaneously, a display system presents the simulated environment to the vehicle's front-facing camera.

This configuration enables synchronized testing of radar and camera based perception, allowing developers to assess object detection, tracking and sensor fusion within the ADAS/AD software stack. The system supports a wide range of scenarios – including critical edge cases and diverse environmental conditions – under controlled, repeatable and safe test conditions. Key ADAS functions such as adaptive cruise control (ACC), automatic emergency braking (AEB), lane keeping assist (LKAS) and blind spot detection (BSD) can be realistically validated within this setup.

Rohde & Schwarz solution

Rohde & Schwarz is redefining VIL testing by embedding the R&S®RadEsT radar target simulator into the CARLA open-source driving simulator. This innovative integration combines the physical realism of OTA radar simulation with the flexibility and openness of a virtual testing environment.

Key benefits of the integration

- **Real-time radar target generation:** Leverage dynamic scene data from the CARLA open-source driving simulator, including vehicles, pedestrians and infrastructure, to generate accurate radar targets in real time, synchronized with the simulation environment.
- **Precise synchronization:** Ensure highly accurate radar stimulation through tight coupling with the ego vehicle's motion, sensor positioning and time references using robust interface and synchronization mechanisms.
- **Scalable and adaptable system architecture:** Compatible with a broad range of chassis dynamo-meters and test benches, this system minimizes setup complexity and maximizes flexibility for different lab and testing environments.
- **Cost-effective VIL testing:** Combine CARLA with the R&S®RadEsT radar target simulator to create a scalable, high-performance VIL setup – at a fraction of the cost of proprietary solutions. Ideal for both development and validation, this approach significantly reduces testing expenses and optimizes budget allocation.
- **Flexible, open-source simulation platform:** Customize your test environment to match specific development goals. CARLA provides full control over traffic scenarios, environmental conditions and sensor configurations – enabling rapid creation of complex edge cases and tailored test scenarios.
- **Realistic, real-time radar stimulation:** Achieve highly accurate radar sensor testing with OTA echoes generated in real time by R&S®RadEsT, driven directly by dynamic CARLA simulation data. This enables synchronized, precise stimulation for repeatable and reliable results.
- **Seamless integration into existing setups:** Deploy effortlessly across diverse test environments, chassis dynamometers, EOL stations or lab setups – with minimal configuration. VIL testing can be embedded into existing workflows without major infrastructure changes.
- **Future-proof, modular design:** Built on a modular, open architecture, this system supports future integration with simulation tools, platforms and data systems – allowing you to scale and adapt as ADAS requirements evolve.
- **Ready for periodic technical inspections (PTI) and fleet testing:** As ADAS becomes essential for safety compliance, this solution supports future use cases such as PTI inspections and fleet-level validation – extending its value beyond development into operational testing and regulatory assurance.

Compact and lightweight R&S®RadEsT radar essential tester, dimensions (W × H × D): 186.5 mm × 138.6 mm × 275 mm (7.34 in × 5.46 in × 10.83 in), weight: 3.2 kg (8 lb)

Summary

Rohde & Schwarz redefines VIL testing by integrating the R&S®RadEsT radar target simulator with CARLA, the leading open-source driving simulation environment. This powerful combination enables precise, real-time radar echo generation synchronized with virtual traffic scenarios and ego vehicle dynamics – supporting realistic, OTA sensor validation within a scalable and modular test setup.

This results in reduced cost and complexity, full control over test scenarios and a future-ready platform designed to meet evolving ADAS and autonomous driving validation requirements.

See also

www.rohde-schwarz.com/product/RadEsT

Rohde & Schwarz GmbH & Co. KG
www.rohde-schwarz.com

Rohde & Schwarz training
www.training.rohde-schwarz.com
Rohde & Schwarz customer support
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