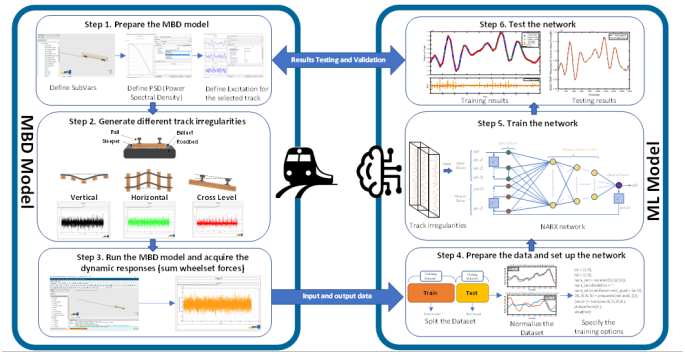
Rail4Future

Projekttitel:	**Resilient Digital Railway Systems to enhance performance**
Projektnummer:	**882504**
Deliverable:	**D1.3.3 Report - Enabling large-scale simulations**

A holistic railway infrastructure digital twin (DT) platform is sophisticated and consists of a series of submodels (e.g., turnouts, tracks, vehicles, etc.) that are built through various methodologies and software. However, integrating these submodels into the DT platform is tremendously challenging due to considerable computational complexity, software and interface restrictions. To this end, we designed a machine learning (ML) based surrogate modeling methodology for the submodel integration in the holistic railway infrastructure DT platform and illustrated the methodology through a case study. In this report, an ML-based surrogate model for multibody simulation of railway vehicle-track dynamics is presented, which can replace the railway vehicle-track simulation executed with the Multibody Dynamics (MBD) Simulation commercial software SimPACK. The well-built ML model can accurately and quickly predict the vehicle-track system's dynamic responses to different track irregularities. Besides, the integration process of the ML-based surrogate model into the DT platform through a standardized open-source Functional Mock-up Interface (FMI) is also proposed. The developed surrogate modeling methodology shows great promise owing to its high fidelity, which is verified by the measurement data collected from the Austrian national railway track system.



In conclusion, the well-built ML-based surrogate model can make quick and precise predictions of the vertical dynamic responses based on different track irregularities. The surrogate model can replace the MBD simulation efficiently and be easily integrated into the holistic railway DT systems, as it has much less computational complexity than the traditional MBD simulation. The calculation efficiency is also greatly improved. For a 5 km long railway, it only takes about 8 seconds for the ML-based surrogate model to finish the calculation, a value that is three orders lower than the time needed for the MBD simulation (30 minutes). Furthermore, the proposed methodology can also enable the integration of different surrogate models into the holistic railway DT Platform in a fast and reliable way.