Case study:

Prototyping the future automotive cloud

In November 2018, Volkswagen Group presented publicly their “One Digital Platform” concept: this allows to connect in-car services as well as run additional services for the vehicles like charging or parking. Especially in the current era of people being always online, there are challenges to satisfy customer needs and expectations, which require a reliable IT infrastructure as a base platform for vehicles and services.

The cloud promises to be the solution for that challenge, especially when a runtime platform like Cloud Foundry and an Internet-of-Things (IoT) service is included. To verify that claim, one brand of the Volkswagen Group, in this case Porsche, organized a group-wide Proof-of-Concept (PoC), and with the help of different partners, like Grape Up, there were various scenarios prototyped. This case study gives more insight about the goals, the scenarios, and the technical solutions.
The challenge:

Providing a seamless customer experience in a changing automotive industry

Digital disruption is transforming the entire automotive industry, and the process of technological development is rapidly speeding up. Porsche is setting a direction for the sports car market. To create a seamless customer experience enabled by the fully integrated vehicle into the cloud, the company has decided to use the IoT paradigm, which empowers the end user to interact with their cars.

"Technologies such as cloud platforms are an essential means of supporting megatrends that bring added value to the driver or passenger. The availability of forecasting functions based on AI in the vehicle and in the cloud, such as predictive air conditioning, routing or parking assistance, will increase travel comfort."

- Thorsten Türk-Steppe, IT Project Manager at Porsche

A connected platform at the center of the ecosystem built around digital services creates further possibilities. By bringing those services to customers, automotive companies gain a smart data source – the car, which becomes an IoT device and a tool in the process of customization that meets user needs. It gives auto companies a unique chance to leverage architectural patterns derived from the IoT world. A perfect example is the virtual representation of the car (with its processes, products and services) in the cloud – a Digital Twin.

"A Digital Twin can capture the behavioral and operational data of the vehicle and provide near real-time data as a basis to analyze the overall vehicle performance, delivering a personalized service for customers. This allows business services to become independent of the vehicles connectivity status to provide functions or content based on last known data points. Additionally, the digital twin could even support answering ad-hoc questions for groups of vehicles sharing the same data model."

The Volkswagen Group has been implementing cloud technologies to its cars for some time now, but there is a strong need for a unified platform for the entire group. The plain data transfer between the car and the cloud via mobile networks is not that challenging, thanks to the number of communication providers available on the market. The challenge occurs when the company is putting solutions on top of it to support various ways of software component communication between cars and the cloud (technologies like Azure IoT, Wireless Car or the VW Group backend “Modularer Backend-Baukasten” – MBB). Having a large number of services deployed in the cars, providing inconsistent APIs combined with the variety of the transport mechanisms significantly complicates integration for both – third-party and in-house developed services. Such a complex design makes even simple cloud-to-car requests tough. Cloud applications have to know how to reach a particular car and which transport protocol should be used for a given in-car service. That extra information needed by cloud service increase complexity and affects the performance of the whole system.
Applying the right IoT and cloud native technologies

Things are getting even more complicated when tackling complex scenarios, especially with advanced user interaction or timing requirements. For example, when the car stays in offline mode longer than anticipated by the user, and other tricky use cases. Let’s use the following scenario as an example: the user wants to open a locked car door, but the vehicle is currently offline. What should happen when the car is back online, but the driver is away? What should happen, when the action was executed but the user could not be notified of the result? Edge cases like this, operations at a huge scale (with thousands or even millions of cars connected to one platform), as well as automated updates for the in-car software modules make this project a huge R&D endeavor.

In the context of e-mobility, the Volkswagen Group including Porsche is simplifying its overall electronic and software architecture. Radically standardizing the software interfaces with a common platform and assuring that software can be updated or upgraded over the whole lifecycle is a revolutionary step in the automotive industry. The PoC contributes to these efforts and requires partners with proven experience in cloud-native technologies.

To find out if Grape Up could be the right partner for such a prototyping work, the Porsche team created a small scoped preparation project to evaluate the collaboration.

Project goals

The Volkswagen Group started to design the way connected cars, IoT platforms and the usage of the Digital Twin concept will determine a superb experience for the passengers. The group uses proven technologies to adopt to the newest trends in a sensible way. By establishing demanding goals, the Volkswagen Group motivates its internal and collaborating teams to achieve extraordinary results. Following goals set for the project were impressive from the beginning:

- Creating a robust, scalable system which can handle thousands to millions of cars from the Volkswagen Group (Volkswagen, Audi, Porsche, etc.) and connect them to one, unified platform.
- Designing the integration into an automotive cloud platform based on IoT components as a baseline for future extensions where users can easily connect with third-party apps, and third-party service providers can seamlessly communicate with a car through the cloud.
- Equipping its cars with service-oriented architecture and testing the possibilities and limits of this communication paradigm between vehicles and the cloud.
- Validating the concept for swapping out the underlying connectivity infrastructure without the need to change the software components in the vehicle or in the backend – as they are using a common unified API layer.
- Validating the Digital Twin concept for complex scenarios including synchronization of the state between the car and the cloud – even when the car is offline.

It turned out that Grape Up delivered on their promises of continuously delivering value in an agile way, to listen closely to the customers’ vision and to come up with ideas to realize it. This gave us the solid confidence to propose Grape Up as implementation partner also for the group-wide PoC.

- Matthias Hub, IT Project Manager and Prototyper at Porsche
The initial collaboration between Grape Up and Porsche was planned to be an R&D project, including the evaluation of general technical opportunities, validating existing ideas and concepts, and investigating into potential business needs a system can solve. After successfully completing the initial phase and documenting the learnings regarding technologies and concepts the cooperation transformed into actually implementing a market-ready solution based on a unified API and communication platforms delivered by chosen providers (Azure IoT, VW Group backend MBB, Wireless Car).

Using the new platform, the Volkswagen Group is able to verify various communication patterns between cars and the cloud and to build on top of it features and services in the future. With Grape Up’s contribution Porsche has implemented a unified API concept that enables its customers to communicate with their cars through the cloud at the same quality level as when they use direct connections (for example using Wi-Fi). Which means that the developer sees no difference in communicating with the car directly or using the cloud. What’s also worth noting: the unified API works well with the Digital Twin concept which leads to cuts in communication with the vehicle as third-party apps are able to connect with the services in the cloud instead of communicating directly with an in-car software component.

Thanks to assistance by Grape Up in implementing cloud-native technology, Porsche has accelerated their release pace and speed up a feedback loop, which allows developing new ideas faster. Porsche has been designing supportive technologies for their automobiles through the years but to respond to the restructuring of the in-car software architecture they needed to build one place where all apps and services could be integrated and connected. By building the platform, Porsche opens up to develop and deploy new functionality in the car and in the backend at the same time or even independently. A similar case can be found in the telecommunication industry with the various mobile phone app stores and the rapidly growing number of apps delivered.
The Grape Up way using Cloud Foundry advantages

Grape Up provides experienced cloud developers that work with the software architecture and coding teams from Porsche as well as other software providers. Projects run by members of the Grape Up team are significant parts of the ambitious strategy that accommodates the on-going digital disruption, which currently reshapes the car industry.

During the entire process, particular teams from Grape Up were responsible for providing essential ingredients for project success. A car-to-cloud communication agent component allows users and third-party application providers to connect with vehicles through the cloud. Grape Up has developed the gateway component that communicates with the car using provided connected car solutions, which are a smart link between a car and the platform, regardless which specific software is actually used by a single car and enables service providers to deliver new apps faster.

Along with the gateway, Grape Up delivered the so-called Vehicle Shadow (part of the Digital Twin concept) that allows gathering data and information transferred to the car through the cloud. A Vehicle Shadow enables the Volkswagen Group to solve complicated use cases (for example what to do when a car is offline and how it should respond to user actions when getting back online) and to take advantage of collected information to improve customer experience. To help Porsche with getting the most out of the data sent by the cars, Grape Up developed an original query language (based on GraphQL and the RSI protocol) which empowers users to query specific information available on the platform.

Porsche uses Cloud Foundry, which is a perfect fit in a project that evolves so often, as this technology allows for great flexibility and development speed. By using Cloud Foundry, the team behind the project is able to cut the time cost of the works with the architecture (development and maintenance) and focus on providing business value. Grape Up has extensive experience both from application development and operations perspective in regard to Cloud technologies with special focus on OSS Cloud Foundry on top of AWS. All that knowledge gathered throughout the years turned out to be extremely helpful in this project and was applied and transferred to the team in order to deliver value fast.

Tech stack

Key technologies used in the project:

Runtimes and Services:
- Cloud Foundry instance hosted by Volkswagen Group,
  Docker/Kubernetes, AWS and Microsoft Azure

Microservices:
- Java/Spring Boot, Netflix OSS/Spring Cloud, node.js

Protocols:
- MQTT / see https://docs.oasis-open.org/mqtt/mqtt/v5.0/mqtt-v5.0.html
- RSI / see https://www.w3.org/Submission/2016/01/
- SQS Messaging / see https://docs.aws.amazon.com/AWSSimpleQueueService/latest/SQSDeveloperGuide/welcome.html
- HTTP/HTTPS / see https://www.w3.org/Protocols/

Databases:
- MongoDB, MySQL, AWS Aurora
Dr. Ing. h.c. F. Porsche AG, with headquarters in Stuttgart-Zuffenhausen, Germany, is one of the most profitable car makers in the world. In 2018, Porsche delivered 256,255 vehicles of the 911, Cayenne, Macan, Panamera, 718 Boxster and Cayman models to customers worldwide. That was 4 per cent more than the year before. Thereby, the sports car manufacturer’s operating profit amounted to 4.3 billion euros, up seven per cent from the previous year’s comparative figure. Porsche declares that its vision is to become the most successful brand for exclusive and sporty mobility.

Grape Up is a technology consulting company that brings together a cloud-native platform - Cloudboostr and a unique approach to software delivery to help the world’s leading enterprises embrace digital transformation, migrate to cloud-native application architecture, and build a culture of Continuous Innovation.

Through implementing a DevOps approach and cloud-native technologies, Grape Up enables enterprises from the most competitive industries to leverage cutting-edge tools and reduce time-to-market for new products and services. Grape Up is an experienced partner in platform enablement and operations, application development, software transformation, and engineer enablement. By providing exceptional support services, the company changes the way its customers run their businesses not only deliver software.

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