

Automatically creating test environments for different HIL test systems

Powertrain Tests at the Push of a Button

To quickly and safely create model integration versions, for example, for testing new powertrains, HIL simulator farms can be equipped with workflow automation that is based on the dSPACE data management software SYNECT.

New architectural approaches in powertrain design, for example, for advanced combustion engines and hybrid drives, as well as the simultaneous increase in variants are a substantial challenge for developers and tool chain managers. To ensure high-quality powertrain systems, Daimler AG has been conducting hardware-in-the-loop (HIL) tests for system verification for some time. To be able to sufficiently reproduce and test the complex and extremely varied interaction between powertrain, complete vehicle, dynamic environment, and network architecture, extensive and highly flexible simulation environments are necessary. For this, various types of HIL simulators are used, which are all universally set up and equipped with I/O that is required for all projects. This helps to quickly adjust the specific configurations to the individual project requirements. The user team simultaneously applies dSPACE HIL systems based on peripheral high-speed (PHS) buses and dSPACE SCALEXIO HIL systems. Several engine and transmission HIL simulators are used in combination for the powertrain development in the various international locations, such as Germany, India, and China. One central data repository in a German location is accessed when developers are creating simulation models

and during the build process for all simulators of the HIL farm. Because new integration versions of the environment and I/O models used in HIL tests must continuously be created in a safe and efficient manner during development and because they must take the various HIL test system configurations into account, an automated approach is indispensable. Therefore, the required builds are conveniently created in the Workflow Management (WFM) solution, which is based on the dSPACE data management software SYNECT.

Why Use Central Workflow Management?

The models used for HIL simulation are a combination of different components, which are developed as modules by various employees.

For testing, the relevant components must be suitably combined. This is done by automating the build workflow. Typically, the following roles must work together:

- Engine modeler
- Transmission modeler
- CAN modeler
- FlexRay modeler
- I/O configurator
- Tool chain and framework manager
- Integrator

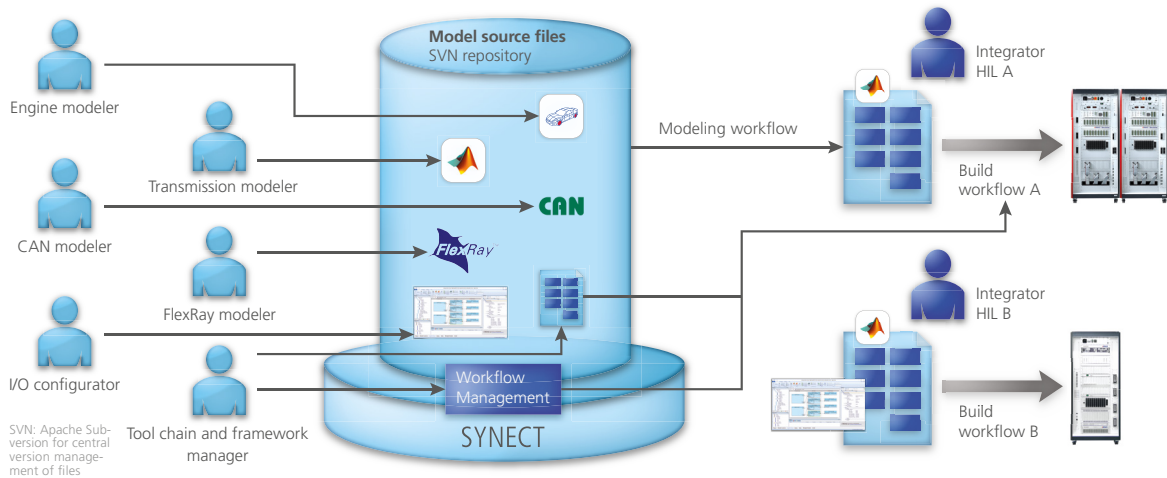
All listed roles can work with different models, model components,

and model versions, while the model sources are stored in a central data repository (in this case, Apache Subversion). To create a new integration version, the individual components must be combined to a case-dependent complete model. And the best thing about it: The SYNECT-based Workflow Management combines all data required for the build process with the help of version control files and direct data access. This, for example, includes the correct versions, parameters, and HIL simulators required for the HIL tests. WFM supports integrators in their tasks so they can quickly and automatically perform the integration using the tool – with a minimum of user interaction or without any interaction at all. There are also other benefits. Not only do all persons involved benefit from the single-source access to the models, it is also possible to automatically handle I/O and buses for PHS and SCALEXIO simulators together. Moreover, multi-builds can be implemented. These are used for automatically creating multiple executables in sequence for various HIL configurations.

Efficient Workflow

By using the SYNECT-based Workflow Management, the developers do not have to manually perform complex model combinations. >>

The SYNECT-based Workflow Management helps users automatically model test environments for vehicle variants and supply them to dSPACE HIL systems all around the world.



The SYNECT-based workflow automation enables integrators to quickly create new integration versions of models used for HIL testing.

WFM contains workflows in which user interactions are explicitly excluded to ensure data consistency. These workflows create what is called release executables, which are used for HIL tests. They can be reproduced at any time and they let you trace the version of the underlying model source repository. This is a necessary prerequisite to directly understand how the test results were obtained. This kind of traceability is necessary to fulfill the ISO 26262 requirements for functional safety. In WFM by dSPACE, the individual workflows consist of steps. These steps are small automation steps in a spe-

cific configuration environment for MATLAB M, Python, and binary files, or for the version control system. The software provides a number of pre-configured steps. However, the users can also create them themselves. Sequencing the steps results in the specific workflow. After the steps have been defined, they can be used in multiple workflows. The execution sequence can be specified via drag & drop. Steps can result in successful completion or errors. These are then included in the results check for the entire workflow. If the execution was not successful, error routines can be run. The company defined the work-

flows for various roles and use cases in a WFM-based HIL project. For example, workflows for modelers are available that open the modeling environment. There are also workflows that provide the entire integration environment to integrators so that the functionality of the release executables can be analyzed and improved, if necessary. Other workflows load the model, perform the analysis, and create the build fully automatically without any user interaction – if required also including activated steps for synchronizing the work copy with the version control system (release builds). All workflows

Loïc Brouillard (left) is the project leader for transmission electronic control units on HIL simulators. Patrick Pfeil (center) is the project leader for modeling and integrating engine electronic control units on HIL simulators. Both are employed at Daimler AG in Stuttgart. Christian Schmidt (right) is a HIL group manager at the Project Center Stuttgart of dSPACE GmbH.

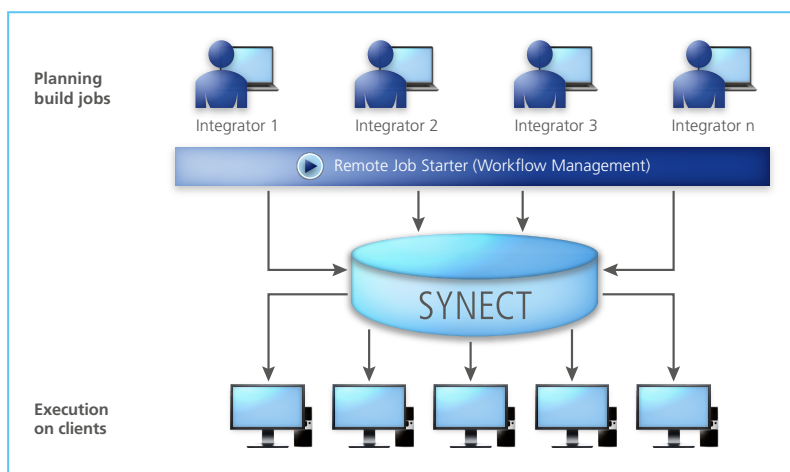
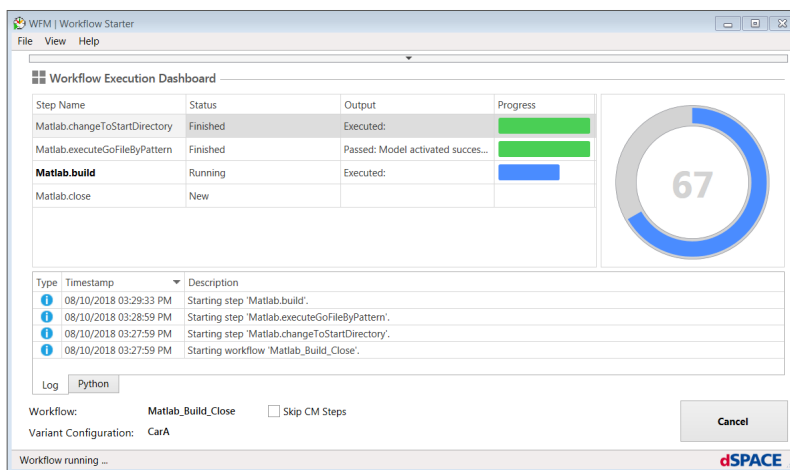
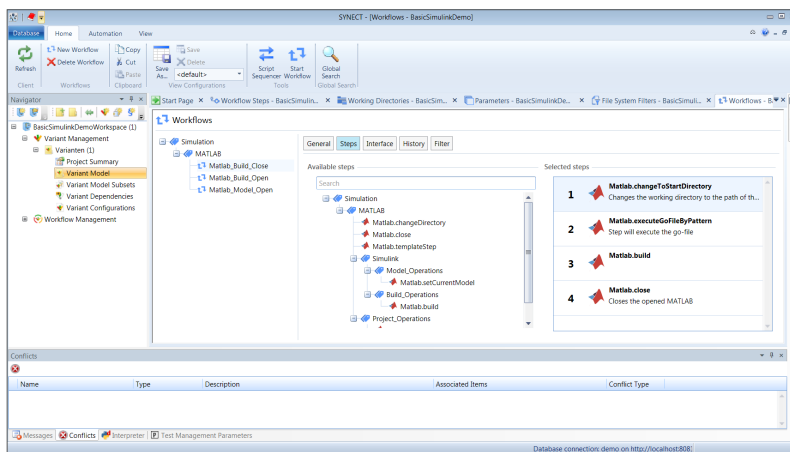


are available for SCALEXIO- and PHS-based simulators and they include the tool automation specific to the relevant HIL technology. The workflows are started with the help of WFM Starter. With WFM Starter, users can select the predefined elements, such as projects and variant configurations, and the workflow that is to be executed. The execution and the execution success is displayed graphically. Another important element when creating HIL executables is multi-builds. These are generated by jobs, which are centrally defined in SYNECT. These jobs can be configured with the help of a scheduler, and their execution on a client can be started by a Remote Job Starter. This way, clients can be efficiently used for remote jobs when no manual operation takes place. In addition, jobs can also be started by events. Furthermore, dedicated build machines can be used that regularly or continuously create builds from the files that are checked into the version control system.

Conclusion and Outlook

The SYNECT-based workflow automation ensures that the simulation models for the HIL-based tests in the area of powertrain development can be created automatically. WFM makes complex tasks in model creation and build processes possible. A manual procedure would not be feasible due to the high and steadily increasing complexity. The tool-supported versioning and the traceability during model creation help meet the requirements of ISO 26262. The plan for the future is to further optimize automation as well as the validation and verification process in combination with using new SYNECT features. The user team was and will continue to be supported by experienced dSPACE engineers. ■

Loïc Brouillard, Patrick Pfeil, Daimler;
Christian Schmidt, dSPACE



Top: Convenient selection of workflow automation steps.
Center: Keeping an eye on things with the Workflow Execution Dashboard.
Bottom: With remote jobs defined in SYNECT, the build clients can be used without manual operation.