

# The Evolution of Power Unit Development Process through MBD

- (Eleventh Report) Improvement of Development Efficiency by Standardizing Power Unit Transient Bench -

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Electrification of automotive power units has been progressing toward the realization of a sustainable society. Hybrid vehicle power units achieve high efficiency through energy management control that coordinates the engine, motors, and battery; however, this increases the complexity of calibration and performance verification. To improve development efficiency for increasingly complex power units, the authors have applied Model-Based Development across the entire development process, from performance design to performance verification. As part of this effort, calibration and performance verification are conducted using a Power unit Transient Bench (PTB) capable of reproducing vehicle driving conditions.

The PTB system reproduces vehicle behavior without prototype vehicles by coupling a real power unit with real-time models implemented on Hardware-in-the-Loop Simulation (HILS). One advantage of using the PTB is that more detailed measurements can be conducted more easily compared with on-vehicle testing. In addition, continuous unattended automated testing is enabled through the use of a bench control system. However, multiple PTB rooms are operated to accommodate different types of tests, and this leads to differences in facility characteristics among rooms. For example, dynamometer configurations, the air-conditioning capacity within the test cell, exhaust measurement equipment, and battery emulator capability differ from room to room, making it difficult for a single room to accommodate all test conditions.

After relocation, substantial preparation is required before testing can resume, including reconfiguration of HILS connections, measurement environments, and automated test scenarios. Accordingly, this study addresses standardization of the PTB system with the aim of shortening the lead time from installation to test start by minimizing preparation work after relocation. The scope of standardization covers three areas: HILS configuration, measurement architecture, and automated test operation. Fig. 1 shows the overall concept of the three standardization efforts.

First, the HILS hardware and models were organized by functional roles. The HILS configuration is standardized by unifying the system into three devices—Chassis HILS, Battery HILS, and I/O HILS—and by allocating the implemented models according to their functions. In addition, signal orchestration on the I/O HILS centralizes signal exchange and allocation among facilities, PU, and models, thereby reducing rework related to I/O configurations.

Second, the measurement environment was standardized by classifying measurement signals by role and defining a layered architecture for signal acquisition, control, and recording. This architecture enabled centralized acquisition and management of measurement data on the CAN network and provided reusable signal configurations across PTB rooms.

Third, the naming conventions and usage of operation signals from automated test scenarios were unified. Wrapper processing was used to accommodate facility configuration differences among bench rooms in a way that prevented their impact on testing, enabling common automated test scenarios across multiple benches. Standardized automated test scenarios were applied to the same power unit before and after relocation in different PTB rooms. The close agreement of the test data confirmed equivalence among the standardized benches.

As a result of applying the standardized bench system to actual development, the average preparation period after relocation was reduced by approximately 80%. These results demonstrate significant potential contributions to improved bench utilization and shorter development lead times.

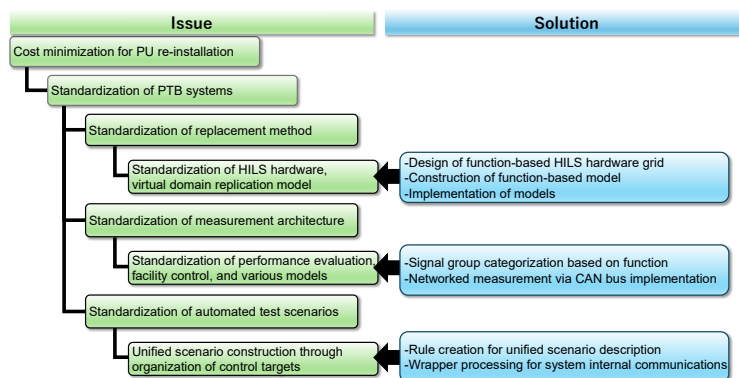


Fig.1 Detailed solutions to achieve standardization