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Effectiveness Testing of ADAS function in the PTI (Periodical Technical Inspection)

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Advanced driver assistance systems (ADAS) and automated driving (AD) functions have become indispensable safety technologies, but their increasing complexity requires reliable validation throughout the vehicle life cycle. From development and homologation to end of line (EOL) testing and Periodical Technical Inspection (PTI), ensuring that sensors such as radar and cameras maintain adequate performance over time is essential. Environmental factors, aging, and misalignment may degrade sensing capabilities, creating potential safety risks. As global regulations -such as the EU General Safety Regulation (GSR2) - mandate ADAS functions like autonomous emergency braking (AEBS), test methodologies must evolve to address these lifecycle wide requirements.

Vehicle in the Loop (VIL) testing using Over the Air (OTA) stimulation has emerged as a powerful, non invasive method to evaluate ADAS/AD systems. OTA simulation stimulates real vehicle sensors with physical signals: radar units receive radio frequency echoes produced by radar target simulators, while camera systems are excited by photorealistic visual projections synchronized with vehicle dynamics. This approach replicates the full signal chain - including optics, RF components, bumper materials, and ECU processing - without modifying the vehicle. Within a closed loop real time simulation environment, the vehicle placed on a chassis dynamometer interacts dynamically with virtual traffic scenes and environmental conditions. Platforms such as dSPACE AURELION and ASM generate sensor level data and vehicle dynamics in real time, allowing precise and repeatable reproduction of critical scenarios such as cut in maneuvers defined in UN Regulation No. 157 (ALKS).

OTA based VIL supports diverse applications: validating ADAS algorithms during R&D, executing regulatory scenarios for homologation, verifying sensor performance during EOL production testing, and assessing in use vehicles during PTI or workshop service. Roller dynamometers are particularly suitable for PTI environments because they allow rapid vehicle loading and require no electrical or signal connections to the test object. Hub dynamometers, while more invasive mechanically, offer advantages for development by enabling accurate simulation of tire–road interactions, including low friction conditions.

European regulatory bodies and organizations such as the European Commission and CITA are now considering updates to PTI frameworks in response to the increasing prevalence of ADAS. Current PTI procedures do not adequately evaluate sensor based functions, highlighting the need for scalable and cost effective test methods. Key challenges include accommodating the diversity of sensor configurations, expanding test scenarios as ADAS functions evolve, minimizing test time within PTI workflow constraints, and reducing equipment costs for inspection stations. Ongoing research has focused on optimizing OTA VIL systems to address these requirements, including expanded radar beam coverage, support for multiple simulated targets, and compact mechanical designs suitable for PTI facilities.

As PTI regulations evolve to incorporate ADAS performance verification, OTA based VIL offers a practical, safe, and highly repeatable methodology capable of supporting long term vehicle safety assurance. Continued pilot studies with inspection organizations aim to refine its applicability and demonstrate its effectiveness as a next generation inspection technology.

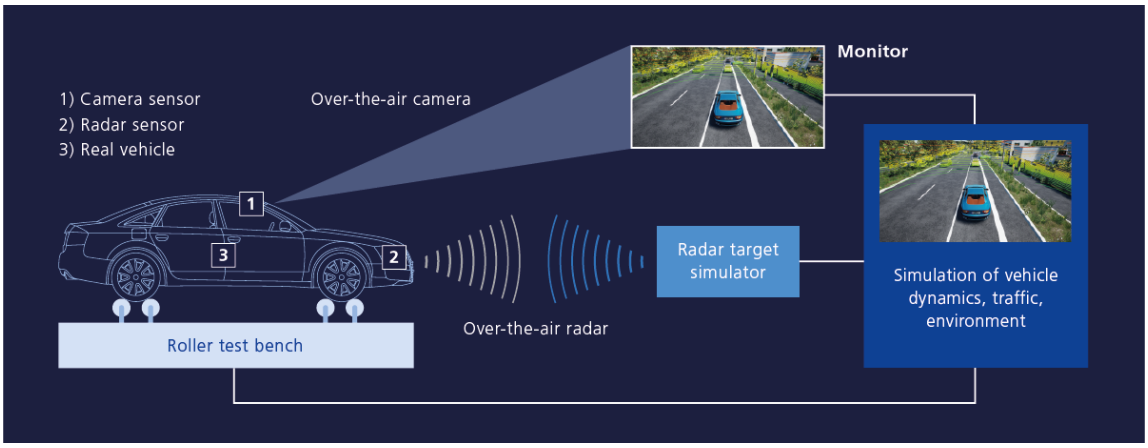

Fig. An example of vehicle-in-the-loop (VIL) simulation setup