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DEFINING THE CONNECTED CAR REVOLUTION

Software already plays a key role in the operation of modern vehicles. But in the future, it will become the defining characteristic of the personal transport revolution.

Over the last few decades, software has assumed an increasingly important role within vehicle design and construction, controlling everything from infotainment systems to engine performance and driving dynamics. Nevertheless, most manufacturers still differentiate on hardware – engine type, power and performance, trim levels, carrying capacity, design, and so on. This reflects a market in which the combustion engine is still king, vehicle ownership is the norm, and a large segment of buyers care about brand image. However, all of these accepted realities are about to be challenged by:

- The rise of electric drivetrains that are easier to control and automate using software;
- A new generation of consumers who demand 'always on' connectivity to information via the Internet, and for whom vehicles are a source of convenient, short-term mobility;
- The increasing importance of a software-defined user experience that will become the key driver of differentiation for automotive vendors.

These trends will have a truly revolutionary impact on the automotive industry. Differentiation between competing fuel sources, engine types and power outputs will become irrelevant. Future generations will care less about brand heritage and more about the experience they receive in the vehicle – regardless of whether a person or a computer is driving.

Today's automotive manufacturers – perhaps facing the additional threat of aggressive competition from completely new

players from outside the industry, such as Google or Apple – will need to define themselves more as lifestyle enablers and service providers, and less as engineers and OEMs. Perhaps they will even collaborate to create innovative hybrid brands that combine the best of the automotive and high-technology worlds to deliver novel user (not necessarily owner or driver) experiences.

No matter how the market rearranges itself, one thing is certain: Software solutions will drive the required transformation. Importantly, success won't simply be a case of having the best software, or securing the most productive partnerships. It will require the ability to continuously adapt services and experiences to vehicle users according to their changing preferences and needs – especially because vehicles will increasingly be used by multiple drivers, each of whom will expect a tailored personal transport experience. That could mean anything from slower or faster acceleration, to a specific selection of infotainment applications. Enabling these options will require constant connection between users, vehicles, manufacturers, workshops, dealerships and technology vendors, among others.

The most efficient, scalable and cost-effective way of enabling this brave new automotive world is to share software-generated data and intelligence between the vehicle, the user and vendors via the cloud. VMware and the EMC Federation have the necessary platforms, tools and expertise to help automotive manufacturers achieve this, and reinvent themselves for the coming connected car era.

PERSONAL MOBILITY, REINVENTED

Today, vehicle personalization is about online configurators and exclusive options programs – the focus is on physical features, from unique paint finishes to different grades of leather upholstery, extra horsepower or bespoke alloy wheels. However, future generations will consume a vehicle less as a personality extension or status symbol, and more as a personal mobility service. In this new era, software will differentiate the customer experience much more meaningfully than the physical attributes of the vehicle, as electric power democratizes performance and automation removes the need for a human driver. At the same time, the rising cost of accommodation in growing urban hubs will mean purchasing a vehicle makes less sense for many people. As a result, ever-larger numbers of consumers will tend to be vehicle users, rather than owners or drivers. So, how will this affect vehicle personalization?

Software will provide consumers with a broader range of experiences, either preconfigured or self-defined – regardless of whether or not they own or drive the vehicle themselves. Everything from driving modes and power



delivery, to entertainment and information services, will be configurable on demand with a few touches, gestures or spoken words.

Manufacturers will leverage this software to deliver new services proactively, with data generated by the vehicle used to drive everything from maintenance and update scheduling, to application delivery or pre-sales and marketing communications – all with minimum effort for the customer.

VMware and the EMC Federation can provide the intelligent data hub and secure network for integrating and managing all of these new services. The result: a new kind of flexible, personalized mobility experience, brought to life by the right combination of cloud- and vehicle-based technologies.

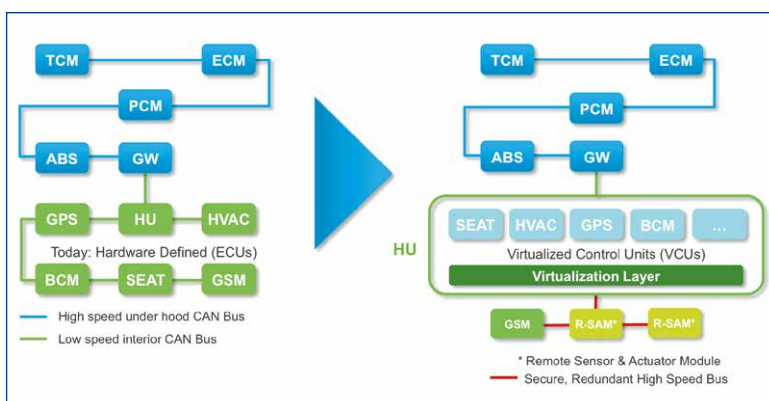
REDUCING THE RISK OF COMPLEXITY

Complexity in modern vehicles is a major source of cost, inefficiency and risk for manufacturers. For example, producing different busses and installing hundreds of ECUs in every vehicle is extremely time consuming and expensive. Long, complex configuration-specific testing processes delay time-to-market. And software faults that must be repaired manually because there is no space or capacity for fault tolerance to be built in to the vehicle, create additional cost and risk.

Fortunately, a solution is in sight: Replacing multiple ECUs with virtual ones (VCUs) hosted on the vehicle head unit, which then becomes a master control unit or MCU. This greatly reduces the cost of development, testing and manufacturing.

In addition, this virtualized environment can be used to test software updates and vehicle behavior anonymously during real-world journeys, and relay information back to a cloud-based data collection and analysis platform. As a result, software updates will only be deployed operationally when they have been perfected through real-world testing. This minimizes the potential risk and cost of a faulty update for manufacturers, and ensures the customer experience is not disrupted.

VMware and the EMC Federation offer scalable ways of collecting, transmitting, storing, analyzing and utilizing the data required to support this vision, as well as coordinating over-the-air delivery of the required updates.



BEYOND SELLING UNITS

During the 21st century, the business models relied upon by vehicle manufacturers for decades – selling units and maintenance services through dealerships, differentiating on brand heritage, generating profits through financing, etc. – will be challenged and then replaced. There are a number of key drivers behind this trend.

For example, the rise of electric vehicles will mean greater reliability, fewer moving parts and almost zero physical maintenance. Future generations of drivers will care less about heritage and ownership, and more about having access to convenient, connected and personalized

mobility services. And driverless cars will reduce the significance of the vehicle's external image, and increase the importance of the internal experience. New services and applications, and the ability to transfer personalized settings between vehicles, will be key to enabling an optimal and variable experience, fuelled by the enormous and constantly growing volume of data generated by vehicles and drivers.

Automotive OEMs need to be able to capture and make sense of this data in order to create the services, applications and offers demanded by the next generation of consumers, and communicate them in a personalized and consistent way across multiple channels.

VMware and the EMC Federation provide the scalable, intelligent big data collection and analysis platforms to support manufacturers in devising new business models from the wide range of opportunities generated by the connected car.



THE FAST ROUTE TO CONNECTED CAR COMPETITIVENESS

For many years, the complexity of the vehicle E/E architecture has kept vehicle and service development in the slow lane, because of the testing effort involved: every single possible configuration of hardware has to be tested separately for every model, which takes months or even years.

If your competitors have the same issue, the risk of being at a competitive disadvantage is small. However, as software increasingly defines vehicle characteristics, manufacturers have an opportunity to accelerate time-to-market by eliminating complexity, and streamlining testing and service development processes. The question is: How?

The answer is to radically simplify and virtualize the control systems in the vehicle so that testing and new service development become permanent, efficient



processes, continuously informed by vehicle and user-generated data. The same software-driven architecture can be used in every vehicle. And that means a permanent end to the separate development of different electronic systems and applications for each vehicle range and model.

The manufacturers that are able to do this first will be one step ahead of their peers. VMware and the EMC Federation have the expertise and technology to help OEMs realize this advantage.

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:

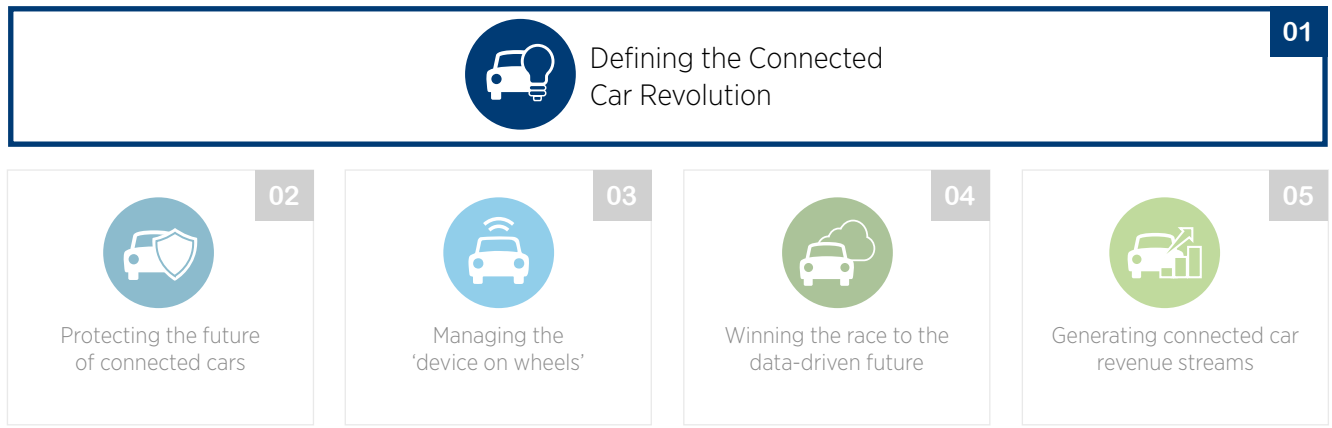
01 Vision: Powering new automotive business models through the secure and efficient sharing of data and intelligence between vehicles, users and vendors via the cloud.

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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About VMware

VMware is a leader in cloud infrastructure and business mobility. Built on VMware's industry-leading virtualization technology, our solutions deliver a brave new model of IT that is fluid, instant and more secure. Customers can innovate faster by rapidly developing, automatically delivering and more safely consuming any application. With 2014 revenues of \$6 billion, VMware has more than 500,000 customers and 75,000 partners. The company is headquartered in Silicon Valley with offices throughout the world and can be found online at www.vmware.com.



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