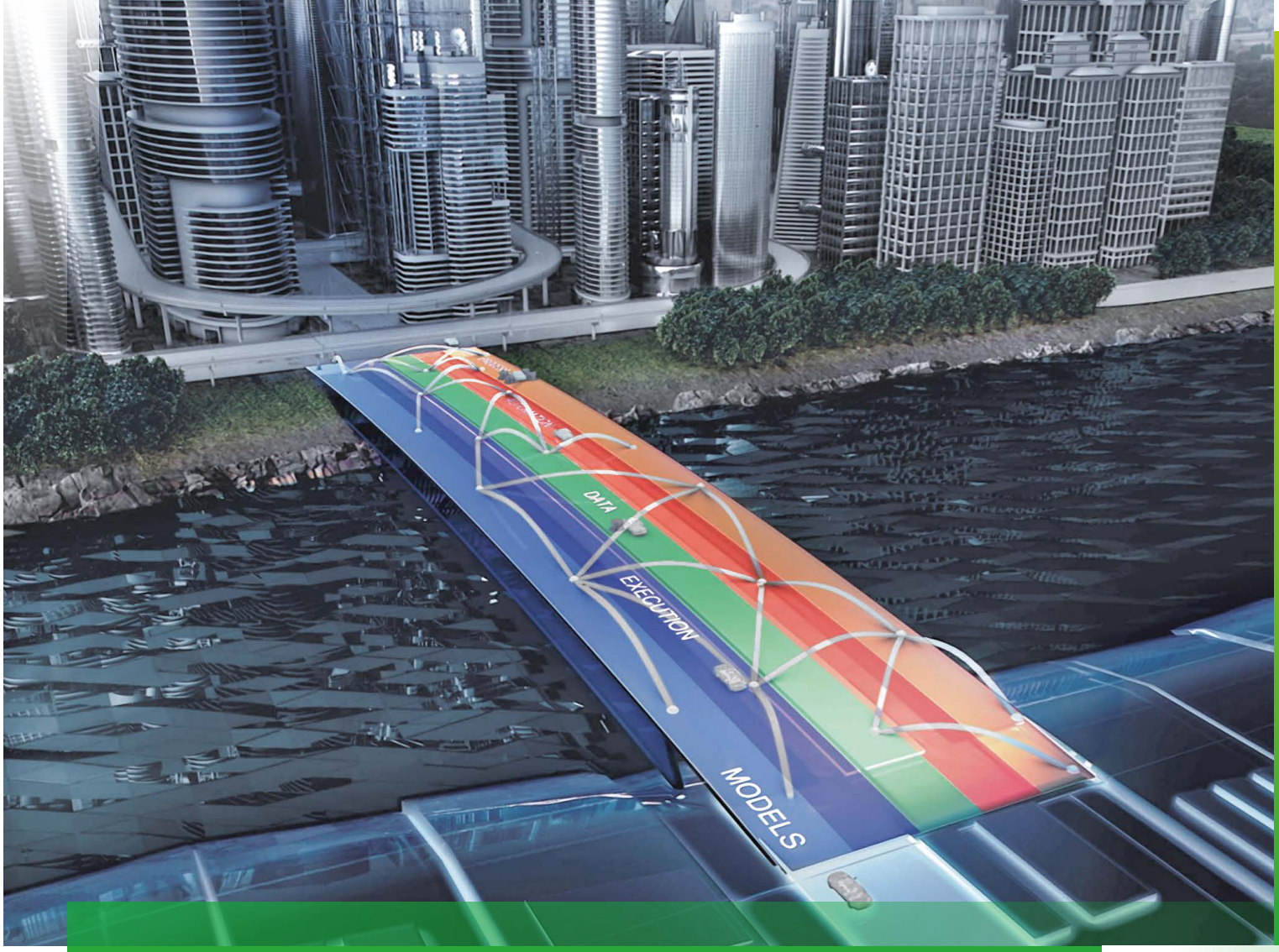
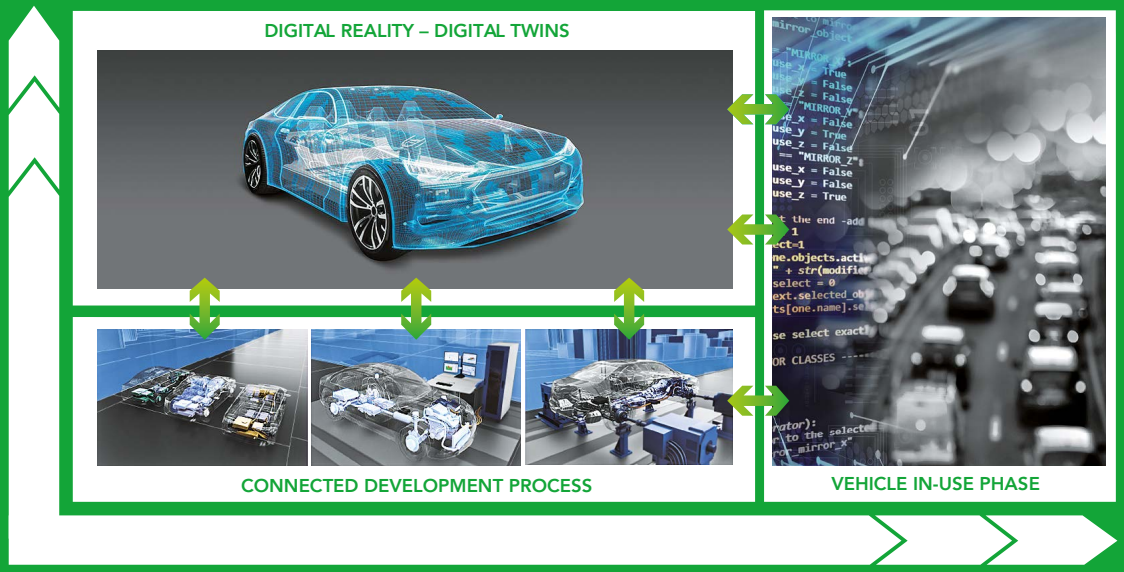


AVL's Development Ecosystem Approach

Connecting the virtual and the real worlds

Augmented Development

The conventional development approach
Traditional vehicle development involves different teams working on individual domains and parts of the vehicle. While all of these teams and disciplines work towards a shared goal of the complete vehicle, they also have individual goals to meet. And it's not until systems and components are integrated – on the testbed or in costly prototypes – that the cross influences can be thoroughly investigated, and synergies understood. This conventional approach is expensive, time consuming, and results in unwanted development loops.

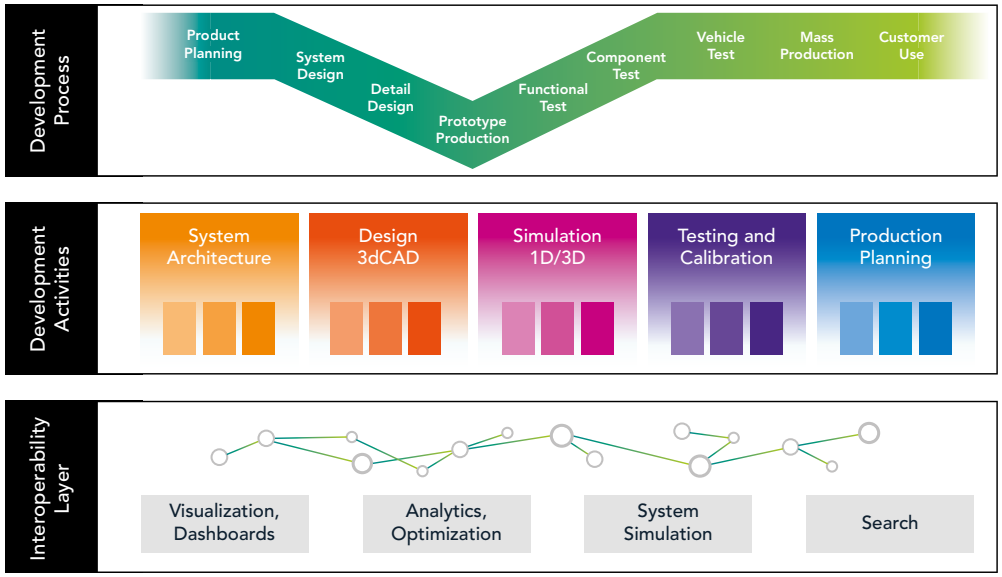


Connecting all stages of development and augmenting them with the vehicle in-use phase and digital twins to increase speed and flexibility.

AVL's holistic ecosystem approach
At AVL we have combined our tools and methodologies into a single approach that revolutionizes vehicle development. Using digitalization, functional prototypes and an end-to-end development philosophy that extends to the in-use phase, we are helping OEMs and Tier1 suppliers to break out of this siloed thinking. Our approach allows teams to easily share their work and progress across the entire project. Furthermore, it utilizes the power of data intelligence to share goals and drive optimization all the while significantly reducing the need of prototypes. This diminishes time to market, saves money, and accelerates innovation.

A layered approach

By harnessing our cross-domain know-how and our Open and Integrated Development Platform (IODP), the development ecosystem allows the rapid realization of project goals on both micro and macro levels. This ecosystem approach can be used to create new development workflows, or to augment existing architectures. It is organized into three layers: the development process, development activities and an interoperability layer.



The development ecosystem combines the development process with individual development activities and the interoperability layer.

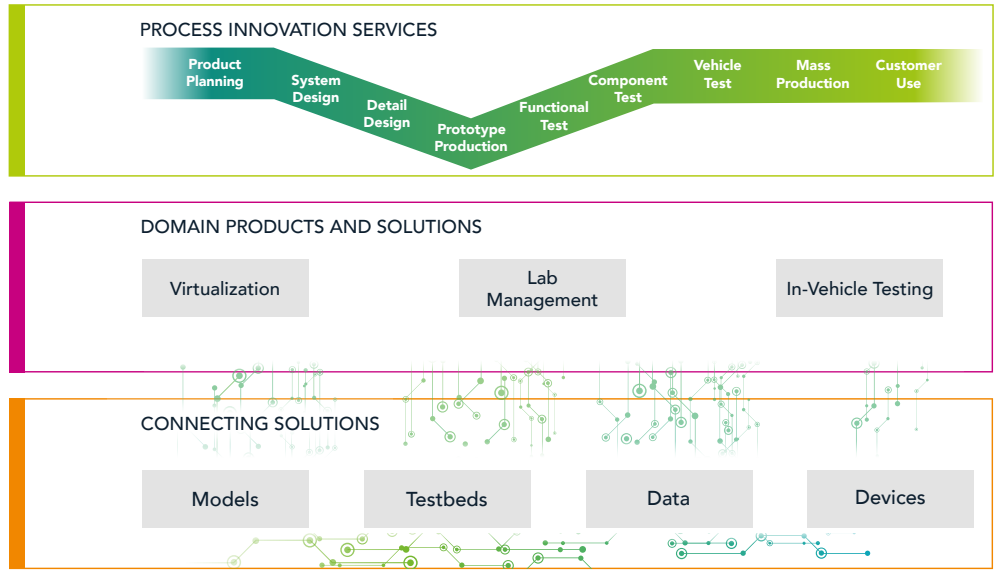
Matching the ecosystem

AVL provides services and tools that match this ecosystem:

The first layer, Process Innovation Services, is designed to optimize each step of the process, from product planning to functional design and component testing, right through to mass production and customer use.

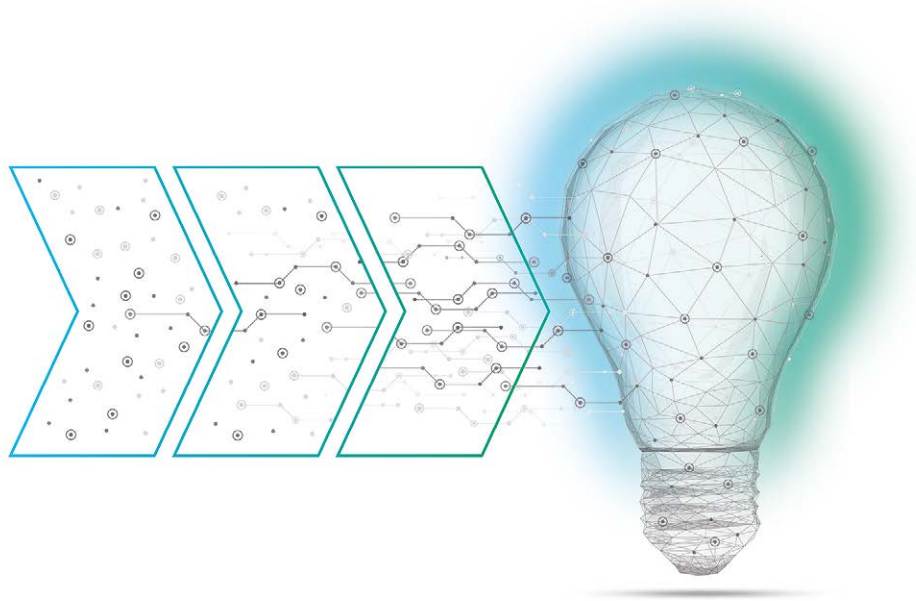
The second layer, Domain Products and Solutions, provides tools for specific domains / applications. It covers virtualization, lab management, in-vehicle testing.

The third layer is the Connecting Solutions layer. It allows the best use and sharing of models, testbeds and data from all activities and devices across the development process - independent of tools or suppliers.



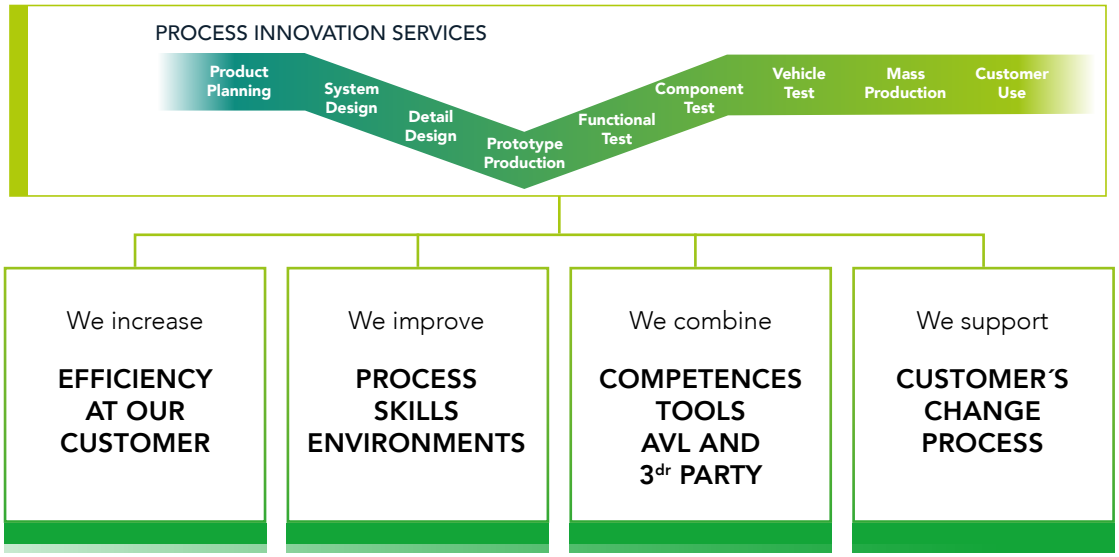
AVL's solution portfolio for the vehicle development process

Layer 1
Process Innovation Services



Smart decisions on development efficiency for a competitive vehicle portfolio
AVL offers a comprehensive approach to support making the right decisions for the demanding questions in the automotive industry:

- Which vehicle portfolio shall be developed?
- How shall vehicles be developed efficiently?
- How can costs be reduced in the test and simulation factory?
- How will digitalization improve the development process?

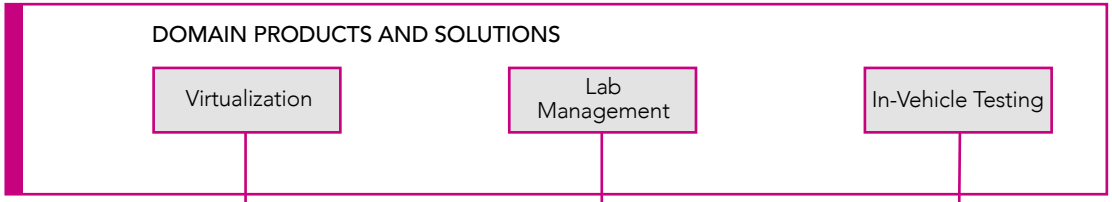


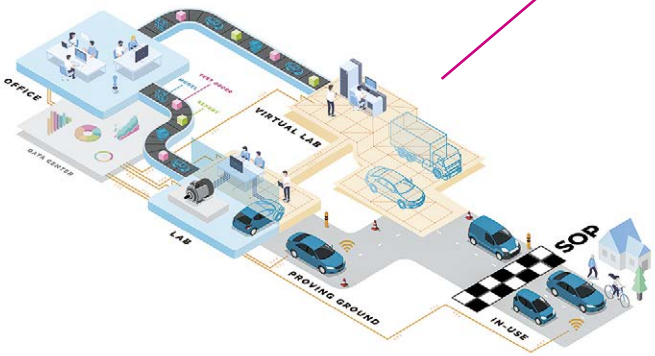
Comprehensive service along the entire development process
AVL is in the unique position to combine its competencies - development methodology, simulation and testing tools - with third-party tools to increase the development efficiency of their customers. We offer our customers a comprehensive service starting from scoping and planning the changes which have a significant, short-term improvement potential through to implementation of the changes in their processes, skills and development environments.

Connected thinking for better results
AVL develops CONNECTED Toolchains as methodologies that combine testing, simulation, data-management and technological know-how to increase the efficiency of a development process in terms of quality, time and cost. By means of efficient "frontloading", engineering tasks are shifted from expensive prototype testing on the road towards early development phases in a partly virtual environment.

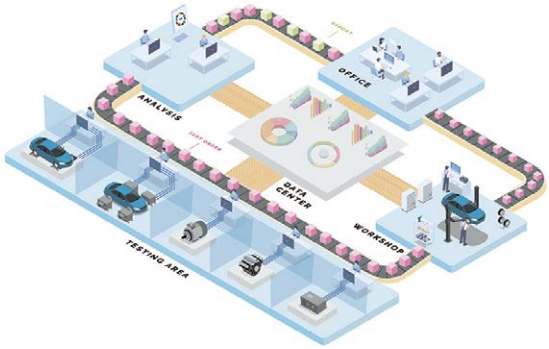
Layer 2
Domain Products and Solutions

The second layer, Domain Products and Solutions, provides tools for specific domains / applications. It covers virtualization, lab management and in-vehicle testing.

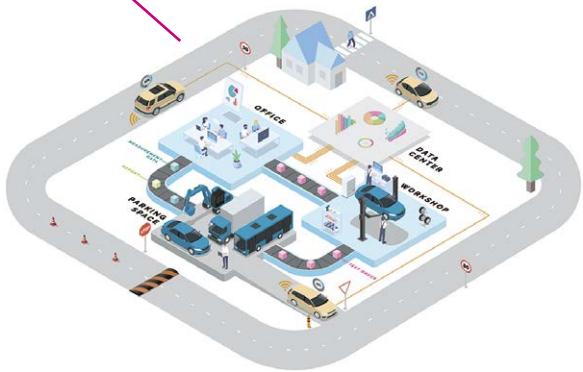




Virtualization
A centralized methodology approach with a fully integrated and automated workflow.



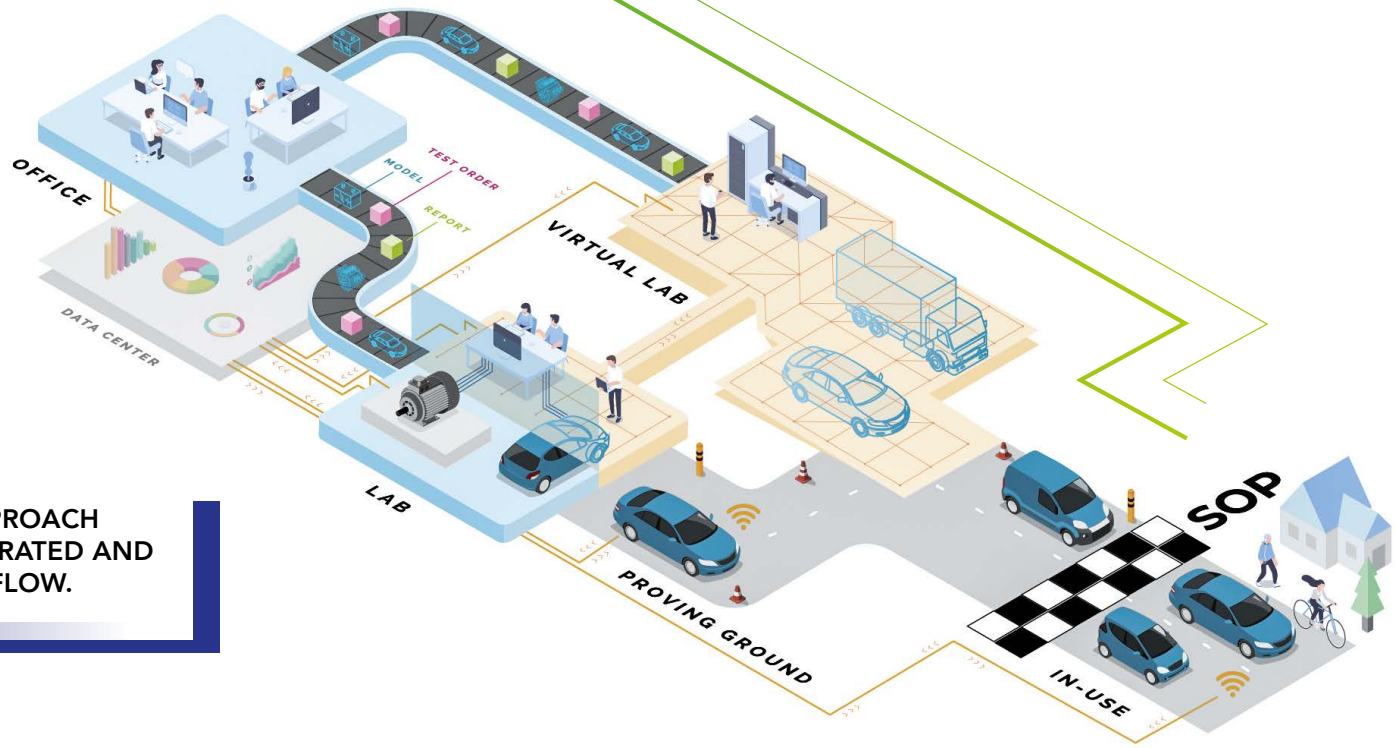
Lab Management
Highest efficiency for your test lab.



In-Vehicle Testing
A proven in-vehicle methodology, maximized data security, and efficiency for the entire fleet.

Virtualization

A CENTRALIZED METHODOLOGY APPROACH WITH A FULLY INTEGRATED AND AUTOMATED WORKFLOW.



THE CHALLENGE

Physical testing in lab and proving ground
In this day and age vehicle development methods are fast becoming outdated. The traditional workflow includes only physical testing in the lab and on the proving ground prior to SoP (Start of Production). Data is shared manually between the lab and the office, and there is a heavy reliance on costly prototypes. This process is slow and expensive, and launching new products takes years.

OUR SOLUTION

MOBEO – AVL's virtualization approach
Virtualization is the change process that transforms a physical and hardware-centric development process to a more extensive use of simulation technologies and methodologies. Virtualization can be applied in varying degrees which are tailored to your needs. We integrate applications of virtual testing technologies and methodologies into a development environment in a simple and effective way. To make workflows even more efficient, MOBEO also connects and streamlines virtualization experiences across the development journey. You can frontload many of your test activities before any hardware has even been built. Furthermore, real hardware testing can be carried out on the testbed in combination with virtual components, to explore synergies and cross-system influences.

A central data hub accelerates the generation, analysis and sharing of data between the office, the virtual lab and the physical lab.

Lab Management

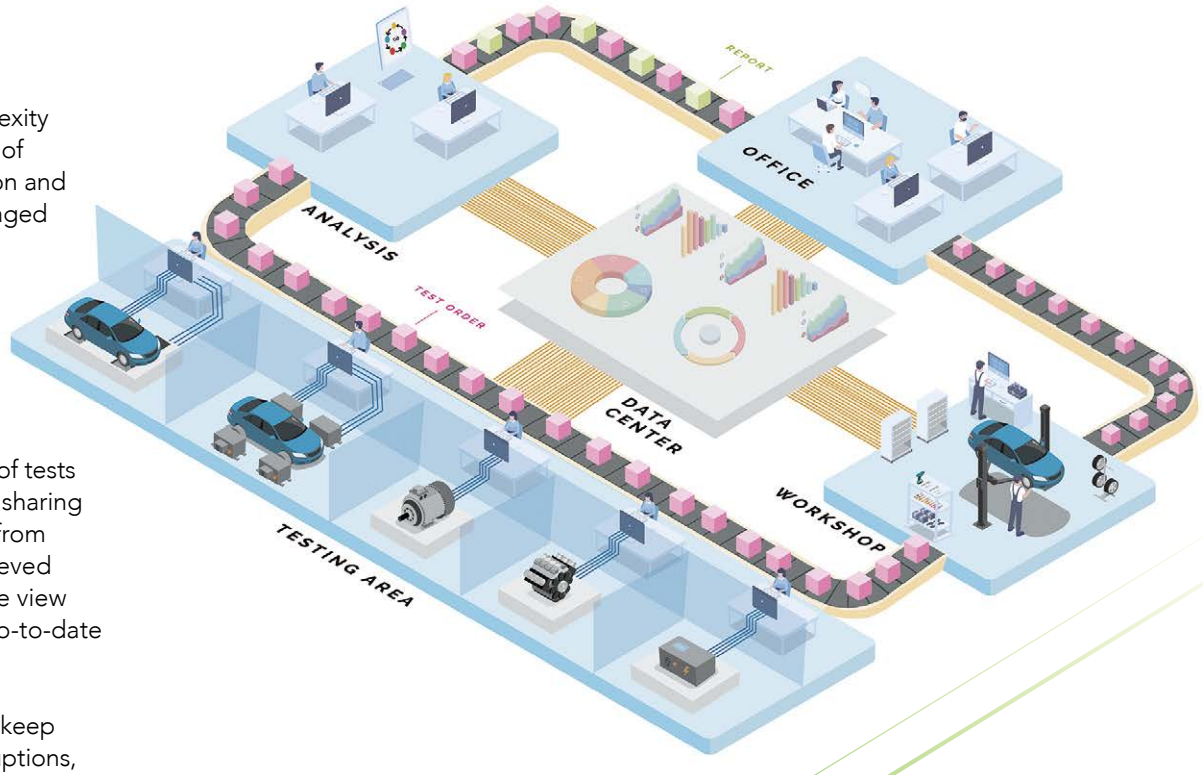
THE CHALLENGE

Manual labs and complex testing procedures
Testing labs are characterized by an ever-increasing complexity regarding testing processes and the amount of data. A lot of labs still operate manually and on-demand. The preparation and execution of tests are based on availability, without a managed process. Only end reports are being shared. This leads to inefficiencies and imprecise planning.

OUR SOLUTION

AVL Lab Management™
By implementing managed test processes the scheduling of tests can be enhanced. Introducing local data centers improves sharing of data and reports. Collecting and harmonizing all data from different in-house or third-party test systems, can be achieved with an intelligent central repository. This creates a unique view on test data and results with accurate, comparable and up-to-date information across the entire lab.

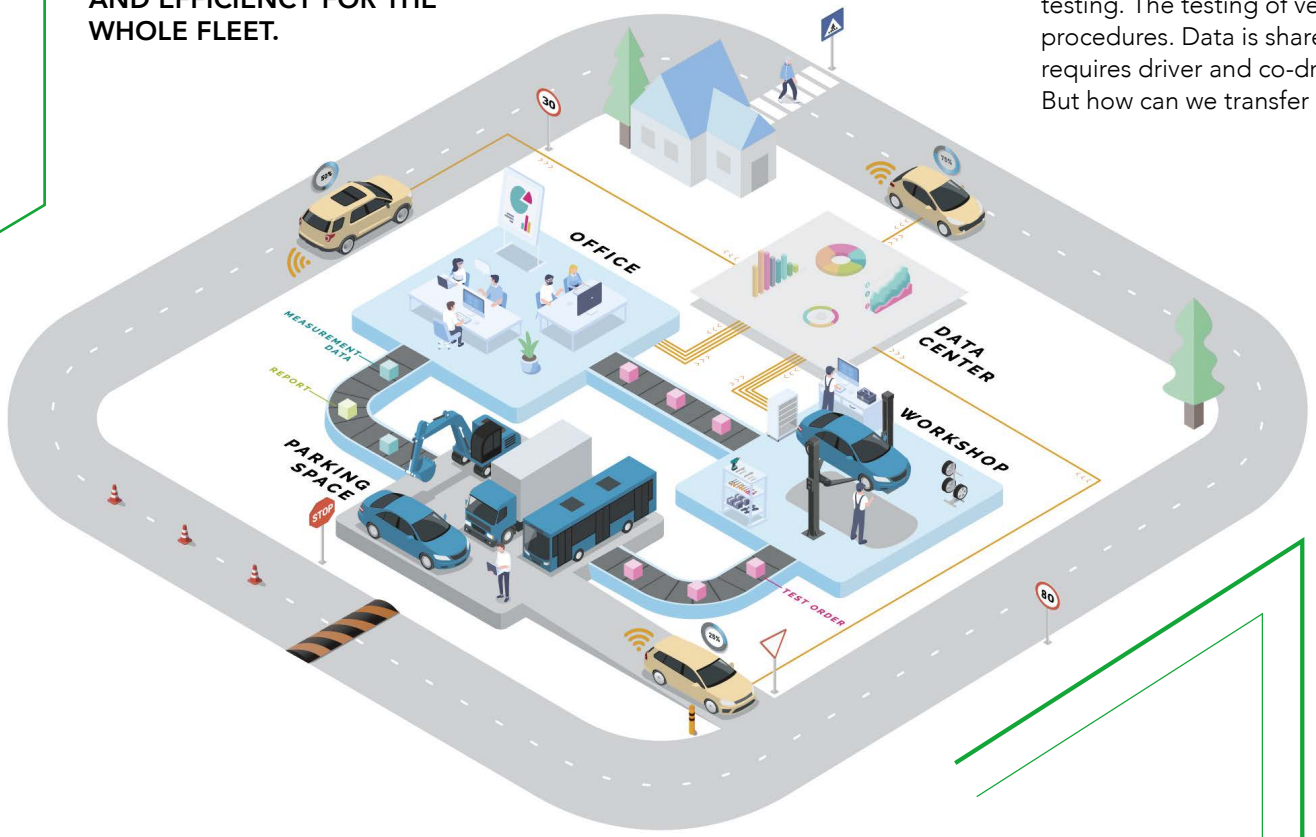
Labs need to make the best use of all available assets and keep downtimes to a minimum. To overcome unforeseen interruptions, monitoring and scheduling is key. Automated workflows streamline these processes and improve traceability. Data is automatically evaluated and can be re-used to avoid executing certain tests completely. Data intelligence yields predictions allowing continuous improvements of the lab operations.



REFERENCE SOLUTIONS FOR BATTERY, PROPULSION AND VEHICLE TEST LABS.

In-Vehicle Testing

A PROVEN IN-VEHICLE METHODOLOGY, MAXIMIZED DATA SECURITY, AND EFFICIENCY FOR THE WHOLE FLEET.



THE CHALLENGE

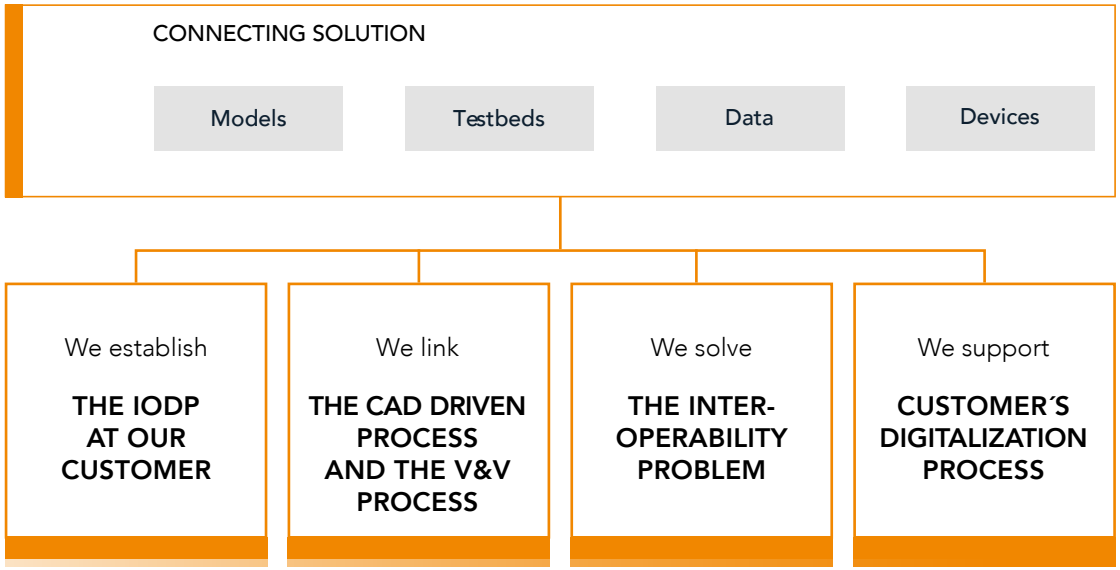
Time consuming and manual procedures
Increasing vehicle complexity has led to higher vehicle testing demands. There is a rising amount of time and money invested in prototype vehicles and in-vehicle testing. The testing of vehicle prototypes on the street is based on manual procedures. Data is shared manually between the lab and the car. This process requires driver and co-driver in the car and is very time consuming and costly. But how can we transfer data to a centralized data storage?

OUR SOLUTION

AVL's in-vehicle testing approach
The test data of in-vehicle testing is transferred into a central hub, which allows more and better traceability and re-use of data. We are aiming to automate in-vehicle testing. Driver guidance and online KPIs eliminate the need for a co-driver. Automatic meta data handling and instant data availability enable a reduced variability of tests and high efficiency of procedures.

Full integration allows a consistent process. Integrated planning, testing and data handling lead to an automated testing process and a strong data intelligence.

Layer 3
Connecting Solutions



The challenge of a heterogenous tool landscape
Within the development process various kinds of tools from different suppliers and in different domains are used. High pressure of time, costs and quality requires continuous V&V (validation and verification) of overall product behavior (from concept to in-use). This requires a strong interaction of development domains which currently exists only to a limited extent.

Solving the interoperability problem
AVL provides interoperability solutions to connect existing tools at our customers. They can build up virtual and mixed virtual/real prototypes using existing models, testbeds or tools. Furthermore it is possible to establish the link between the CAD driven process and the V&V process. Moreover, all relevant data entities in the V&V process can be managed easily to guarantee consistency and therefore traceability.

THE BEST USE AND SHARING OF DATA FROM ALL ACTIVITIES ACROSS THE DEVELOPMENT PROCESS - INDEPENDENT OF TOOLS OR SUPPLIERS.

AVL's connecting solutions include:

Model.CONNECT™: Connect all your simulation models that you already have in use to create virtual prototypes.
Testbed.CONNECT™: Connect your simulation to the testbed.
Device.CONNECT™: Connect your globally distributed devices – vehicles, software and test devices – with data centers to build your IoT.
Data.CONNECT™: Connect all your existing data sinks and sources.

Application, Skill and Process Services

THE CHALLENGE

Our customers are faced with multiple challenges. A technology shift towards electrification, ever tightening emission regulations, a reduction of development resources and time, plus the desire to benefit from data science. It is hard to focus on the right things and to develop the right skills.

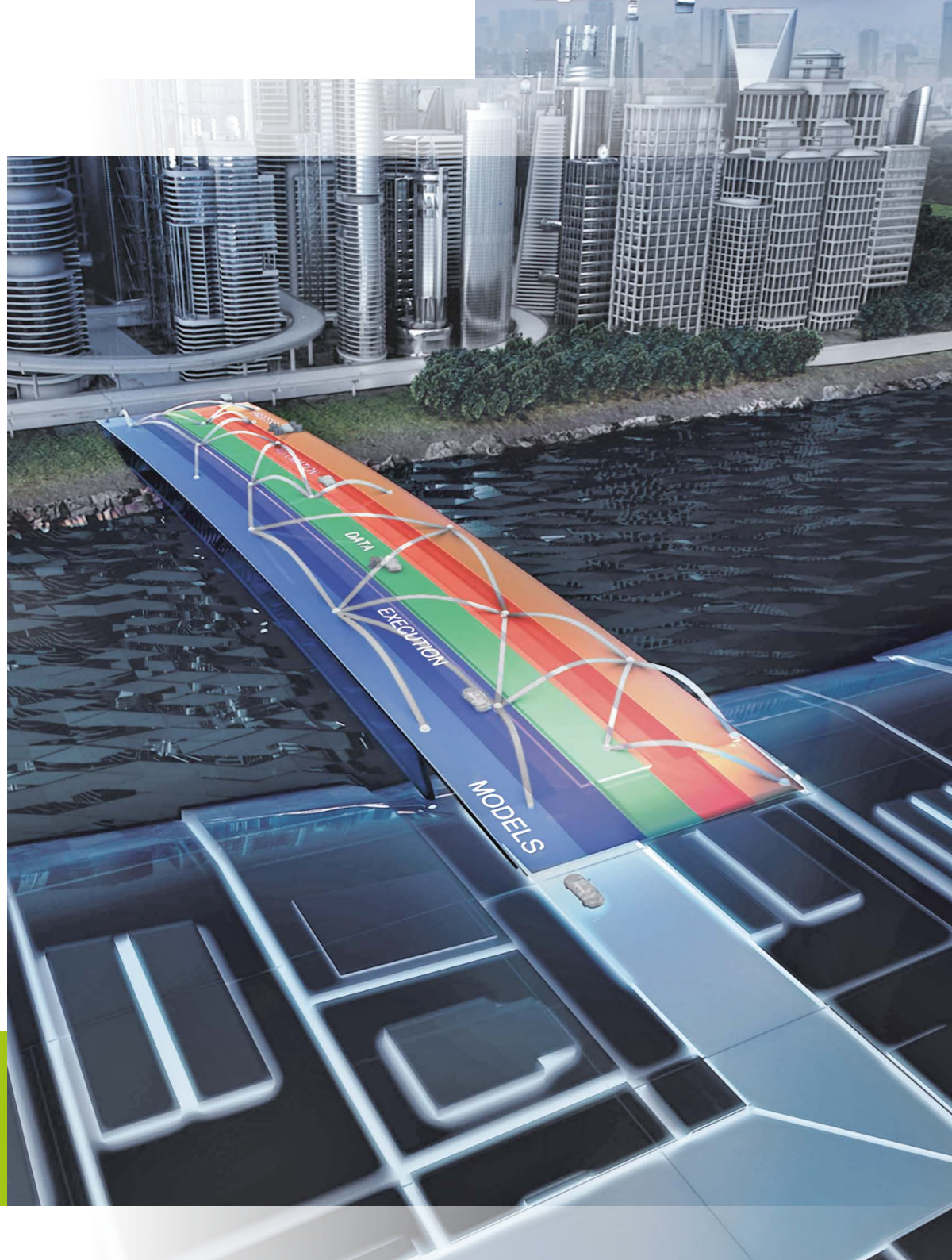
OUR SOLUTION

AVL application, skill and process services
At AVL Application Services, the customer and his particular development task are the focus. This development task is usually part of a development or testing process. Whether there is a need for test planning, test execution or measurement data evaluation, whether the development and test process is to be improved or new test methods or test tools are to be used, AVL Application, Skill & Process Services helps to master the challenges of developing modern powertrain concepts.

The spectrum of applications ranges from holistic concepts for improving test bed productivity, through applications for simulation and automated test execution, test validation and data evaluation, to the implementation of specific functionalities.In all our activities we not only focus on delivering good results but we also pay attention to the individuals, their fears and reservations, their skills and its development. Success comes with people who believe in their work, trust their results and have confidence in their tools.

Break out of silo thinking

- Realize project goals on both micro and macro levels
- Augment existing architectures
- Connect tools, departments and even third-party solutions to accelerate your workflow



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