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WINNING THE RACE TO THE DATA-DRIVEN FUTURE

From proactive remote maintenance, to the mass-market adoption of driverless vehicles, data is at the heart of the coming connected car revolution.

Connected Cars are on the rise, and Gartner predicts that the number of connected vehicles worldwide will reach 250 million by 2020. The more connected and software-centric these vehicles become, the greater the volume and complexity of data that must be collected, analyzed and leveraged by automotive OEMs to generate revenue, loyalty and brand capital.

Today, manufacturers do not have the infrastructure in place to cope with the volume and variety of data that will be generated by the mass-market adoption of connected cars. And so in the short term, they may require assistance from third-party suppliers that do have the scalable computing resources and know-how to collect and analyze the rising tide of vehicle data. However, in the longer term, it makes sense for manufacturers to control as much of this data collection and analysis as possible, in order to extract and own the value that it produces.

For example, access to a continuous stream of connected car data will help manufacturers improve overall customer satisfaction by enabling a more proactive approach to resolving technical vehicle problems. There will also be an opportunity for manufacturers to: sell certain types of data (such as weather or traffic information) to third party organizations; cross- and up-sell services to vehicle owners and drivers; and evolve the vehicle-as-a-service business model, from people collecting and dropping off vehicles, to vehicles collecting and dropping off people. All of which will help manufacturers offset declines in revenue from traditional

car sales, as people begin to see vehicles more as a utility than as a status symbol.

Ultimately, data will become the lifeblood of the automated automotive future, in which the data-centric services that define the user experience in the vehicle, from automatic route optimization to immersive entertainment, will become more important than the vehicles themselves.

VMware's Pulse™ IoT Center consists of 3 core components that give automotive OEMs the IT platform they need to maximize these opportunities, by making vehicles an integral part of the Internet of Things:

1. A scalable, highly resilient and available infrastructure based on a VMware software-defined data center and public cloud platforms like IBM Softlayer or AWS.
2. A cloud-based data management suite that enables the client collection and analysis of telemetric data in near time, and the communication of commands and alerts based on the results
3. Intelligent device agents that aggregates data from sensors and executes actions within the vehicle, based on commands from the management suite

These capabilities put VMware in a unique position to support the success of automotive OEMs in the data-driven vehicle era.

SCALING UP FOR A CONNECTED FUTURE



If we assume Gartner's prediction of 250 million connected cars by 2020 to be fairly accurate, automotive OEMs face a huge challenge in dealing with the surge in data volumes created by this growth. With a relatively small number of connected cars on the road collecting and transmitting data from a small number of vehicle systems, types and volumes of data are fairly predictable. But as the number of connected vehicles and the pervasiveness of software inside them increases, data volume and complexity increases dramatically. As a result, the scalability of the

infrastructure supporting the collection, storage and analysis of this data will become a key success factor for manufacturers.

Today, few manufacturers have the required infrastructure to cope with connected cars generating data at scale. But in the long-term, maximum growth and profitability will depend on controlling as much value as possible, in order to make the most of the business opportunities that huge volumes of rich vehicle data create.

Building the infrastructure to support these opportunities efficiently will depend on the smart interplay of scalable cloud computing resources, and striking a balance between analyzing data in the cloud and in the vehicle. It will also require intelligent management of data transmission in order to use network resources efficiently. This could mean, for example, storing data in the vehicle when no data connection is available, and transferring it when back in range, when the car is stationary for a long period, or at defined intervals.

VMware is a pioneer in cloud computing and over-the-air management, and has the expertise and vision to leverage this technology in the data center and in the connected vehicle, in order to give automotive OEMs a competitive advantage.

PARTNERING FOR QUICK WINS

Realistically, it will take time for vehicle manufacturers to build the infrastructure and capabilities they need to make the most of connected car data. In the short term, there is an opportunity to work with 3rd-party businesses such as telecoms or automotive component firms that have established cloud-based big data infrastructures, and may have greater expertise in managing, analyzing and extracting insights from large volumes of customer data.

Partnering with these companies will give vehicle manufacturers fast access to the capacity and capabilities they need to get to market quickly with new services. But it will also provide a great learning opportunity that will help them shape their own data infrastructure, should they wish to own and operate it themselves in the future.

VMware has the cloud platform, data management solutions and automotive expertise to provide a technology bridge between automotive OEMs and their suppliers, enabling them to create maximum value for themselves and vehicle users.



THE PROACTIVE PATH TO HAPPIER CUSTOMERS

Today, relationships between vehicle manufacturers and customers are still primarily reactive. Servicing and sales appointments are usually initiated by the vehicle user, and require a physical vehicle inspection or sales meeting at a dealership. The connected car era will turn this situation on its head.

Let's take maintenance and repair as an example. Connected cars will feed a continuous stream of data to manufacturers, enabling ongoing assessment of the condition of every in-vehicle system. At the same time, intelligence built into the vehicle head unit or the cloud will enable one system to react to data produced by another. So, if a potentially hazardous issue, such as excessive brake wear, is detected, the vehicle systems could work together to inform the driver and automatically book a repair appointment at a convenient location, whether the user is at home, on holiday, or on a business trip. With the right analytics tools, manufacturers will also be able to spot patterns in

the data streams they receive. So, if a large proportion of vehicles of a particular model report the same issue in a short space of time, it will become clear that a recall may be needed. This will enable the manufacturer to start and complete the recall more quickly, and make changes to production processes so that the issue does not recur in vehicles currently on the production line. The same concept can also be applied to new vehicle development, by giving test cars to selected customers pre-launch, in order to uncover any issues that weren't identified through internal testing processes.

Faster resolution of issues, and the prevention of them for future customers, will contribute to higher overall customer satisfaction and loyalty. VMware is the ideal vendor to support vehicle manufacturers with an intelligent, scalable infrastructure that will empower them to make the service experience more proactive.

DATA AND THE DRIVERLESS FUTURE

Today, many households own or have access to multiple vehicles that spend most of their time either standing idle or operating below their capacity. Large areas of land in towns and cities are given over to parking. And governments often respond to more cars and growing congestion either by building more roads and more parking, which takes up even more land, or by pushing people towards public transport, which is often expensive, overcrowded, and unreliable. One exciting potential alternative is the multi-user driverless car.

Sometime in the next few decades, fully autonomous vehicles will be programmed by users to continuously pick up and drop off passengers from within a family, company or other user group from anywhere. MIT has estimated that this scenario could meet everyone's personal transport needs with 80% fewer vehicles. Not only that, each user will be able to adapt their experience according to personal preferences, in everything from the route taken, to in-vehicle entertainment. The societal implications are significant and include: the virtual elimination of congestion and improved safety through fewer cars, more efficient routing, and fewer accidents; the reuse of land used for parking for more creative commercial or recreational purposes; and a significant reduction in the environmental impact of personal



transport, from improved air quality to lower consumption of natural resources.

If this vision becomes reality, automotive manufacturers will need to transform their business models from vehicle engineering, manufacturing and sales, to the provision of personal transport services on a pay-per-use basis. In this scenario, the ability to collect, manage, analyze and utilize data effectively to provide the most efficient, effective and personalized services will be the difference between success and failure.

VMware has the big data infrastructure, secure over-the-air data and software solutions, and in-vehicle technologies to help vendors reinvent their businesses.

CONNECTED CAR BUSINESS BRIEF SERIES

The VMware Connected Car Business Brief Series explains how VMware helps automotive OEMs build a highly scalable and secure infrastructure for the connected car and driverless vehicle era. The brochures cover the following topics:

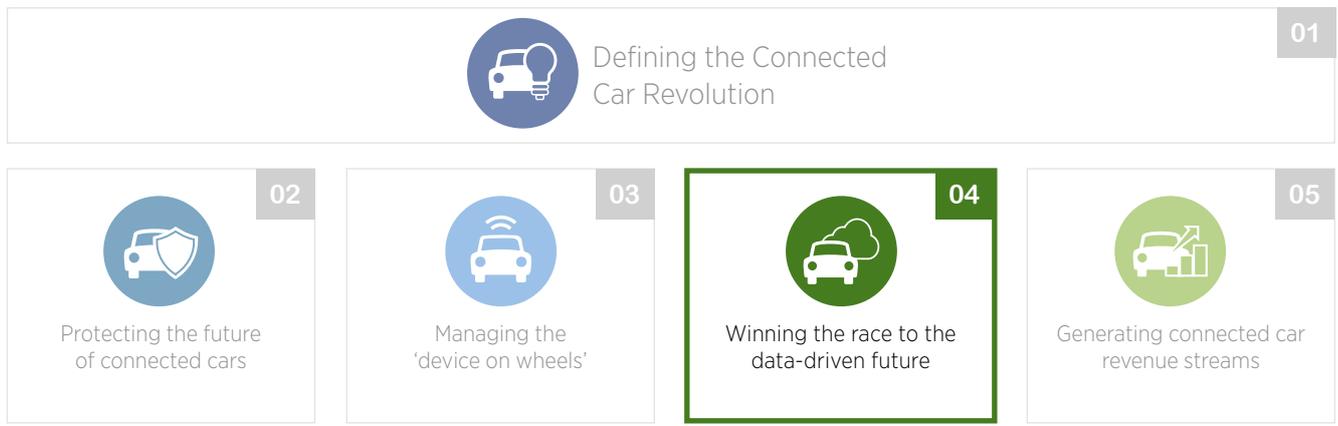
01 Vision: Powering new automotive business models through the secure and efficient sharing of data and intelligence between vehicles, users and vendors via the cloud.

02 Security: Innovative segmentation-based approaches to security in data centers, vehicle head units and wireless networks that minimize business risk and protect drivers.

03 Software over-the-air: Secure collection, analysis, management and delivery of real-time data transmitted over-the-air between drivers, vehicle head units and vendors.

04 Data collection & analysis: Maximum value from connected car data supported by the software-defined data center, secure public cloud infrastructure, cloud-based data management and intelligent in-vehicle device agents.

05 New business models: Driving new revenue streams through data recycling, shaping the in-vehicle user experience on demand, driverless transport services, and more.



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VMware, a global leader in cloud infrastructure and business mobility, helps customers accelerate their digital transformation. VMware enables enterprises to master a software-defined approach to business and IT with its Cross-Cloud Architecture™ and solutions for the data center, mobility, and security. With 2016 revenue of \$7.09 billion, VMware is headquartered in Palo Alto, CA and has over 500,000 customers and 75,000 partners worldwide.



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