Use of TRACE 3D Plus Models with Spawn for Rapid Prototype Development in Modelica Environment

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Spawn was released with Modelica Buildings Library (MBL) in 2021 to support new use cases in HVAC and controls. Spawn reuses the envelope and daylighting modules of EnergyPlus and the interface in MBL (that utilizes Functional Mockup Interface-FMI) allows it to couple them to HVAC and control models developed in Modelica (Wetter et al. 2020). As Spawn uses subset of EnergyPlus modules, the building envelope information is needed in the form of input data file (IDF). Generating these EnergyPlus files could be a tedious task and TRACE 3D Plus (TRACE) simplifies creation of such models.

TRACE is built on EnergyPlus engine with enhanced features that are added based on industry experiences. Due to prebuilt templates, gbXML import and building-wizard module in TRACE we are able to quickly build building envelope models of complex geometry, zone structures and use cases (e.g. mixed use buildings, hospitals etc.) in TRACE. The models developed in TRACE are directly not compatible with EnergyPlus, as the additional TRACE objects, new fields in existing EnergyPlus objects, additional control options create mismatch with EnergyPlus engine and input data dictionary (IDD).

Previously we evaluated Building Controls Virtual Test Bed (BCVTB) to co-simulate models developed in TRACE, however, this solution did not widely get used in projects with co-simulation requirements due to various usability related concerns.

EnergyPlusToFMU (Nouidui et al. 2013) was used to co-simulate TRACE models where there is a clear separation of model and controls. As Modelica-based complex two-phase flow models became available, we had co-simulation requirement of building models from TRACE with Modelica-based equipment models. Such modularization involved lot of workarounds with IDFs.

To meet the requirements mentioned above, we adopted a solution that converts TRACE idfs to EnergyPlus idf. A Python conversion script was written that compares the IDD files of TRACE and EnergyPlus, removes additional fields and replaces them with EnergyPlus compatible alternatives. In this conversion the model loses features that are available in TRACE. After the conversion process the script runs the original TRACE model with its executable and converted IDF with EnergyPlus executable and compares the results and report if there are major differences.

Figure 1 explains the steps involved in using the TRACE model with Spawn. As a test, we used Buildings.ThermalZones. EnergyPlus.Examples.SingleFamilyHouse.AirHeating model from MBL and replaced the idf with similar model created in TRACE.

Along with supporting new use cases in HVAC (e.g. use of two phase flow HVAC equipment models) and controls (e.g. demand-response management) this workflow has simplified the FMU export of building models that are developed in TRACE. For such export we have created causal wrappers for Spawn that allows click-of-a-button export of TRACE buildings. These FMUs have been used for model sharing and to test Artificial Intelligence (AI) and Machine Learning (ML) based controls.
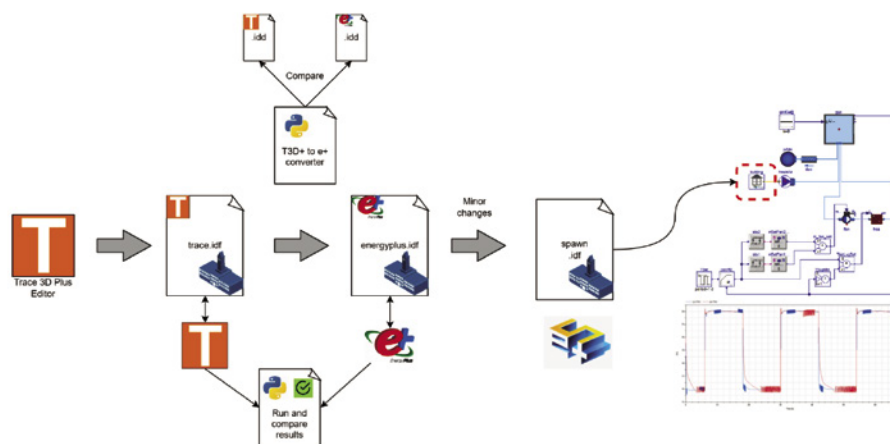

Figure 1. Workflow to use TRACE model in Spawn