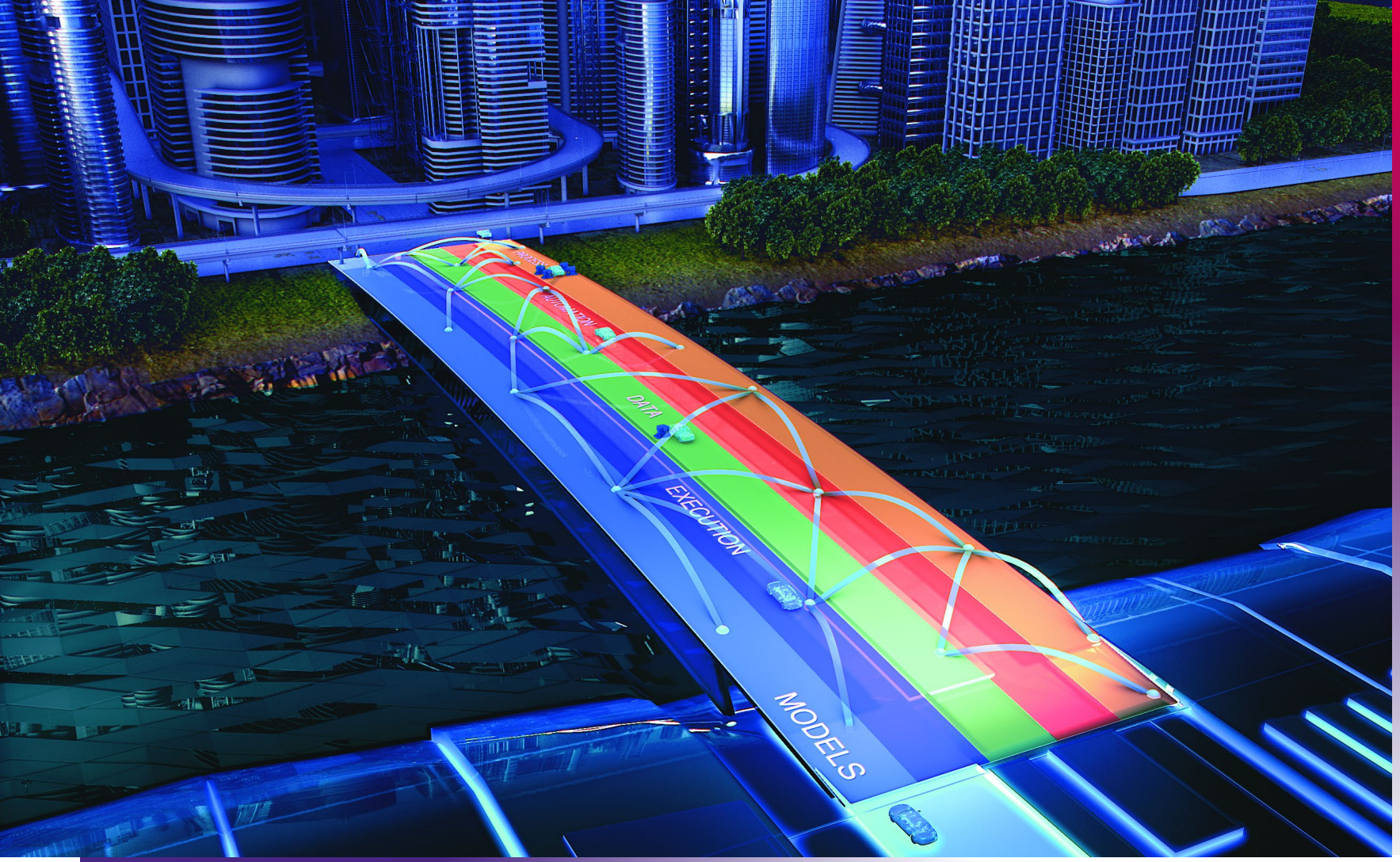


WHITEPAPER

Via CONNECTION into a new age of collaboration

AVL .CONNECT EXPERIENCE

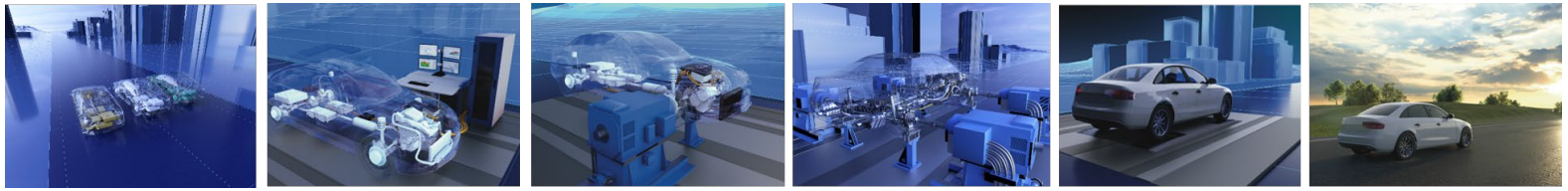
Integrated and Open Development Platform

The Integrated and Open Development Platform is a strategic orientation of AVL. The aim is to **connect all elements of the vehicle development process**. And this step by step and **independent of tools and manufacturers**. Neutral connectors interlink simulation models, testbeds, data or analyses to create more flexible environments for the development of a new generation of intelligent and efficient vehicles.

Whether alternative powertrains, autonomous driving or integral safety - current development topics demand one thing above all else: **interdisciplinary cooperation with a consistent focus on the overall product**. Ultimately, it is not the individual system that determines market success, but the overall performance that the vehicle delivers to the end customer every day.

In practice, however, there is often a lack of decisive connections between individual results in order to be able to make reliable, holistic decisions. The potential to integrate simulation and testbed, or even to connect individual testbed systems, is only partially utilized. The exchange of results is similar: here, **different applications and data formats prevent the analyses** from being used across department boundaries.

- *How do developers nevertheless manage to make their contribution to the overall vehicle more transparent and make the results available to other departments?*
- *How can teams at every developmental level effectively connect their work results and bring them into an overall context?*



Connectivity. Made simple.

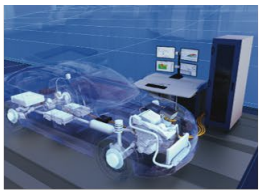
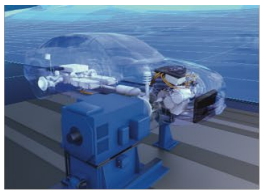
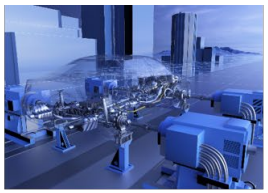
The answer is **IODP**. The acronym stands for Integrated and Open Development Platform and describes the AVL strategy of **establishing a holistic system development through extensive integration** - across all areas and phases!

AVL has gained comprehensive experience in recent years and has created simple and accessible ways to gradually implement the integration of models, testbeds, data, and processes.

Central to this is:

- Tools already established in the company can still be used
- Simple, step-by-step adaptation of the methodology to concrete development tasks
- Measurable added value through integration/connectivity

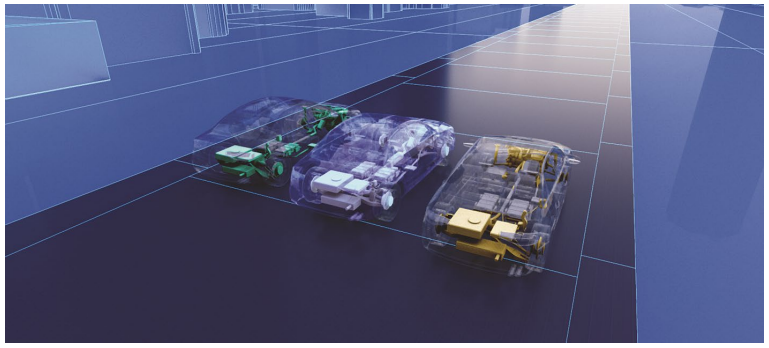
With the IODP modules *Model.CONNECT™, Testbed.CONNECT™, Data.CONNECT™, or Device.CONNECT™* this interconnection succeeds. These solutions network independently of tool manufacturers and individually tailored to the development task. Usually, the cross-linking begins with individual projects and is extended step-by-step to further areas of an organization. It does not require any hard cuts but develops rather as a consequence of successful integration into the concrete development task and environment.

Model.CONNECT™

Connecting models of different domains

Model.CONNECT™ ensures that the **simulation models of different components and systems** can communicate with each other. If these are combined to form a complete virtual vehicle, systematic design decisions regarding customer-relevant properties can be made already in the concept phase. Model.CONNECT includes patented co-simulation technologies that uniquely compensate for feedback errors and ensure numerical stability.



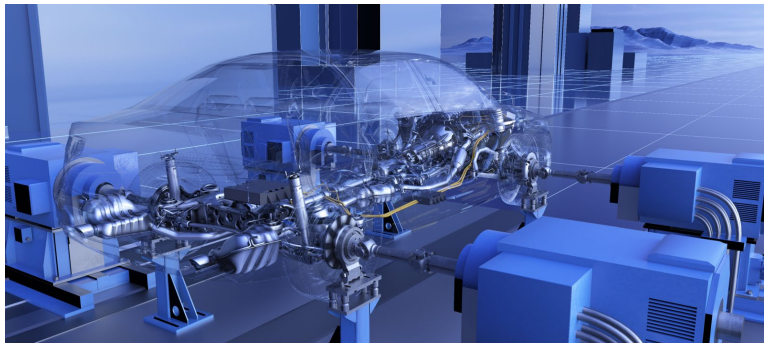
Use case

A vehicle developer has the task of designing an electric vehicle that achieves a minimum range of 200km with an appropriate operating strategy. He is faced with the choice: should he design a purely electric vehicle with a large battery, choose a hybrid approach, or integrate a fuel cell? What is the optimal configuration of the new vehicle? With Model.CONNECT he can effortlessly combine and configure the respective functional models of the powertrain components from the various departments to create a complete vehicle. He uses simulation to test this virtual prototype and its operating strategy in realistic scenarios. The decision for a design variant is usually made through systematic trade-off analyses, e.g. between minimum energy requirements, best acceleration, minimum costs and emissions, maximum range, and other customer-relevant factors. He can then validate his powertrain concept for different driving styles, for example. With Model.CONNECT, the virtual prototype is also prepared for usage on the testbed.

Testbed.CONNECT™

Connecting simulation and test

Testbed.CONNECT™ brings **simulation models and testbeds** together so that they merge into a complete system consisting of hardware and software. From a testbed perspective, this means an extension of the test possibilities, because missing real components can easily be replaced by virtual models. Conversely, from a simulation perspective, a model can be replaced by a real component, e.g. to improve modeling. In addition, Testbed.CONNECT connects the different testbeds of a test field with each other if required.



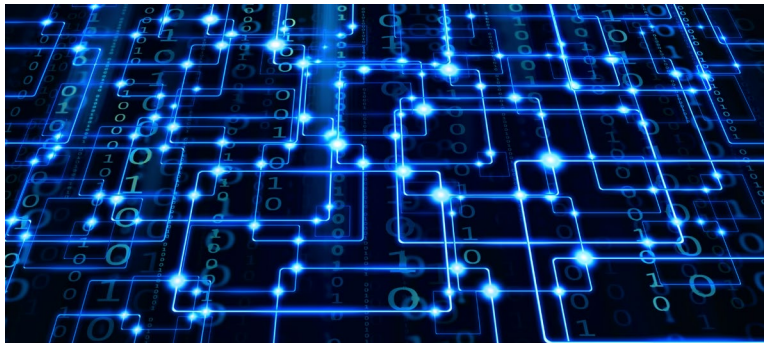
Use case

After a comprehensive validation of the hybrid concept in the office, all real components are extensively tested on the testbed. Due to a large number of individual elements in hybrid powertrains (combustion engine, transmission, e-motor, battery, and power electronics), early integration tests play an important role. However, before all real components can be tested together, their maturity levels must be verified individually. This is where the combination of simulation and testing comes into play. On the engine testbed, the real combustion engine and e-motor can be examined in interaction with the simulated or emulated remaining powertrain components. At the same time, the battery can be tested on the testbed. Here the real battery is supplemented by the simulated engine or the emulated e-motor and examined in the overall system. Later, thanks to Testbed.CONNECT, the individual testbeds can be connected to form an integration testbed in order to secure the entire virtual/real network of the hybrid powertrain. This allows step-by-step integration to run efficiently and in parallel.

Data.CONNECT™

Connecting analyses

Data.CONNECT™ connects **data from different sources**. The data remains in its original database but can be related to each other. Users can thus gain more knowledge from the numerous results and analyses generated by the various development teams. The everyday life of a development engineer is shaped by the use of a multitude of different tools. Each of these tools manages, stores, and processes data, results, and analyses separately. Thus, correlations and trade-offs are often difficult to identify or recognized too late.



Use case

Suitable connection can be used to transparently trace which calibration data set was used to generate certain measurement results on the e-motor testbed and in the application system. In this way, the development knowledge gained on the testbed can be integrated, preserved and restored at a later point in time without additional effort. This means, for example, that additional measurement campaigns/batches in the process can be avoided and a more efficient use of all generated results can be ensured. Access to data can also be facilitated for other teams - for example, to improve engine models.

By linking the model libraries of the e-motor, battery, transmission and combustion engine with the respective CAE data, the simulation models and results can also be kept synchronized with the design department on an ongoing basis. This not only brings the simulation and testing closer together but also simulation and design.

Device.CONNECT™

Highly secure connection of devices

Device.CONNECT™ is **a highly secure data transmission pipeline** that enables globally distributed test devices or vehicles to be connected to freely selectable data centers without opening the local network infrastructure. These data centers are supplied with information on the condition of the devices or vehicles. Conversely, data from the data centers can be transferred to the objects. This type of distributed intelligence enables the connected devices to be automatically controlled, monitored or maintained via remote access. The patented connectivity technology from Device.CONNECT ensures absolute operational reliability (safety) and the best data protection (security).

Use case

Device.CONNECT enables advanced service concepts. Manufacturers of test devices and test software can, for example, determine the optimum time for updates and maintenance work on the basis of data analysis. This avoids unplanned downtimes in the test fields and significantly reduces maintenance costs. Mobile measuring systems (e.g. PEMS), which must deliver reliable results in the test vehicles for in-use tests and RDE tests, can also be maintained using predictive maintenance. This remote maintenance approach can likewise be applied to production vehicles. Device.CONNECT offers secure technology with which vehicles can be updated to the latest software status via over-the-air (OTA) updates.

Device.CONNECT is another important component in the development process for advancing digital consistency. Organizations have a secure way to implement cloud-applications with which they can connect the work of different areas. For example, data from real RDE test drives on the road can be stored directly in a cloud and then re-run on the testbed in the test field.

Summary

With the Integrated and Open Development Platform, companies can make the transition to **a new era of collaboration through step-by-step integration**. Users from different disciplines become high-performance teams that

- pursue common goals efficiently,
- can rely 100% on functioning structures,
- are very agile and can adapt flexibly to new circumstances.

High-performance teams are able to optimally synchronize team members and their tasks. The smooth interaction of team members, processes and tools is the key here.

This succeeds with the IODP modules.

ABOUT AVL

AVL is the world‘s largest independent technology partner for the development, simulation and testing of powertrain systems as well as innovative automotive solution concepts.

www.avl.com

CONTACT US

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