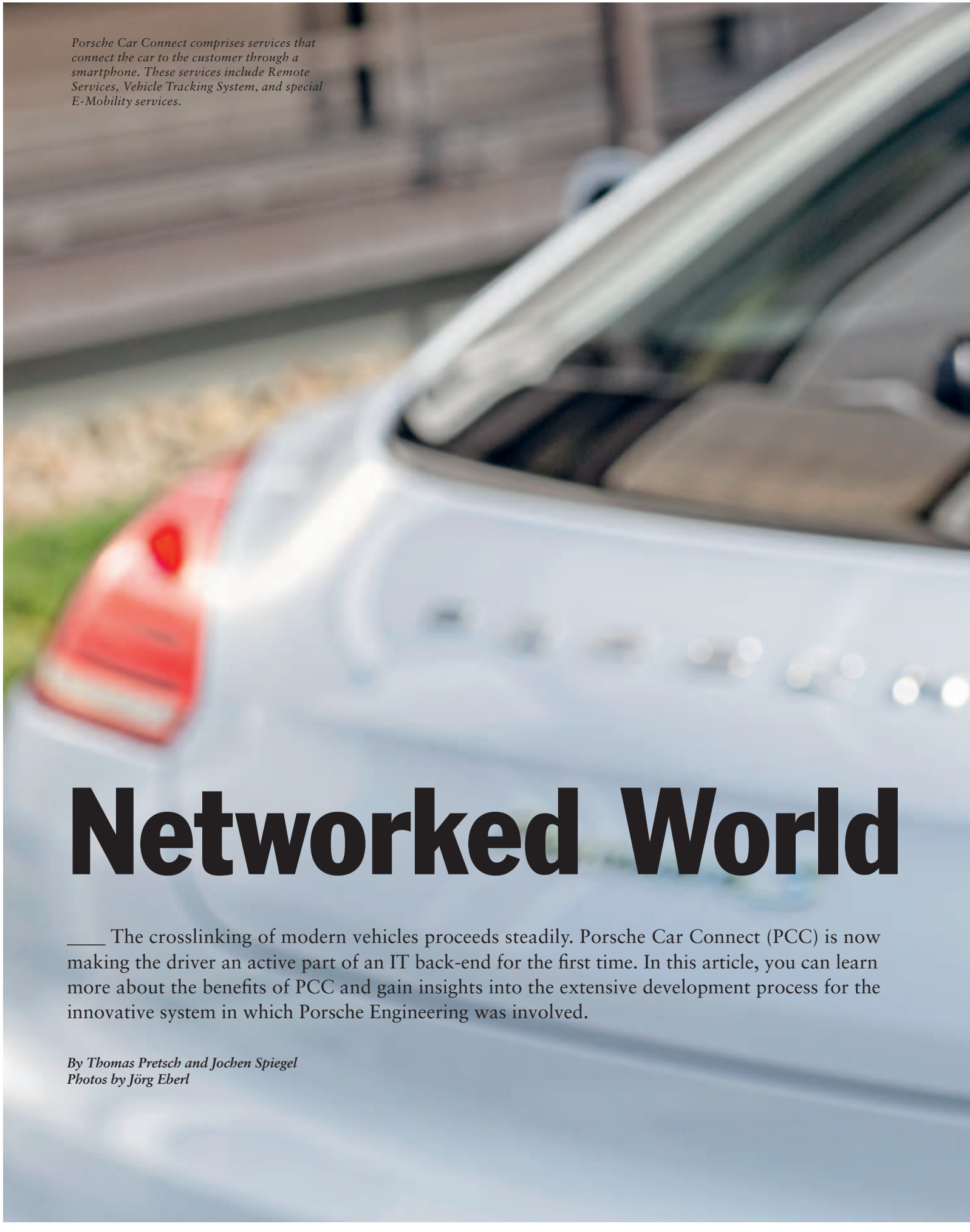


Porsche Car Connect comprises services that connect the car to the customer through a smartphone. These services include Remote Services, Vehicle Tracking System, and special E-Mobility services.

Networked World

The crosslinking of modern vehicles proceeds steadily. Porsche Car Connect (PCC) is now making the driver an active part of an IT back-end for the first time. In this article, you can learn more about the benefits of PCC and gain insights into the extensive development process for the innovative system in which Porsche Engineering was involved.

By Thomas Pretsch and Jochen Spiegel
Photos by Jörg Eberl


4:20 PM
E-Mobility
Plug Status
PLUGGED
Battery
CHARGING
30 KM
E-Range
Remaining Charge Time
00:09 H
Charge mode
Departure Timer 1
Single: 22.04.2013, 06:10
Climate Control Timer: ON
Charge
Timer

E-Mobility status display

Electric range with current charge level

By means of the Porsche Car Connect system, the driver can use a smartphone app to access a variety of vehicle functions without being in the direct vicinity of the vehicle. This form, or rather expansion, of connectivity presents new challenges for the entire development chain—from specification of the functions and application in the vehicle to manual, semi-automatic, or fully automatic tests, and raises a lot of questions along the way: How do you unite the driver and the vehicle data in a convenient way when the customer knows neither the chassis number nor the registration number when the vehicle is ordered? How can the system be put into operation quickly and efficiently? Should the customer be able to connect multiple phones to the vehicle, or perhaps control multiple vehicles with a smartphone? To find the right answers and solutions to these questions, we had to design, test, and ultimately institute new processes.

What exactly is Porsche Car Connect (PCC)?

Porsche Car Connect integrates two additional components into the networked reality of modern vehicles: the smartphone and a secure server. The latter ensures the correct authentication and thus secures communication between the two components—vehicle and smartphone. The functional scope of PCC is divided into three major blocks: e-mobility, remote, and security services. The functions of the "E-Mobility" package, for example, enable easy setting of departure times, i.e. the time at which the vehicle should be fully charged and ready to depart. If the customer has also purchased the "auxiliary air conditioning" option, the vehicle can be set to have a certain cabin temperature at departure time. The advantage is obvious: if, for example, the cabin is heated while the car is connected to the power grid, it doesn't have to use energy from the high-voltage battery.

The "Remote Services" area includes information about the current mileage, remaining range, tire pressure, and the status of the doors and windows. The vehicle can be located and its position displayed on a map, allowing easy calculation of a route to the car. While the ignition is switched off, the blinkers and horn can also be used to make the car easier to find. It is also possible to define areas using a map outside of which a notification is sent to the customer's smartphone.

Under the "Security" menu item, you'll find functions like the Porsche Vehicle Tracking System (PTVS), which has been available as an option for all Porsche models since 2005. Among other things, this package includes an automatic emergency call in case of an accident that triggers the airbags, as well as extended breakdown assistance. If the customer calls for help via the "Porsche Assistance" smartphone app, additional information about the vehicle's location and vehicle statuses can also be transmitted, allowing quick and targeted help in case of a breakdown.

Privacy and data protection are guaranteed

With the multitude of means to locate the vehicle, it should be noted that the driver—not least for privacy reasons—always maintains control of his or her data, including data regarding location. A corresponding menu item in the instrument cluster enables the driver to temporarily remove the connection between one or more smartphones to the vehicle. Excluded from this are of course the safety-related functions such as locating the vehicle when the automatic emergency call is triggered or in case of vehicle theft.

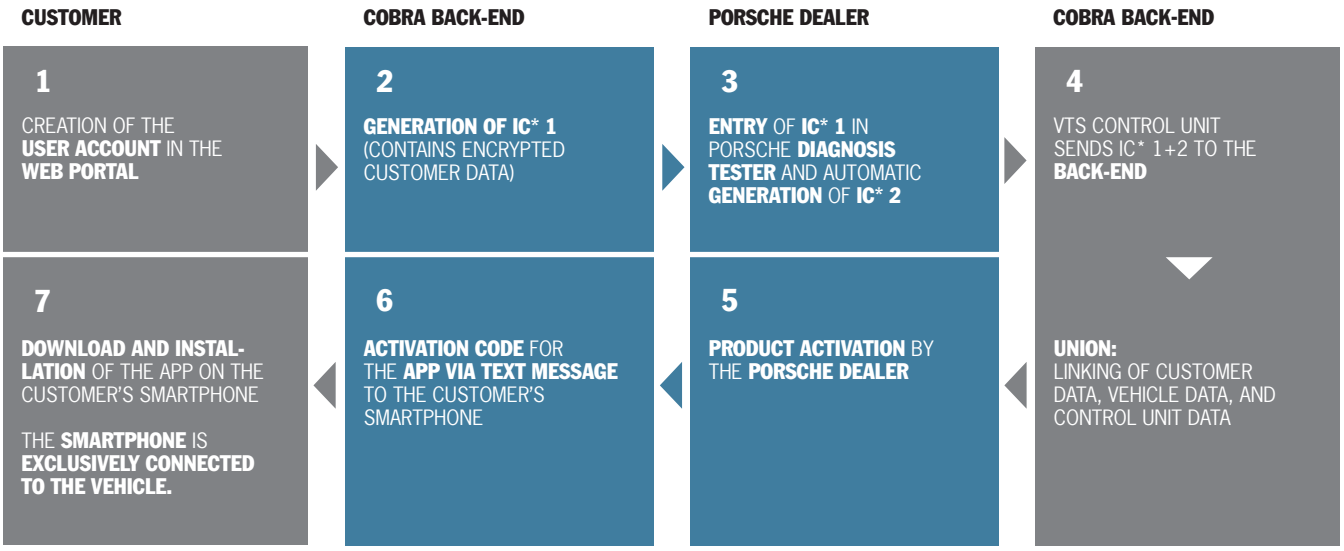
Comparison of driver and vehicle data

When configuring the vehicle, the customer knows neither the chassis number nor the registration number, as already mentioned. So there had to be some way of bringing the driver's data and that of the vehicle together at a given point in time.

To do so, a process was developed that made it possible to link the data in a simple, fast, and secure manner. First the customer creates a PCC account through the Porsche website (www.porsche.com/connect) by entering his or her e-mail address and cell phone number. He or she then receives an e-mail and text message with a confirmation code that must be entered in the next step for verification purposes. Once the user's personal information, including name and address, has been entered, the installation code (IC) is sent to the user, who then gives it to the dealer to use in putting the system into operation.

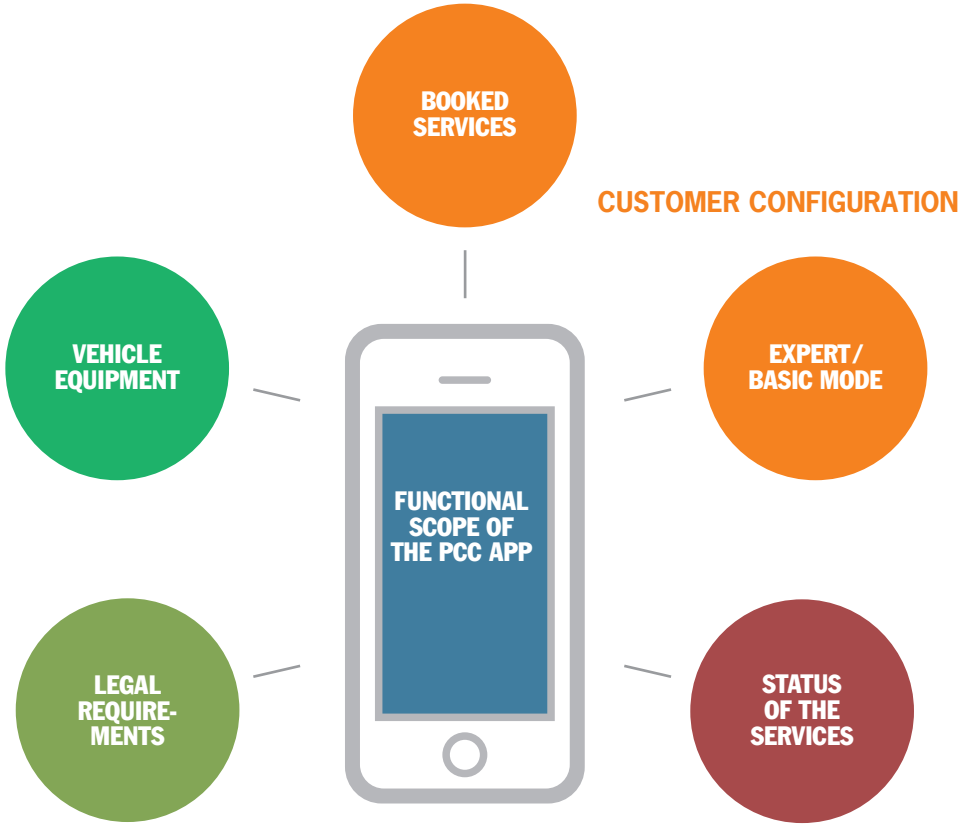
Once the dealer has received the vehicle, he or she can put the system into operation using the Porsche integrated Diagnostic Tester (PiDT) and the installation code. The process was designed to be highly automated to prevent incorrect configuration of the system due to human error. While the system is being activated, for example, information about the equipment, color, and chassis number is output automatically. Here is where the first communication with the secure server takes place: the customer's installation code entered by the dealer and the automatically output vehicle data are sent to the server, where the user data and vehicle data are now linked. This forms the basis for the configuration of the system in the vehicle and the subsequent function tests. To ensure compliance with country-specific insurance requirements, the triggering of the horn, blinkers, and engine immobilizer ›

Customer portal for Porsche Car Connect



* Installation code

Registration and start-up process



Several dimensions impact the function of the smartphone app.

is automatically checked by the PiDT. After a successful check, the system is automatically activated by the server, and the customer receives a welcome text message with a link to the PCC app and the activation code required for it. After installing the app and entering the activation code, the customer can access the vehicle. Afterwards, other vehicles and smartphones can be added and linked via the portal as needed. It's possible, for instance, to control multiple vehicles via an app and switch between the vehicles. In the same way, multiple cell phones can be linked to one vehicle.

The changing appearance of the app

During the system start-up, some data regarding the vehicle configuration is output and sent to the server. When the app is opened for the first time, this configuration is checked and the appearance of the app is automatically adjusted, in particular as concerns the vehicle-specific menu items and optional packages such as the E-Mobility, Remote Services, and Security submenus.

Innovative testing as part of the development process

As we have just seen, there are a number of possible variations with respect to the appearance of the smartphone app as well as the underlying functions. And then there was the expansion of connectivity beyond the vehicle itself to the customer's smartphone. This required new approaches in testing to enable end-to-end checking of the communication chain. Thus the term "connectivity" has multiple meanings in the PCC context.

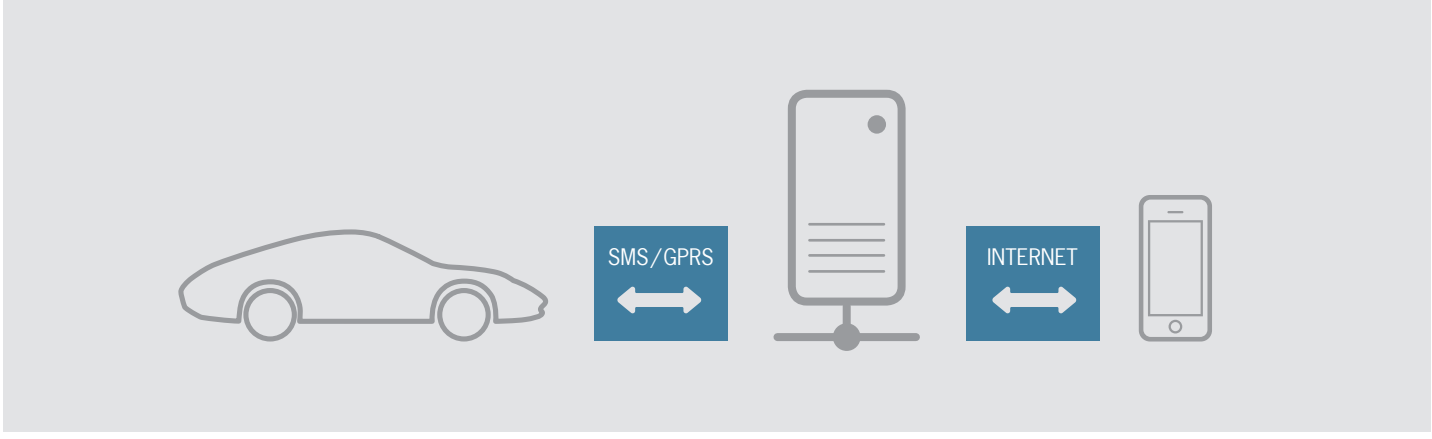
One aspect is the networking of the VTS control unit within the vehicle and the associated dependencies with other control units. One example here would be setting the departure timer, in which—in addition to the correct routing—the instrument cluster and charging electronics are critical in painting a picture of the overall function.

The greatest challenge, however, lies in the "smartphone—back-end—control unit" communication path, which required a completely new form of testing for the automotive industry. As the figure below shows, not only the individual components had to be validated, but also their interfaces and thus the complete end-to-end chain.

If we now add the aspect that each individual component has different release cycles, models, and smartphone generations, as well as several dimensions of customer configuration (see page to the left: lower graphic), the complexity of the task quickly becomes clear.

To handle all of these challenges, new approaches had to be developed in the "test environment" area. Vehicles were developed into special unit carriers to represent a particularly realistic environment. This involved integrating Porsche Car Connect into existing series-like vehicle structures, in which adjustments to the signal routing were made and simulations were carried out. One example was the use of the interface control unit to simulate the charge electronics. The interface control unit made it possible to integrate e-mobility capabilities in a conventional vehicle. This enabled functions such as setting the departure timer or outputting the climate control status so that these things could ultimately be validated on the customer front-end: the smartphone app.

Another important point is the enhancement of the data loggers in the context of cellular phone communication/air interface. To track the data exchange between the vehicle and ›



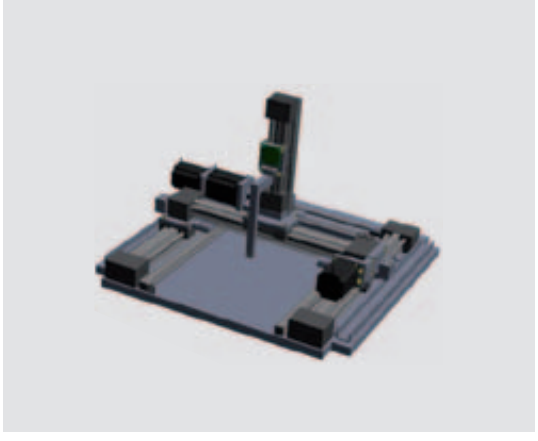
End-to-end communication chain

server and understand temporary limitations in the availability of the control unit in the GSM network, special loggers were added directly to the control unit. These can record the internal control unit communication and analyze it as needed.

To handle all of the test cases and their permutations, automated testing on hardware-in-the-loop systems (HiL systems) was employed. In this context, an existing HiL system was enhanced to enable automated testing of the requirements of the entire end-to-end chain.

Beyond the control of power supply units—for instance, for voltage drop and on-board voltage drop scenarios—the antennas attached to the VTS control unit (including the GPS and GSM antenna) can be automatically connected and disconnected. Another important role in this regard was played by the modular robot integrated in the HiL (figure at the bottom left), which can operate any smartphone. One typical application case is the "childproof lock" that suspends communication to the vehicle when it has been awakened remotely more than 100 times via smartphone app. We also had to bear in mind that Porsche Car Connect is already offered for many different model lines. For this reason, a modular plug-in concept was established in the HiL system that made it possible to depict any model line and take the respective factors into account in the test environment. The automated tests conducted on this specially adapted HiL are supported by other trials specifically related to the respective vehicle carried out on department-based HiLs. Here the connectivity of the control units is the focus, which enables an overarching view of the complete vehicle.

In the automotive industry, a "hardware-in-the-loop system" is a simulation set-up combining real hardware components (e.g. control units) with software-based simulations, which thus enables highly realistic testing.



Operating robot for any smartphone

The bridge between automation and customer behavior

To ensure complete coverage of the functions of Porsche Car Connect, in particular from a customer viewpoint, endurance tests, field testing and internal testing by the team are indispensable.

In view of the fact that the communication module plays a crucial role within the VTS control unit, cross-national testing is imperative and requires special expertise in communications and mobile technology to take account of the various conditions in different environments. The developer's concentrated view of the products is an additional part of the examination of other open functional topics.

Endurance testing can be regarded as the bridge between the developer and the customer. In these tests, the product is used multiple times daily and defined inspection catalogs are used. This leads to important insights into behavior in cases of greater-than-normal usage. The respective driver systematically tests the smartphone app using the test catalog and documents any issues that arise.

Field testing, by contrast, reflects typical behavior and tests realistic behavior patterns.

Many other comfort functions are possible

The expansion of the networked components to the customer creates the scope for a number of potential new functions for interaction between the driver and the car. Porsche Car Connect

A great number of tests must be carried out to ensure proper functioning of the PCC from a customer viewpoint.

thus offers the customer more ways of interacting with the car and greatly increases the convenience of such interactions.

For the development engineers, these new functions and the expansion of connectivity beyond the vehicle itself present a variety of new challenges in the areas of specification, application, and testing that will continue to grow in the years to come. Topics such as remote diagnostics, car-to-car, and car-to-infrastructure are still in the early stages and offer a wealth of potential for further developments. Porsche Engineering will play a role in shaping this connected new world. It should be very exciting. ■

PANAMERA S E-HYBRID Fuel consumption (combined): 3.1 l/100 km; CO_2 emissions: 71 g/km; energy consumption: 16.2 kWh/100 km; efficiency class: DE/CH A+/A