Connected Vehicles Delivering New Levels of Fun!

Recently, the automotive industry has experienced a surge in the development of CASE-focused products and services, leading to a rapid increase in connected vehicles. Amid this trend, we have been developing a "connected" app that integrates our flagship product, motorcycles, with smartphones.

The second generation of this app enhances bidirectional communication through our cloud service. This not only delivers new value to our customers but also facilitates product improvements and the introduction of new services through big data analysis and utilization.

Introduction

Recently, the automotive industry has experienced a surge in the development of CASE (Connected, Autonomous, Share & Service, and Electric)-focused products and services.

In the field of connectivity, a component of CASE, connected vehicles functioning as ICT (information and communication technology) devices are rapidly becoming widespread as ICT evolves. Connected vehicles provide unprecedented value and services through ICT.

1 RIDEOLOGY THE APP MOTORCYCLE

As companies in the motorcycle industry provide many different services, Kawasaki Motors has also researched and developed RIDEOLOGY THE APP MOTORCYCLE since 2017. This smartphone app connects to motorcycles via Bluetooth and is designed to help customers feel the enjoyment that can only be experienced through riding motorcycles and to provide new value.

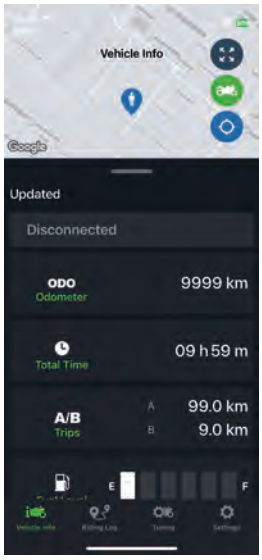
2 Development policy for the second-generation app

The first-generation app (**Fig. 1**) was launched in 2019 to enhance convenience and customer experience, and offers the following functions by connecting motorcycles with smartphones.

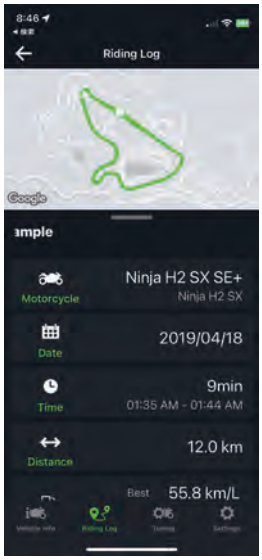
- Vehicle information (**Fig. 1 (b)**)

  This is a function for viewing information such as remaining fuel amount and battery voltage when the

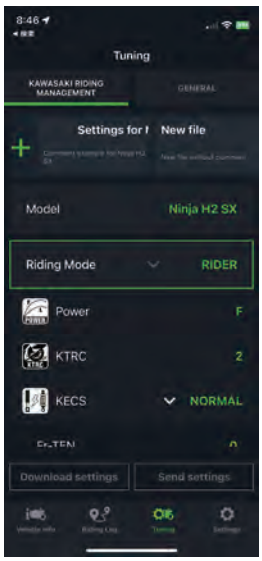
(a) Wireless communication interface



(b) Vehicle information



(c) Riding log



(d) Vehicle settings

Fig. 1 Features of 1st-generation app

engine is stopped (IG-OFF). This function can be leveraged to plan fueling on the next ride or to review data during maintenance.

- Riding log (**Fig. 1 (c)**)

  This is a function to display overview information on any riding section such as riding distance, time, and fuel efficiency, and show sensor values such as riding speed and gear information in graph form. This function can be leveraged to analyze your ride on a race track, etc.

- Vehicle settings (**Fig. 1 (d)**)

  This is a function to operate and configure various settings that determine the feeling of the ride, including vehicle riding modes (such as normal mode, sports mode, or rain mode) from the app. You can effortlessly configure the settings without the hassle of cumbersome switch operations.

The second-generation app (**Fig. 2**) launched in 2021 offers the following new functions that create more opportunities for riders or people with similar hobbies to meet.

- Sharing riding logs (**Fig. 2 (c)**)

  This is a function to share the above-mentioned riding logs with others. Users can benefit from others' logs when planning a motorcycle tour.

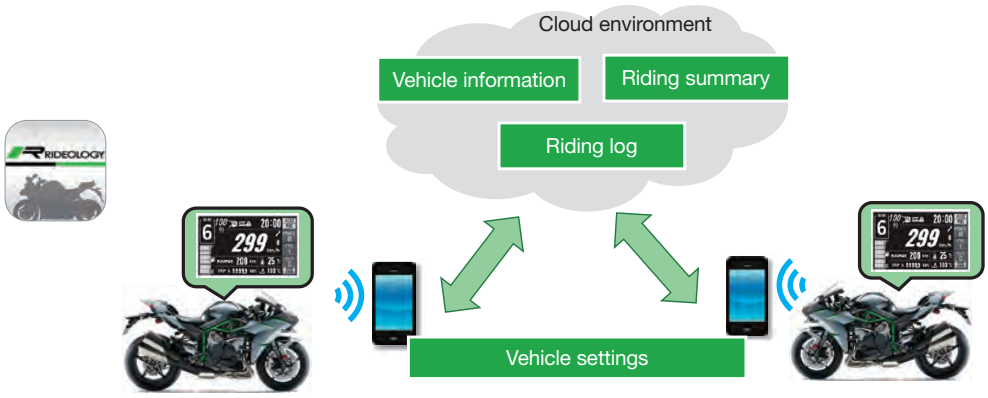
- RIDEOLOGY SCORE (**Fig. 2 (d)**)

  This is a function to indicate the fun levels of the ride in riding logs.

- Sharing the current location (**Fig. 2 (e)**)

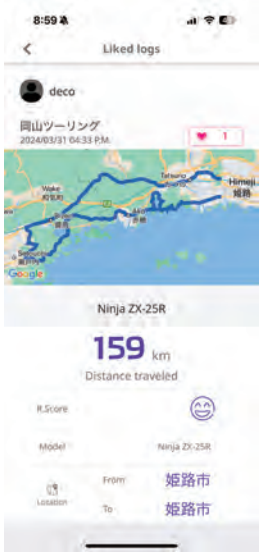
  This function can be leveraged to send your current location to app users to invite them to join the ride.

Many functions of the second-generation app serve users by connecting them via the Internet. We also

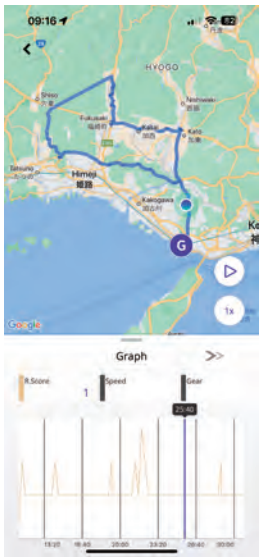


(a) Wireless communication interface

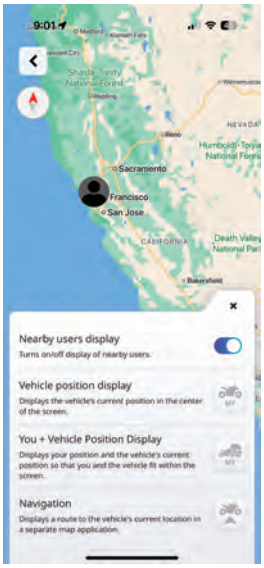
(b) Home screen



(c) Sharing riding logs



(d) RIDEOLOGY SCORE



(e) Sharing the current location

Fig. 2 Features of 2nd-generation app

focused on the benefits that arise from connecting us as the app provider and users. The benefits include identifying how the app and vehicle are used based on data obtained via the Internet, which can be utilized for future vehicle development, and immediately detecting functional defects.

3 Technical challenges

(1) Development of the app and cloud environment

(i) Creation of a cloud environment mechanism

Building the system requires not only a means of communication using the Internet but also a server to accumulate and calculate riding logs and other data. Users must select an on-premise environment to internally manage and operate the server or a cloud environment that simplifies management. Because we assumed international deployment and anticipated that the number of users would increase year by year, we decided to introduce a cloud environment. Doing so takes into account a system that has flexibly adjustable hardware specifications and can operate continuously for 24 hours a day. One technical challenge in building a cloud environment is establishing a mechanism to efficiently develop and operate the system with limited development resources.

(ii) Shorter response time

Because riding logs will be stored in the cloud environment, we need a system configuration with security measures to protect personal data that minimizes

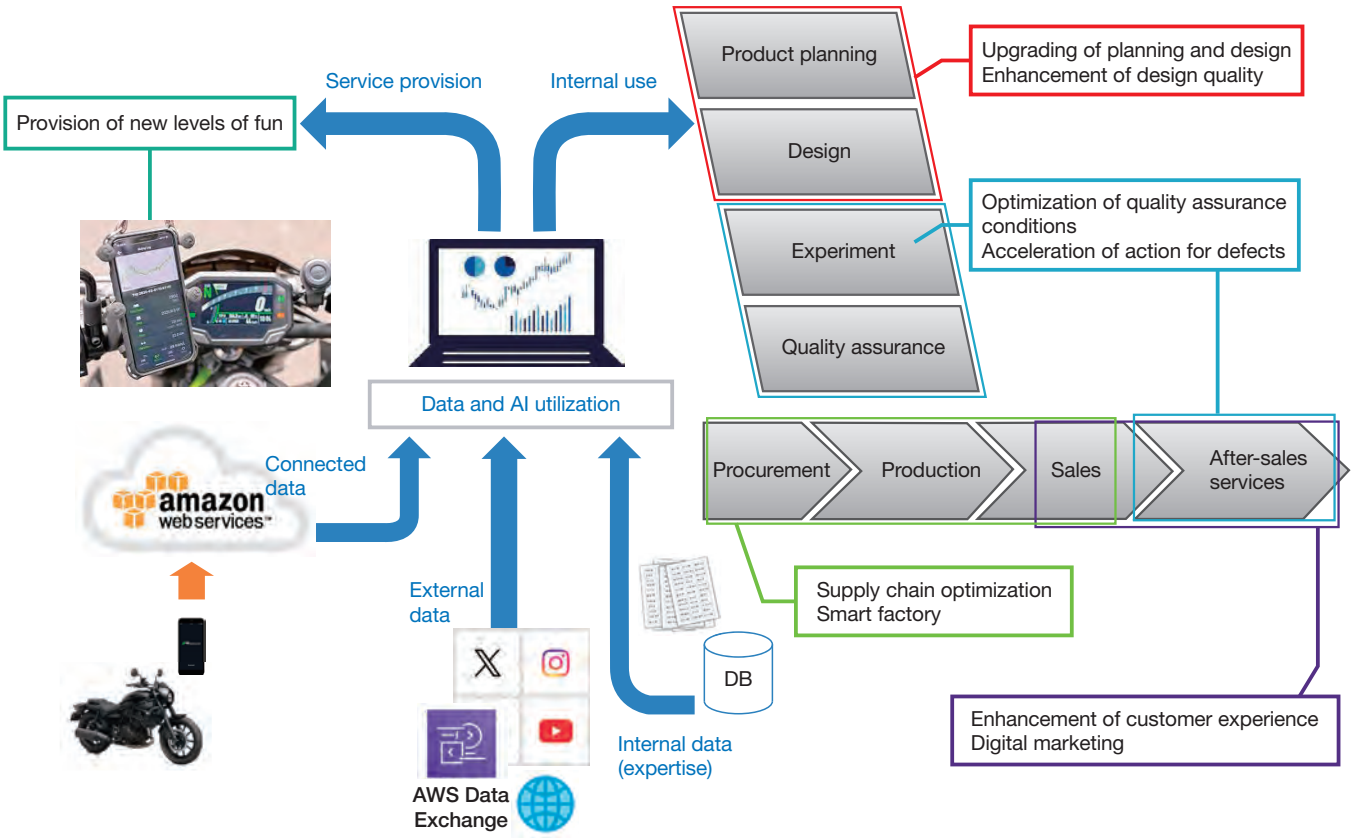


Fig. 3 Image of big data utilization

response delay due to communication between smartphones and the cloud.

(iii) Visualization of riding log sharing

Sharing riding logs means making riding data such as vehicle speed and fuel efficiency information available to the public. Because disclosing this numerical information to other users may encourage dangerous riding, we had to consider an alternative way of sharing riding logs with some visual information in place of numerical information.

(2) Data analysis and utilization

Components of motorcycles frequently exchange various data via CAN communication. We analyze this data during the vehicle development stage and use it for evaluation and improvement. In contrast, the circumstances of vehicles in the market largely depend on riders, riding environment, and other factors, which are very difficult to accurately identify and apply in the development phase. At present, information that can be collected from the market is limited to findings from user feedback sessions at the planning stage, defect information from dealers, and other sources.

We will leverage the "connected" app to overcome these challenges by collecting more accurate data, such as vehicle data and route information, on the cloud. Analyzing and leveraging this big data is expected to improve our products, enhance the quality of after-sales services, contribute to marketing, and promote the provision of new services as shown in **Fig. 3**.

A technical challenge here is the need to properly process and adjust a vast amount of data that will eventually be frequently sent every day from several hundred thousand vehicles around the planet and accumulate it in a secure but easily available method.

4 Initiatives to overcome the technological challenges

(1) Development of the app and cloud

(i) Creation of a cloud environment mechanism

To reduce the time taken to develop the app and cloud environment, we adopted Amazon Web Service (AWS) and the configuration shown in **Fig. 4**. AWS enables us to build the system by combining small-scale functions called microservices. We emphasized early defect detection during development and operation, performance

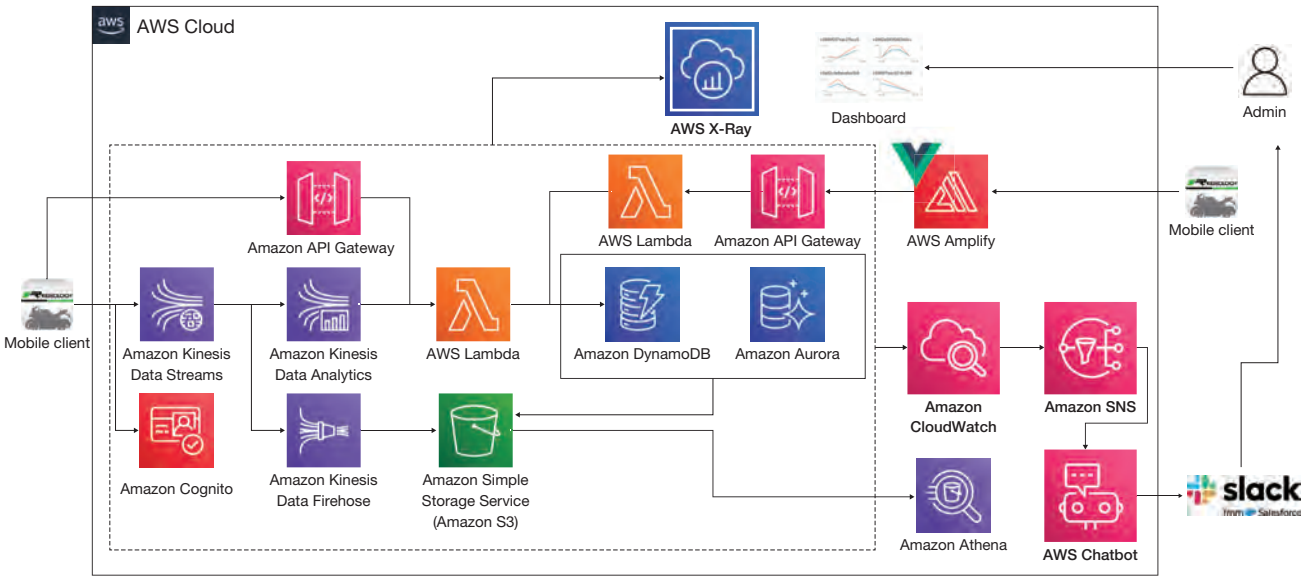


Fig. 4 AWS architecture diagram

Fig. 5 3D animation

Fig. 6 Business intelligence dashboard

monitoring, and other aspects, and introduced the following services.

- Amazon SNS and Amazon Chatbot

  These services form a mechanism to send arbitrary notices by microservice, including error information, to major social media services.

- AWS X-ray

  This service make it easy to locate performance bottlenecks and the root causes of errors across microservices.

- Amazon CloudWatch

  This standard log monitoring service in AWS enables you to create necessary dashboards.

(ii) Reduction in response time

The adoption of Amazon Kinesis Data Analytics made it possible to start continuously sending vehicle information as soon as the collection of riding logs starts, and to save and analyze them in real time. This service is enjoyable because users can view results in logs shortly after data collection ends.

(iii) Visualization of riding log sharing

To make riding log information available to the public, we adopted 3D animation as shown in **Fig. 5**, enabling users to visually enjoy viewing their riding status while avoiding showing vehicle speed and other numerical data.

(2) Data analysis and use

We adopted an architecture to store data in Amazon S3 via Amazon Kinesis, mentioned in the previous section, to stably and securely collect, process, and accumulate a huge amount of data sent at high frequency from several hundred thousand motorcycles. In addition, we separated the data analysis infrastructure above the app backend system to facilitate authority management and set a rule to avoid bringing sensitive data, including personal data in the data analysis infrastructure, to promote internal data utilization. This ensures security.

Regarding the data analysis infrastructure, data sent from the app through the backend system is processed to be visualized on BI dashboards according to usage as shown in **Fig. 6**. We have also leveraged AWS services to automatically extract, convert, and store data to reduce data processing work required for the app to operate.

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Conclusion

Over 100,000 motorcycles are now connected to our second-generation app for motorcycles, which was launched three years ago. We have continued to further improve quality and include new functions to satisfy customers' requests and expectations. We also launched a new app for off-road four-wheelers in June 2024, and plan to gradually support new models and expand this service to other products.

Future work will involve creating and providing new value with not only products but also connected services by supporting always-on connection, which is commonly used in passenger cars.