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Change in Management: BMW Group Technology Office USA.

Innovation Center in Silicon Valley.

Mountain View / California. Effective September 1, 2011, Dr. Dirk Rossberg will become the new head of the BMW Group Technology Office USA in Mountain View, California. He succeeds Stephan Durach, who is returning to BMW AG in Munich after three years in the United States. On his return, Stefan will head the BMW Group Entertainment and Mobile Devices Department.

"I feel privileged to have spent time here and am delighted that we were able to implement some key changes during my tenure in Mountain View. An example of this innovative change was the quick series integration of the Pandora App into BMW's Connected Drive BMW Apps and MINI Connected options.," commented Stephan Durach as he reflected on his achievements (Pandora is a leading on-demand music service in the USA). "I'm now looking forward to taking on new challenges with series development in Munich – I'm definitely in a position to transfer a wealth of experience from the Technology Office."

Stephan Durach received a degree in electrical engineering from the University of Karlsruhe. In January 1998, he launched his career at the BMW Group in software development. Before he moved to the USA in 2008, he headed the team for display control concepts. Leading magazine "Fast Company" voted Stephan Durach one of the "100 most creative people in business" in 2011 (<http://www.fastcompany.com/most-creative-people/2011/stephan-durach-bmw>).

"Silicon Valley offers a unique environment for integrating new technologies into vehicles as fast as possible," is how Dirk Rossberg evaluated his new working environment. "Where else can you find market-leaders from an immensely wide range of sectors, outstanding universities, innovative start-up companies, as well as venture capitalists and business analysts in such a small area? They empower us to identify the trends of tomorrow. I'm looking forward to addressing lots of exciting issues and working together with my highly committed team," enthused the new leader of the Tech Office.

Dirk Rossberg received a degree in electrical engineering from Munich Technical University, majoring in gas and fluid sensors. He began his career at BMW in 1997. His most recent position involved heading the departments for driver assistance systems and infotainment platforms, where he succeeded in rolling out a large number of innovations in series production over a very short timeframe.

The BMW Group opened its Technology Office in Palo Alto, Silicon Valley in 1998. When the team moved to Mountain View and a bigger office complex in 2011, the BMW Group Technology Office USA gained many new opportunities for exploiting new technologies, including an autonomous infrastructure in electromobility.

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More on the BMW Group Technology Office USA.

The start-up mentality typical for the area offers the small, dynamic team the opportunity to work efficiently and the capability to respond to the latest innovations. Trends are identified and evaluated. If the idea cannot be implemented in a specific project, the team moves on and focuses on the “next big thing”. However, if the technology looks promising, a prototype is initially modelled and then transferred via the product development process to series development.

The teams are currently carrying out intensive research into the following areas:

- **Trends and technology.** Trend scouting forms the overall framework for all projects. The idea is to track down trends emerging from companies of all sizes and across various disciplines. After an evaluation has been carried out, a joint discussion is held to decide whether or not the technology can be integrated within the vehicle. If this is the case, a joint venture is launched with the partner company.
- **Sustainable mobility.** Innovative technologies for improved fuel efficiency of conventional cars, and alternative fuels, like hydrogen, along with electrification are all part of BMW's future product strategy. Electric vehicles, smart grid, sustainable energy and mobility services are currently in focus at the BMW Technology Office.
- **The car as an open platform.** Smart phones and their applications are becoming increasingly integrated within our daily routine. Interfaces can transform the car into a communication link and provide drivers with safe, fast and easy access to web services while they are driving.
- **Cloud Computing – always online.** Vehicles that can predict the traffic-light phases? Motorcycles that automatically gather information about road conditions? When vehicles are connected to a network of their surroundings new horizons are opened. Driving environment information can reduce the volume of traffic in major cities, protect against safety risks and promote more environmentally aware and comfortable mobility.

Current projects at the Technology Office.**1. In collaboration with universities – Dasher App and MINI StreetLog.**

The BMW Group Technology Office USA works closely together with local universities like Stanford University, the University of Southern California and the University of California at Davis. For a number of years the Tech Office and the departments for Mechanical Engineering, Design and Computer Science at Stanford University, one of the world's most prestigious universities, have partnered to offer students an opportunity to work on projects with BMW. Similar

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to the situation in a start-up company, the students initially develop their own ideas and proposals for a solution to a problem defined by BMW. This process teaches the students about entrepreneurial approaches and provides the BMW Group with stimuli and creative initiatives. Recent years have witnessed this process yield concept ideas and new initiatives generating solutions for a reinterpretation of the BMW iDrive rotary/pushbutton device as a joystick and solutions for simple, safe and weatherproof integration of mobile devices in the Combi Instrument of motorcycles.

Progression of project work.

After the first project briefing, the students operate in the same way as a small company. As is commonplace in Silicon Valley, the concept ideas are initially presented to a group of venture capitalists who provide the students with valuable feedback.

Ideas are then refined with the BMW Team at weekly meetings and ultimately one concrete solution is selected to be made into a prototype. The students are given access to test vehicles and development software. The current focus of the program is based on MINI Connected and revolves around the integration of smart phone applications in the vehicle – “Dasher” and “MINI StreetLog”.

Dasher App and MINI StreetLog.

Dasher was developed by a student team in 2010 to provide a video-based trip log. The iPhone is fixed in a special holder on the dashboard and connected to the vehicle. After the App has been activated, the camera in the smartphone records the road and displays the journey. The link with the vehicle also displays vehicle data like gear, speed, engine speed and position of the steering wheel. After the journey, the route taken can be replayed with the vehicle data overlayed and in sync with the video. The journey can then be replayed again at a later point for various purposes like driver training.

The current project MINI StreetLog is based on Dasher and expands the app with crowd sourcing functionality. Crowd sourcing is a trend in many areas of application development and describes the collection of information about lots of individual users in order to gain an overall picture of a situation which can then be made available to individual users. The MINI StreetLog project involves the camera of each individual iPhone recording the traffic-light phases and sending them to a central server which stores the information about all the recorded signal phases. The large number of users enables a database to be created that summarises the traffic-light information from all the journeys and redistributes it to everyone according to location. This information can be displayed in the vehicle using the smart phone. The driver then knows, for example, the number of seconds before the next traffic light will turn red or how long the lights will still be green. This information can assist a driver in optimally adjusting their speed profile to the phases of the traffic lights and therefore drive more safely and more efficiently in terms of fuel. This solution supplements the “Smart Cruising” research project where the vehicle provides drivers with information about the phases of the traffic lights for the same purpose – but based on traffic-

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management data.

2. Smart Cars meet Smart Traffic Lights. Intelligent communication between traffic lights and vehicle.

Anyone driving a car in urban settings uses far more fuel than when they are driving on a rural road or highway. This is mainly due to the acceleration and braking caused by cross-roads and traffic lights. Optimising this stop-and-go traffic flow while at the same time reducing fuel consumption, CO2 emissions and noise is the aim of the research project “Smart Cars meet Smart Traffic Lights”.

New solution for transferring data.

The BMW Technology Office USA is working on the project “Smart Cars meet Smart Traffic Lights” to develop a pragmatic and cost-effective solution for communication between vehicle and traffic lights. The developers are working on interaction between fourth-generation mobile wireless networks and established traffic management systems. This allows important information about traffic-light phases to be transferred to the car using BMW ConnectedDrive. Using the same infrastructure, vehicle data can also be transferred back to the traffic-management system.

This system enables BMW EfficientDynamics features like Auto Start-Stop to be used more effectively. Drivers can also adjust their speed to the traffic-light phases on the basis of this information or leave it to active speed regulation with “Smart Cruising”. The speed profile calculated enables the vehicle to use the information about any a green phase in a series of traffic lights and travel with minimum fuel consumption in urban traffic.

More than just the green.

“Smart Cars meet Smart Traffic Lights” research is being carried out in cooperation with a government sponsored research project being run by the US Department of Transportation. The project “Advanced Traffic Signal Control Algorithms” involves the BMW Group Technology Office USA working together with the PATH Program of the University of California Berkeley and the University of California Riverside. The team at the Tech Office and partner universities are researching the options for improving traffic flow in inner-city areas by analysing network information gathered from vehicles.

3. Always Connected Motorcycle.

The developers at the BMW Group Technology Office USA are addressing the possibilities of linking motorcycles communications in the research project entitled “Always Connected Motorcycle”. Integration and use of a data link for a

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motorcycle presents many unique challenges. Motorcyclists always need to keep their eyes on the road, the options for display are restricted, available installation space is severely constrained and communications channels need to be operational even in remote areas. The developers therefore opted for a direct satellite link because this is available all over the world.

“Safety First”.

Safety is the main focus of all motorcycle riders and is therefore the primary interest of the BMW Group. In the goal of safety, an emergency button was developed. As soon as it has been triggered, the location is forwarded automatically via the satellite communications link to a server where appropriate an response can be dispatched.

“Social safety functions” were also developed, including the “Crowd Sourcing Road Hazard System” allowing riders to highlight hazards to each other. Conditions like loose pavement on the road or pot holes constitute a hazard for motorcyclists. The innovative system permits alerts and warnings about hazardous circumstances to be issued to other motorcycle riders. When motorcyclists pass a dangerous hazard on the road, they use the satellite link to post a warning alert. The rider can select between four preset warnings for fast and maximally easy operation without entailing any distraction and then post the warning at the touch of a button. A server then registers the type of warning and pinpoints the location of the hazard with GPS data. If other users of the system ride close to the area of the hazard, they are warned in good time.

The “Group Rider Function” is another social safety function where riders can register temporarily as part of a group. Each group member can then see on a map where the other group members are located and join up with the group. The system can also check the distance between each of the group members. If a member of the group leaves a defined radius, the other group members are notified. The system also allows short, predefined messages to be sent within the group, such as a suggestion to stop.

4. Open the car as a platform.

The BMW Group is the first company worldwide to offer application-based and comprehensive integration of the Apple iPhone in vehicles with MINI Connected since 2010 and in BMW vehicles since March 2011. This provides a completely new in-car entertainment experience. Functions like Google™ Local Search, Facebook and Twitter make the vehicle a fully integrated part of the digital and networked world of the driver. The latest development step sees the BMW Group using the technical possibilities of MINI Connected and BMW Apps as a platform for integrating additional services and functions of other providers. This approach highlights its leading position for integrating mobile devices in vehicles.

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A platform with boundless opportunities.

The current version of MINI Connected already offers ten different functions. But it's not going to stop there. The BMW Group is already cooperating with other premium infotainment providers to make their services available in the vehicle. The popular and free web radio service Pandora has been exclusively available in the USA for the first time as an App with BMW and MINI Connected, coming onstream in January 2011 for the MINI and in April 2011 for BMW. This makes music streaming and an individual account with all favourites lists and cherished stations also available in the car. The Pandora App is only the first step. Other partners and new services and applications will follow in the future.

Expandable flexibly and fast.

The developers at the BMW Group have created a very flexible platform with the applications-based implementation of MINI and BMW Connected. This allows new functions from the infotainment world to be quickly incorporated in the vehicle. New functions can be easily transferred by an update of the Apps in the vehicle – without the need for any changes to be made in the vehicle itself. The close proximity of the BMW Group Technology Office USA to Silicon Valley – the innovative citadel of the entertainment electronics sector – and the close cooperation with partner companies ensure a high level of innovation for future functions and services. In the past, this proximity has also helped to make BMW the world's first automotive manufacturer to achieve integration of the Apple iPod in the audio system of its vehicles as early as 2004. And the BMW Group was again ahead of the game in presenting the first exclusive technology solution for integrating the iPhone in vehicle infotainment systems in 2007.

Additionally since March 2011 with the introduction of Plug-In, the familiar iPod operating interface is being displayed and operated on the car monitor. Plug-In directly uses the iPod function of the iPhone. Therefore the BMW customer also has access to all extensions like Genius mixes in the vehicle. That allows the driver to automatically create playlists from songs of his media library that harmonize well together. All saved playlists are being displayed with the original album covers – just like on a iPhone or iPod.

5. Passenger entertainment with the Apple iPad.

The market launch of the Apple iPad started a revolution in the market for mobile devices. It created a new product category and also an array of attractive options for using this. The BMW Group Technology Office USA is working on providing the customer with a maximally seamless integration of the iPad in an entertainment package for passengers. The Tech Office is working on a concept which will allow passengers to call up information on the current vehicle status or experience the technical details of the car in the electronic manual. Integrating the iPad into the car's infrastructure also provides all the car's occupants with a shared infotainment experience. For example, music tracks can

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be played with Bluetooth audiostreaming over the car's audio system or a new destination can be entered in the navigation system.

BMW ConnectedDrive: networking the digital lifestyle worlds of the customer.

Linking up the iPad offers other opportunities for passengers to interact with the car in the future that extend beyond our package of passenger entertainment. Similar to other BMW ConnectedDrive Services already available, like Google Send to Car or the functional scope offered by the remote functions, the iPad also provides customers with an integrative interface outside the vehicle. This allows the customer to send navigation destinations from the iPad to the vehicle or call up information on the status of the vehicle from outside the car. This seamless networking of the iPad with the car represents a logical implementation of the vision espoused by BMW ConnectedDrive. This positions the car as part of the digital lifestyle world of the customer.

6. Robotics: Cooperation on open platforms.

A new research initiative by the BMW Group Technology Office USA is promoting an open developer platform (Open Source) in robotics. The Tech Office is making an Open Robotics Research Vehicle available for this initiative. This is a hardware platform that facilitates cooperation and development on multisensor perception and intelligent control systems. "Safety, efficiency and comfort features are already well established in the automotive industry. However, there is still a great deal of potential for driving the state of the art forward by promoting the robotic community," explains Darren Liccardo, Research Engineer at BMW Group Technology Office USA.

There is a strong community of robotics researchers in academia and private industry sectors who use Robotic Open Source (ROS). The BMW Group intends to increase its participation in this community with the aim of developing future safety and driver assistance systems. The Tech Office is providing a vehicle for this open cooperation in the interests of efficient research. "Open platforms allow in-house and cross-sector objectives to be pursued," according to Liccardo. The robotics team recently launched the research initiative with the Stereo Vision Algorithms project using ROS and OpenCV. These are Open Source Software Systems that have been proactively developed by scientists and industrial robotics researchers. "On the basis of open-platform programs, we can now present the first initiatives relating to the surroundings of the vehicle," comments Liccardo.

The BMW Group Technology Office USA would like to bring together automobile manufacturers and suppliers, academic research and diverse other industries, with the aim of achieving joint goals with the assistance of the Open Robotics Research Vehicle. The next generation of driver assisted systems is

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likely to also have complex automated functions requiring a deep level of integration. Open cooperation is the best way of achieving this goal.

7. Focus on sustainable mobility.

The relocation of the BMW Group Technology Office USA from Palo Alto to a larger space in Mountain View allows the BMW Group to consolidate research activities on electromobility in the US. "We now have more space available and this enables us to address all the multifaceted areas of electromobility," explains Stephan Durach, Head of the Technology Office USA. In 2011, the BMW Group will be building infrastructure in Mountain View that permits the demonstration of the entire electric mobility ecosystem. The integration of renewable energy generation, electric energy storage and vehicle charging will be the most visible features of this new research environment in Mountain View. Joining forces with partners from industry, government and academia will facilitate the BMW Technology Office's development of even more efficient and innovative sustainable mobility solutions. The new electromobility lab will provide insights into how a real-world ecosystem might develop.

Insight into the entire life cycle.

Starting with the generation of electricity using a solar photovoltaic array, engineers in the BMW Group Technology Office USA will carry out research on electric vehicle charging and use. They will also look beyond the plug. Their latest research projects are looking into the smart grid and intelligent charging. For example, they are investigating how charging can be coupled with wind or solar energy generation, or how vehicle communication with electric utilities can provide grid benefits. BMW ActiveE will be playing a key role in these research projects because it offers a wide range of initiatives for future developments and is therefore the ideal work platform. It has a telematics interface which provides drivers with wireless communication to the vehicle, even when they are not sitting in it. Engineers are working intensively on demonstrating a variety of communication pathways to the vehicle and are continuing to play a proactive role in driving forward the remotely controlled functions of the vehicle, such as the Smartphone control of charging that is already available.

The specialists at the BMW Group Technology Office are also looking into the recycling and re use strategies for an electric vehicle. For example, they are thinking about how the batteries can be re-used after they have finished their service life in the vehicle. Even if they are no longer suitable for use in the vehicle, they may still have sufficient capacity for other purposes. The use of battery systems as home or community energy storage devices is being examined, in order to facilitate the fast charge of an electric vehicle or to store renewable electricity.

Research in the network.

Projects beyond this infrastructure are also taking place, with universities and other external partners playing an important role. For example, the user study on

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the MINI E, which was recently completed together with the University of California at Davis, demonstrated that the MINI E was able to cover 90 percent of the mobility needs of its users. Another important finding of the user study was that participants underwent a remarkable change in awareness of energy and mastery of energy use as they used the MINI E more. They changed their driving behaviour to increase fuel efficiency and acted more sustainably outside of the car as well. Some customers invested in solar to power their homes. The BMW Group is currently carrying out research into this phenomenon in the "Green electricity valuation study" in cooperation with UC Davis. The BMW Group is expecting further important findings and initiatives from this research to inform future product and service offerings in the area of electromobility. Because for the BMW Group sustainability – and therefore also electromobility with regard to the whole value chain – is a crucial strategic success factor.

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The BMW Group

The BMW Group is one of the most successful manufacturers of automobiles and motorcycles in the world with its BMW, MINI and Rolls-Royce brands. As a global company, the BMW Group operates 25 production and assembly facilities in 14 countries and has a global sales network in more than 140 countries.

During the financial year 2010, the BMW Group sold 1.46 million cars and more than 110,000 motorcycles worldwide. The profit before tax for 2010 was euro 4.8 billion on revenues amounting to euro 60.5 billion. At 31 December 2010, the BMW Group had a workforce of approximately 95,500 employees.

The success of the BMW Group has always been built on long-term thinking and responsible action. The company has therefore established ecological and social sustainability throughout the value chain, comprehensive product responsibility and a clear commitment to conserving resources as an integral part of its strategy. As a result of its efforts, the BMW Group has been ranked industry leader in the Dow Jones Sustainability Indexes for the last six years.