

BMW at the Consumer Electronics Show (CES) 2016 in Las Vegas. Table of Contents.



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1. BMW innovations at the CES 2016 in Las Vegas. Highlights.

- BMW Group at the Consumer Electronics Show 2016 (CES, 6 to 9 January 2016 in Las Vegas). Impressive exhibition profile highlights leading position in the area of Connected Car.
- **BMW i Vision Future Interaction** – Concept Car provides an outlook on the networked cockpit and the user interface of the future.
- BMW i Vision Future Interaction with high-resolution vehicle displays whose content adjusts to match the situation; function control with gestures, touch-sensitive surfaces and voice control.
- Information for the driver through head-up display, instrument cluster with three-dimensional display and 21-inch panorama display.
- BMW i Vision Future Interaction with world premiere of AirTouch: sensors recognise movements made with the hand and also depth movements. This means that the panorama display can be operated like a touchscreen without having to actually touch the surface.
- Reduction of control elements to a minimum. Three drive modes – Pure Drive (driving yourself), Assist (assistance systems intervene actively) and Auto Mode (highly automated operation) – selectable at the steering wheel.
- **Internet of Things** stands for even more comprehensive networking which facilitates new services for more efficiency and comfort.
- The intelligent Open Mobility Cloud of the BMW Group connects networked systems such as a BMW i3 and a Smart Home with personal end devices like smart phone or smart watch.
- The Open Mobility Cloud networks the correct information and functions, and uses intelligent control to allow complex processes to be started automatically, without their being requested or having to be initiated with an app.

- Users are provided with predictive information relevant to them personally by networking with the Open Mobility Cloud.
- Mobility Mirror – mirror and display medium at the same time, component of the Internet of Things networked using the Open Mobility Cloud.
- Important information for the day is shown in the Mobility Mirror display, such as personal calendar, mobility options, energy status of the smart home, charge status of the BMW i3, weather forecast.
- Gesture Control Parking: The BMW i3 recognises gestures, and drives into and out of a parking space fully automatically.
- Remote 3D View: The research application uses the cameras in the BMW i3 as constituent elements of the Internet of Things. The images taken by the cameras can be streamed to networked end devices and provide an overview of the area around the vehicle.
- Bumper Detect uses an innovative system, identifies whether the driver's own vehicle being parked has been bumped and activates the vehicle cameras. The networked systems at the same time send a message to the driver's smart phone, and images are sent if requested.
- Bumper Detect also recognises whether unauthorised persons are tampering with the vehicle and sends images to the networked mobile end devices.
- **BMW Connected** is a prototype of a personalised digital assistant for individual mobility. The focus is on the needs and requirements for mobility of the future.
- BMW Connected and the Open Mobility Cloud represent a radical new conceptual approach to mobility. BMW Connected is available all the time on all networked end devices: at home, on foot or on the move in the user's own vehicle, or on public transport.
- The platform for BMW Connected is the Open Mobility Cloud with a highly flexible service architecture.
- The Open Mobility Cloud offers far-reaching capabilities for machine learning and data analysis. The more frequently users make use of the digital services, the more effectively they can be personalised.

- Information relevant to the user is always provided at the right time. BMW Connected learns, for example, routes which are taken on a regular basis and proactively informs the user if any disruption is expected along the route.
- **BMW ConnectedRide** – Motorcycle laser light in the BMW K1600 GTL concept vehicle with a range of 600 metres for main beam.
- Head-up Display helmet projects necessary or requested traffic and vehicle information directly into the visual field of the driver
- **Future Mobility Solutions: Light & Charge** – simultaneously innovative street lighting with LED technology and charging station for charging the high-voltage batteries of electric vehicles.
- Standardised connection for charging cable from electric vehicles including vehicles from other manufacturers, cashless payment. Vehicle start using the smart phone app or RFID card.
- **BMW i 8 Mirrorless** – System with three cameras replaces the rearview mirror, covers larger viewing angles and eliminates dangerous “blind spots”.
- Images from the cameras are united on a display which replaces the interior mirror. Presets for the camera or display are not necessary.
- System evaluates camera images and provides a situative response to imminent hazards, for example with yellow warning icons.
- Superimposed trajectory lines provide support during parking, and the passenger can also observe the traffic behind the vehicle.
- **BMW i3 Extended Rearview Mirror** links up mirror and camera technology. In the interior mirror, the mirror view is overlaid with very precise images from a camera positioned on the roof. This provides a significantly extended field of view.
- **New control concepts from BMW:** BMW gesture control in the new BMW 7 Series for controlling information, entertainment and communication functions.
- New control freedom for rear-seat passengers with BMW Touch Command.

2. BMW i Vision Future Interaction. Outlook on the networked cockpit.

Vehicles with highly automated driving are an important milestone on the road to Vision Zero, the idea of accident-free individual mobility. This increases the aspirations of drivers for the user friendliness of vehicles, for the presentation of information and for digital networking of the information. Occupants are increasingly also wanting to communicate with the outside world supported by unrestricted quality and in the scope they are normally accustomed to. At the CES 2016, the BMW Group is using the Concept Car BMW i Vision Future Interaction to show what the user interface of the future might look like – including support from high-resolution vehicle displays where the content responds to the situation. In order to make the interaction of the passengers with the vehicle as intuitive as possible, all functions are controlled using touch-sensitive surfaces, gestures and voice.

Interior compartment responds flexibly to the demands of the future.

The Vision Car is based on the BMW i8 Concept Spyder. The interior has a thoroughbred, sporty and flexible profile. On the one hand, it supports the driver in manual driving mode with a clearly defined focus. On the other hand, when the vehicle is in its highly automated mode, the interior provides an opportunity to relax in the innovatively designed seats and to make proactive use of the time gained through the expanded content available on the central information display. Just as the vehicle adjusts automatically to drive mode and the surrounding environment, the digital content is optimally presented at any given time. Drivers look at data such as the charge status of the vehicle batteries or the routes offered before commencing the journey on their smart phone, smart watch or Mobility Mirror. These are then automatically transferred to the appropriate menus, map displays and driver information on the panorama display in the BMW i Vision Future Interaction. The transition from mobile device to display in the vehicle takes place seamlessly.

Innovative instruments, panorama displays, 3D views.

The BMW i Vision Future Interaction has a Head-Up Display, an instrument cluster with three-dimensional display, and a 21-inch panorama display which extends over almost the entire passenger side.

The driver receives key drive information on the high-resolution Head-Up Display, which reflects the most important data such as speed, speed limits or navigation information within the field of vision on the front windscreen. The

instrument cluster is located directly behind the steering wheel and information is shown here in three-dimensional display (autostereoscopically). As well as the usual information about speed, consumption and range, the driver is also provided with information here about vehicles on the road ahead or oncoming vehicles which are not yet in his or her field of vision. The driver is consequently able to respond at an early stage to all conceivable traffic situations. This also applies during highly automated driving. If the driver needs to take over command of the vehicle, the system provides an appropriate alert. The technology acts predictively so that the driver has at least five to seven seconds to respond.

Information prepared to suit the situation

The central panorama display is the most striking interaction element of the BMW i Vision Future Interaction. It extends from the centre console across the entire passenger side and appears to flow harmoniously out of the dashboard panel. The display height of eleven centimetres means that the dashboard panel is not higher than in the BMW i8 and it permits an optimum view to the front of the vehicle. The high-resolution panorama display in the BMW i Vision Future Interaction is almost 40 centimetres wide while the screen diagonal is 21 inches.

When the driver gets into the vehicle, this panorama seamlessly displays the content which is provided by the vision of the Open Mobility Cloud from BMW and it can also be seen automatically using the BMW Connected App on a smart phone or other digital end devices. The display adjusts automatically, in response to the drive mode of the BMW i Vision Future Interaction. In future, for example, the system could switch automatically from pure audio to video transmission during phone conversations, if vehicles are driving in fully automated mode. Drivers and passengers also have the option of unrestricted access to Web content, mails or audiovisual offerings.

While the driver remains active at the steering wheel, information in reduced scope is displayed on the large panorama display in order to minimise distraction and maintain the focus entirely on what is happening on the road.

The number of control elements is reduced to a minimum in the BMW i Vision Future Interaction. The most important of these elements – the drive mode selector switch – is located on the left-hand side of the steering wheel. This is used to select between the three drive modes. The “Pure Drive” mode meets the typical BMW high aspiration for sheer driving pleasure at all times. Assistance systems are used passively here and they only give warning alerts without actually intervening in the control of the vehicle. The “Assist” setting provides optimum networking with the surrounding environment. The best

route is calculated in real time and fed into the navigation system. The vehicle supports the driving performance of the driver and intervenes actively if there is danger of an event such as a shunt accident, or if an obstacle on the road appears to be a safety risk. When the vehicle is in "Auto Mode", the vehicle itself takes over control of sideways and forward orientation, accelerates independently, brakes and steers – without the driver having to intervene at all. In the near future, this could already be permitted on certain approved stretches of road, for examples sections of German motorways or in Car Pool Lanes in the USA.

The BMW i Vision Future Interaction proactively gives drivers an alert if they are in a zone for highly automated driving. The driver can then change the drive mode as appropriate. The steering wheel is illuminated in blue in the highly automated drive mode. The colour scheme therefore provides a visual cue that the driver is in this drive mode. If the vehicle leaves the approved lane for highly automated driving and has to take control of the steering wheel again, a red light signal conveys this requirement. The BMW i Vision Future Interaction is therefore already providing an indication today of what the control functions might look like in the future in highly automated vehicles.

Interaction with AirTouch, sensitive surfaces and voice.

The development engineers are using new human-machine interfaces to control and select the content on the large panorama display, and this offers a large number of new options for interaction. One of them is AirTouch, gesture control for all communication, information and entertainment functions in the vehicle. It allows the big screen to be operated like a touchscreen – without actually having to touch it.

Sensors are installed in the area of the dashboard panel which responds to hand movements. A movement of the hand can be used to go to a position on the panorama display and the selected icon is highlighted visually. If the hand is moved forward (push gesture), the icon is activated or the menu displays the next level.

AirTouch has a second option for carrying out this confirm action. An AirTouch switch is located on the steering wheel which briefly illuminates if a menu or icon can be activated. A tap is sufficient to select the desired program in this way or to select a preset. There is also a similar button for the passenger located on the side panel. This enables passengers to use one hand to navigate through the menu and very quickly confirm inputs with the other hand.

The menus in AirTouch are not in the form of lists but appear as large tiles. Four of these tiles are located beside each other on the display. The system provides car occupants with context-sensitive option menus – for example, if music is currently running on a streaming service, buttons are displayed on one of the tiles that allow you to go forward or backwards to titles, stop playing or start again. The intelligent menu control of AirTouch reduces selection steps. AirTouch recognises which control steps are necessary next and shows these in the display. This allows the driver to concentrate on what is happening on the road or offers additional convenient control options if the vehicle is driving in highly automated mode.

Touch-sensitive surfaces in the wide and generously proportioned central console offer an additional control element. A sensitive control surface is provided beneath the leather upholstery which can be used by the driver or passenger in order to navigate through the menus or option lists by tapping, swiping or sliding movements – as in a smart phone or tablet. The entertainment and information systems in the BMW i Vision Future Interaction can also be conducted by spoken control commands, in other words by recognition of natural language.

The character of the interior changes depending on the drive mode.

If the driver changes to highly automated mode, the colour of the steering wheel is not the only thing that changes. When the vehicle takes over control, lots of additional space suddenly becomes available for the people inside. The steering wheel moves forward by several centimetres and this opens up more space. At the same time, the contoured, sculpted sports seat changes its character. Elements in the side upholstery give the seats a lounge profile which enables the driver to turn more to the right in order to look at the panorama display in a more relaxed position. The new freedom of movement is also supported by an extended headrest and the generously dimensioned central armrest.

The objective is to enable drivers to make relaxed and effective use of the freedoms offered by highly automated driving – and when drivers want to take the wheel themselves and enjoy sporty driving fun, the ideal enablers typical of BMW are provided in the ergonomic design of the seat and steering wheel. This extends through to support from vehicle technology which shows information like the ideal line or braking points on a selected stretch of road in the BMW Head-Up Display.

Open sportiness of the BMW i Vision Future Interaction.

The athletic design of the BMW i Vision Future Interaction reveals the qualities of an open two-seater which unites dynamic driving, efficiency and

visual elegance with a rather special aesthetic appeal. The Concept Car combines intelligent lightweight construction with the advanced drive technology of BMW eDrive. It is finished in the exterior colour of E-Copper Orange, with highlights being accented in Frozen Grey (kidney-shaped grille, tank cover and front and rear sills), and in high-gloss black below the entrance.

The BMW i Vision Future Interaction uses innovative LifeDrive architecture which is structured with separate function units that operate independently of each other. The Life Module made of carbon-fibre reinforced plastic (CFRP) forms the very lightweight passenger cell. Meanwhile the Drive Modules, which are primarily manufactured from aluminium – drive train, chassis and safety structure – take over the functions relevant for driving. The characteristic binary division of the LifeDrive concept is also reflected in the design and deliberately emphasises the basic elements. Highly expressive surfaces and precise lines create a harmonious transition from one module to another.

The headlamps designed with BMW laser light technology are a defining element at the front. They are configured in the u-shaped design of BMW i. The flat engine bonnet is styled with a V that opens up to the windscreen. It forms the starting point for the typical Black Belt, which continues on the rear cover and constitutes a characteristic feature of the BMW i models. The side view is defined by the short overhangs typical of BMW vehicles. They combine with the wedge shape of the sills to generate the athletic character – contours and lines create a sense of strong forward motion even when the vehicle is at rest. Similar to the front, the rear of the vehicle is flat, while a powerful rear diffuser, air vents in a three-dimensional design and the u-shaped tail lamps with LED technology give the impression of exceptional breadth to the BMW i Vision Future Interaction and define its sporting aspirations.

A top priority for designers was to integrate the architecture of the large panorama display into the basic concept of the interior design and to accommodate elements in the surface structure which are typical for BMW i vehicles. The instrument dashboard therefore has a structure which is comprised of overlaid pentagons and hexagons. This design is a hallmark of BMW i and is simultaneously a symbol for the seamless networking of the BMW i Vision Future Interaction.

The interior compartment is styled with a mix of colour and material made up of plastic, carbon and leather, which creates an aura of high quality, emotionality and thoroughbred pedigree. The seats are upholstered in leather amido and textile, and a leather core made of natural leather. The same

leather is also used on the dashboard, combined with a monofilament technical textile which also provides the floor covering for the BMW i Vision Future Interaction. Dark leather amido is combined with semi-aniline leather in Ice Grey to cover the central console. Buttons on the steering wheel made of polished aluminium emphasise the high-tech character of the BMW i Vision Future Interaction.

3. Internet of Things. **Comprehensive networking permits new services for more efficiency and comfort.**

The BMW Group ranks among the leading vehicle manufacturers when it comes to networking driver, vehicle and environment. Today, apps already provide many different opportunities to make use of digital living environments from the interior of the vehicle. At the CES 2016 in Las Vegas, the BMW Group is providing an insight into the future of networked mobility. The Internet of Things is increasingly leaving the computer in the background and is instead connecting the things in our daily lives which can be equipped with new “smart” functions owing to the installed computing capacities. In order to make the vision of BMW Connected become a reality, a highly flexible service architecture is necessary – the Open Mobility Cloud. It links up networked systems such as the BMW i3 and the smart home with various personal end devices such as the smart phone or smart watch. This configuration enables the Open Mobility Cloud to provide automated control of complex processes which are in tune with the needs of users, without their having to be requested individually or started using an app. The Internet of Things is creating completely new, innovative functions which make daily life easier.

How networked systems simplify the routine of daily life.

At the CES 2016, the BMW Group is presenting a typical everyday situation in a Smart Home with a BMW i3 as the vehicle. The Smart Home and the BMW i3 together become constituent networked elements of the Internet of Things. All relevant information is therefore available at any time. The example of the daily routine is used to demonstrate how the areas of home/lifestyle and mobility are connected up using the Open Mobility Cloud. Functions can start up and run automatically at the right time and at the right place, and they can also influence each other at the same time.

The presentation in Las Vegas shows how the everyday routine already changes in the morning. An intelligent mirror is hanging in the hallway which links up the personal diary schedule and the different end devices of the user. Apart from the mirror image, the Mobility Mirror also displays information which is adjusted to the user’s current situation and their personal routines, appointments and tasks. The Mobility Mirror is networked with the Smart Home and through the Open Mobility Cloud also with the BMW i3. It therefore combines all the necessary information around the area of mobility and home/lifestyle in the Smart Home. Appropriate information for the entire day is displayed on the surface of the mirror: for example, before the start of a

journey the charge status of the BMW i3, which has been charging up overnight in the garage. BMW Connected also enables the Mobility Agenda with appointments including available mobility options displayed on the basis of the current traffic situation (Real Time Traffic information). Personal preferences, appropriate recommended departure times and other relevant information for the trip such as weather are also provided. If errands that have to be run can be integrated in the selected route and the day's commitments – such as shopping or taking the children to school – these are also integrated. Predictive information that is relevant to the user is made available and complex functions are accepted through BMW Connected. Networking through the Open Mobility Cloud responds to the needs of users and frees up time for them to concentrate on the issues that have prime importance for them.

The intelligence of the Open Mobility Cloud links up the right information and functions.

The user experiences the networking mechanisms as seamless not least because alongside the digital agenda, routine actions also trigger follow-on actions which take place for the convenience of the user at exactly the right time. The intelligence of the networked systems also identifies the step the user has to carry out next. At the CES, the BMW Group demonstrates a number of features including how the BMW i3 drives out of the garage entirely automatically as soon as the vehicle is required for the mobility option and the vehicle key has been picked up to leave.

The system also responds dynamically to the changing needs of the user. For example, if one of the other mobility options offered in the mirror – such as DriveNow, the motorcycle or public transport – is selected, departure and arrival times are adjusted automatically to match the relevant information for the means of transport and this information is then integrated in the personal Mobility Agenda. Networking with the Open Mobility Cloud controls these processes in such a way that the functions of daily life are carried out automatically, and exactly when they are necessary – triggered by the personal digital agenda or by typical actions which allow conclusions to be drawn about what the user is likely to want to do next.

Mobility Mirror – view of the daily routine at any time.

The Mobility Mirror is a mirror and a display medium with a high-resolution display. The personal calendar is displayed here in accordance with the current situation. It shows the available mobility options for a day including the relevant departure and arrival times. Data from the Smart Home is also visible at a glance. For example, it indicates whether the doors or windows are closed, when the light is being switched on and off automatically, and whether

the alarm system is being activated. It also shows the current energy status of the house. As soon as the BMW i3 starts to move fully automatically, triggered by the Mobility Agenda because the key has been picked up, cameras installed in the vehicle transmit images by means of BMWConnected to the mirror. The user can then follow the parking procedure on the Mobility Mirror as necessary. The possible charging options for the BMW i3 are also displayed and automatically preselected on the basis of the most effective option in the light of personal appointments. The BMW i charging services offer a selection of three charge options: Smart Solar, Off-Peak Charging and Immediate Charging. Smart Solar optimises the charging procedure in relation to maximum use of self-generated and stored solar energy from the BMW i home storage system. Off-Peak Charging selects the charge times so that electricity is extracted at the most favourable tariff time. Immediate Charging recharges the batteries as quickly as possible. If there are no imminent appointments, the Mobility Mirror fulfils its primary function as an ordinary mirror and provides a brief overview of the most important data for the personal Mobility Agenda on the vehicle and the house. This reduction to the main content can naturally be obtained manually by the user at any time.

AirTouch is a new form of gesture control which is used in a similar form in the BMW i Vision Future Interaction and can also be integrated with the Mobility Mirror. The preferred charge option can be changed by a simple gesture, for example if the BMW i3 needs to be available and fully charged earlier than anticipated. Equally, an alternative mobility option can be selected if the preset option does not meet current needs. A sensor records the movements and converts them into interactions without any contact. Confirmation of the function is provided by a push gesture. BMW gesture control in the new BMW 7 Series highlights the extent to which BMW has already mastered this form of control. It can already be used to carry out functions associated with telephone, information and entertainment systems.

More convenience when parking – Gesture Control Parking.

The Open Mobility Cloud recognises when specific functions are next expected by users. In the Smart Home, picking up the vehicle key is the signal to open the garage door and this action gives the networked BMW i3 the signal to leave the garage. The vehicle reverses automatically, turns and positions itself outside the door ready for when the driver leaves the house. The research application BMW Gesture Control Parking means that the BMW i3 can also drive into and out of a parking space while on a journey without the driver sitting in the vehicle. The function is triggered by a wave gesture which is recognised by the smart watch and transmitted to the vehicle.

After having arrived at the venue for an appointment, the BMW i3 helps to find a free parking space. Once the system has identified a free space, the driver selects it, stops and gets out of the vehicle. While the driver is standing beside the BMW i3, the smart watch is activated using an individually configurable activation gesture. The subsequent wave gesture gives the starting signal for the parking procedure and this is transmitted to the BMW i3 by wireless connection. The use case demonstrated at the CES shows the vehicle reversing independently in a semicircle, then moving forward into the vacant parking space while controlled by the vehicle sensor system, and finally locking the doors. The manoeuvre to drive out of the parking space is also triggered by wave gestures that are picked up by the smart watch. The BMW i3 reverses out of the parking space independently and then positions itself in the right direction ready to drive away.

Today, the BMW Group has already made parking easier with the Parking Assistant and this increases convenience for drivers. The driver only has to hold down a button in the vehicle and monitor the parking procedure for driving into a parallel or perpendicular parking space. The BMW 7 Series can even be manoeuvred into tight head parking spaces or garages by remote control from outside the vehicle. The BMW Group is now using future Gesture Control Parking to highlight the target of offering users a convenient solution for a parking space in any situation.

At the exhibition in Las Vegas, the BMW i3 drives in fully automated mode and without a driver. Last year, the BMW Group already demonstrated its high level of expertise in vehicle automation at the CES. The research applications 360 Degree Collision Avoidance and Remote Valet Parking Assistant allowed a BMW i3 to move independently, dynamically and without a driver through a multi-storey car park, demonstrating the extent to which the BMW Group has already mastered this technology.

Remote 3D View – vehicle environment in view.

While drivers today continue to drive, steer and even park their vehicles themselves, the BMW i3 is carrying out many procedures automatically at the CES 2016. It will drive up in front of the house, drive into the garage for automatically inductive charging, or park independently while on a journey. The BMW i3 recognises its environment, moves with the necessary safety and care, and locks itself up automatically. The Remote 3D View application also keeps the driver optically networked with their vehicle. In this process, the assistance system uses the vehicle cameras which otherwise support manual parking. Four cameras permit a 360 degree view round the vehicle. The images taken by the cameras are displayed by live streaming through BMW Connected on various end devices such as the smart phone or the Mobility

Mirror. They can be used in the Smart Home to monitor the BMW i3 driving automatically out of and into the garage.

Bumper Detect – the virtual observer.

Parking damage is a familiar and aggravating symptom accompanying the dense traffic in the modern world, particularly in highly populated innercity environments. Everybody will undoubtedly have experienced their own vehicle having sustained damage in a car park without anybody coming forward to own up as having caused the damage – possibly because the fact that contact was made with the car went unnoticed. The BMW Group is presenting Bumper Detect at the CES 2016. This is a research application that is able to give a helping hand precisely in this situation. An innovative sensor system in the vehicle identifies whether another vehicle has bumped into the driver's vehicle and activates the cameras which then provide images for Remote 3D View. At the same time, networked systems send a notification to the driver's smart phone over BMW Connected as a signal that the sensors have registered a contact with the BMW i3. The images from the camera are transferred to the smart phone on request. If unauthorised individuals are tampering with the BMW i3, the movement sensors again register the activity and send a message to the driver's smart phone and if requested stream images, for example to mobile end devices. This means that the driver can establish quickly whether somebody was only making a mistake and had tried the wrong car or whether other measures are necessary.

Controlling the Smart Home from the BMW i3.

The Internet of Things represents the next stage in networking, but the BMW Group is already facilitating control of Smart Home functions and end devices from the vehicle. The android-based Smart Things app on the Samsung stand at CES 2016 is perfectly integrated in a BMW i3 (also possible with all other models from the BMW Group fitted with ConnectedDrive Services). This system allows installations like the heating in the Smart Home to be controlled while driving along, using the iDrive Controller and the Control Display. The driver can additionally check from the vehicle whether the windows and doors are closed or whether the alarm system has been activated.

The BMW Group is also demonstrating that the BMW i3 is integrated in the digital living environment of the user through BMW Connected even when the vehicle is parked. Networking the Open Mobility Cloud with the Smart Home thereby makes complex scenarios possible. For example, the BMW i3 can be pre-air-conditioned during a wake-up scenario in the house when starting the heating or switching on the coffee-maker. Ideally, this is carried out while the vehicle is still charging and the range is therefore not affected by this.

Integration of the Samsung SmartThings App enables BMW ConnectedDrive once again to highlight the capability to integrate innovative applications swiftly into the vehicles of the BMW Group.

4. **BMW Connected.** **The personalised digital assistant.**

At the Consumer Electronics Show 2016, the BMW Group is giving the first insight into the prototype for a personalised digital assistant to support individual mobility: BMW Connected. This vision represents an intelligent, highly personalised world of digital services which integrate the vehicle seamlessly into the life of the user. Users and their personal and very individual needs are situated at the centre of the services, irrespective of whether they are moving around with or without a vehicle. The approach to mobility adopted by the BMW Group with this digital assistant is radically new in the automobile industry. A wide range of different end devices are perfectly integrated into the networking system – mobility becomes seamless – and users have more convenience when they are moving around. At the same time they save time, money and energy.

Information is seamlessly integrated, anytime and anywhere.

BMW Connected supports mobility of the future with new services. This personalised and intelligently prepared content is always accessible at any of the networked touchpoints. These include the smart phone, smart watch, tablet, computer and all the connected end devices. In the smart home, for example, there might be an intelligently networked mirror with a display function inside an apartment. Mobility starts long before you get into the vehicle. That is why it is so important for BMW Connected to empower all the different digital end devices to provide bespoke access to the information needed to match individual contexts.

Personalised services, prepared on the basis of the user's needs.

An important part of BMW Connected is universal integration embedded in all the vehicles fitted with BMW ConnectedDrive. This might be the user's own BMW, but it could also be a vehicle from Drive Now or a BMW being driven as a hire car – all the relevant information is seamlessly accessible. Even when the driver leaves the vehicle, all the data are displayed on different digital end devices. BMW Connected responds to the mobility of the future which already starts long before embarking on a journey and by no means ends after leaving the means of transport. The vehicle functions can still be controlled remotely by smart phone, and information can be accessed. The vehicle now becomes even more intensively integrated as a component of digital life.

Personalised and context-sensitive services can be put in a bespoke structure to suit users' needs if their individual mobility requirements are known. The BMW Group records data for this purpose, analyses it and generates an individual Mobility Graph for the user on the basis of the analysed data. This data includes favourite journeys along specific routes, regular traffic obstructions on the route or the opportunity to find a parking space in a given part of town.

A highly flexible service structure is necessary to achieve the vision of BMW Connected – the Open Mobility Cloud. This is a scalable system capable of learning which is based on data analytics and machine-learning capabilities. The intelligent system processes data and information from a wide range of different sources to create the basis for enabling personalisation and context orientation of services. The learning capability of the system facilitates ongoing perfection of personalisation and bespoke modification to suit the needs of the user, and this is enhanced with frequent use of BMW Connected.

Open Mobility Cloud can integrate content from third-party providers.

The open and exceptionally flexible service architecture of the Open Mobility Cloud permits fast connection of third-party content through standard interfaces. This content can be enriched by the individual mobility graph of each user, with targeted and tailored access being provided in turn – seamlessly across all digital end devices. The Open Mobility Cloud also permits integration in other networked systems, which transforms BMW Connected into a digital assistant for the user in the environment of mobility.

Journey Management – central component of BMW Connected.

Reaching your destination with the minimum expenditure of resources – fast, comfortably and punctually – constitutes a basic need of everyday mobility. Journey Management is therefore a key element in the vision of the BMW Group for individual mobility of the future. Mobility needs can be planned taking the current situation into account. There may also be a sudden need for mobility or arrangements may change at short notice. The solutions offered by BMW Connected are correspondingly flexible and this means they can support users in managing their personal mobility. Information on battery charging stations and vacant parking spaces or real-time traffic information are organised intelligently and they can then be accessed by users at the appropriate time. The learning capability of the Open Mobility Cloud allows places that are visited frequently to be stored automatically. Real-time traffic information can be used to calculate the necessary driving time for the commute to work or the school run for the user's child. The information forms

the basis for reminder messages to the networked end devices indicating when it is time to start in order to arrive punctually at the next appointment. This ensures that users are informed that they may arrive too late at their destination in good time rather than receiving the information only when they look at the vehicle navigation display.

Solutions tailored to a personal Mobility Graph.

BMW Connected is perfectly integrated in BMW vehicles. Travel destinations are one example of information that can be transferred from a smart phone into the navigation system, or current arrival times can be sent to contacts from the vehicle at the touch of a button. The parked vehicle can be closed by smart phone and the navigation to the final destination can be passed on seamlessly to a smart watch. The vision of BMW Connected highlights a wide range of very different mobility options that are intended to offer the user the right solution at the right time: personalised, context-sensitive and individually tailored to the personal Mobility Graph.

5. **BMW Motorrad ConnectedRide.** **Concepts for motorcycle laser light and helmet with head-up display.**

BMW Motorrad will be displaying two innovations at the Consumer Electronics Show (CES) in Las Vegas on 6-9 January 2016. Laser light for motorcycles and a helmet with a head-up display will be presented, setting new standards of motorcycle safety, along with a technical outlook of how they may be employed in series models of the future.

BMW K 1600 GTL concept vehicle with BMW Motorrad laser light.

See and be seen has always been one of the central axioms of safe motorcycling, for which reason BMW Motorrad has long since dedicated itself to the continued development and optimisation of motorcycle lighting units. Over the years, this has seen the introduction of adaptive headlights for riding in curves, LED daytime running light and dynamic brake light in BMW motorcycles. And like so often, the development was able to benefit from synergy effects with BMW automobiles.

In the case of the K 1600 GTL concept vehicle presented here, the BMW Motorrad laser light is derived from a design from the automobile division of the BMW Group. The innovative laser technology is already available in the new BMW 7 Series as well as in the BMW i8. BMW Motorrad has now adapted this technology – which is as established as it is forward-looking – for motorcycling applications. Not only do laser light headlamps generate a particularly bright and pure-white light, but they even achieve a high-beam range of up to 600 metres, which is double that of conventional headlights. The safety of night-time riding has now increased significantly as a result, due not only to the increased range but also to the precise illumination of the road. Moreover, the laser technology has a very long service life, thanks to its compact, robust and maintenance-free construction.

BMW Motorrad laser light has been incorporated in the K 1600 GTL concept vehicle as a feasibility test. BMW Motorrad is testing the use of this headlamp technology in series vehicles in the course of its preliminary development.

Head-up display helmet: road information always in your sights.

In road traffic, it only takes a fraction of a second or a brief distraction to put the rider in a dangerous situation. In 2003, BMW became the first European automobile manufacturer to introduce a head-up display as optional equipment for BMW automobiles.

The BMW head-up display projects necessary or desirable traffic or vehicle information directly into the rider's field of view, allowing him to maintain constant observation of the traffic on the road, with no distraction. This would appear even more important with motorcycles than it is with cars, because it can sometimes only take a brief visual distraction to put the rider in a critical road situation.

With a view to offering this technology in motorcycles of the future, a pre-development process was conducted in which a BMW Motorrad helmet was fitted with an innovative head-up display function. This enables the projection of data directly into the rider's field of view. This means that the rider no longer has to glance at the instrument panel and he is able to concentrate fully and without distraction on the road traffic.

All displays are freely programmable; ideally, to provide the best-possible support for rider safety, only information that is helpful and relevant to the current situation should be displayed to the rider at any given moment.

Safety and comfort information for an even more emotionally charged riding experience.

The display options comprise safety-relevant information, for instance data relating to the technical status of the motorcycle, such as tyre pressure, oil level and fuel level, travel speed and selected gear, speed limit and road sign recognition, plus warnings of impending dangers.

By means of the future V2V (vehicle-to-vehicle) communication, it might also be possible to display information in real time, for example to give due warning of any suddenly impending hazards.

Moreover, the head-up display also allows the visualisation of content designed to increase rider comfort. An example would be the planned route along with navigation advice prior to commencing a journey.

The helmet with head-up display also offers interesting possibilities for making the highly emotional experience of motorcycle riding even more intensive and at the same time safer. For instance, an action camera pointing forwards, located inside the helmet, can record video footage of the journey directly from the helmet. A second camera oriented towards the rear could at some point in the future perform the function of a 'digital rear-view mirror'. And last but not least, this technology also enables the visualisation of other riders in a motorcycle group. This enables the rider to see where his companions are at any given moment.

The helmet, which is also fitted with an integrated mini-computer and loudspeakers, is controlled from the left-hand handlebar fittings using the BMW Motorrad multicontroller. As well as operating the camera, this allows the rider to comfortably select the information he requires.

The necessary information display technology can be integrated in existing helmets, without affecting either wearer comfort or rider safety. The operating time of the system with the two replaceable batteries is around five hours.

BMW Motorrad wants to develop this innovative technology to series-production level within the next few years, thus adding a further safety feature to its already wide range of rider equipment.

6. Future Mobility Solutions. **Light and Charge – innovative street lighting and charging station.**

The BMW Group is using its significant technological expertise for a holistic commitment to electric mobility that extends far beyond the development of vehicles. Testimony to this endeavour is provided by particularly efficient street lighting systems which also serve as charging stations for electric vehicles. The prototypes are part of the pilot project “Light & Charge”. This framework will soon be extended to entire streets in Munich, Oxford and Los Angeles, which will be upgraded with the innovative charging stations linked to street lighting. This new system is currently being discussed with decision-makers in the metropolises of London and Berlin.

Light & Charge combines the most advanced LED technology for street lighting with a cashless option for connecting up to charging high-voltage batteries used in electric cars. The individual street-lighting units can be fitted on a modular basis with up to four specially energy-efficient and high-luminance LED modules depending on the lighting requirement. Since the LED technology permits particularly targeted alignment of the light beams – in principle as with headlights for vehicles – unnecessary and environmentally invasive scattering of light can be avoided.

The Light & Charge units of the BMW Group have a standardised connector for the charging cable of electric vehicles, including those manufactured by other manufacturers. The integrated control unit features contactless starting for the charging procedure using an app with a smart phone or the RFID card (Radio Frequency Identification Card).

The Light & Charge technology is just one of numerous projects that the BMW Group is driving forward with partners from government, the energy sector and the automobile sector throughout Europe and the USA with the aim of successfully establishing electromobility.

7. **BMW i8 Mirrorless / BMW i3 Extended Rearview Mirror.** **Camera technology for improved rear vision and more safety.**

BMW i is presenting BMW i8 Mirrorless at the CES 2016 in Las Vegas. This is the first time a camera monitor system has been launched that offers BMW drivers a pioneering form of rear view with the potential to replace conventional exterior mirrors. Although different versions of driver assistance cameras are used, there has so far been no digital use of the rearview mirror which can be deployed in series vehicles. The BMW Group has also provided a demonstration with the BMW i3 Extended Rearview Mirror of how camera display systems can extend the field of vision in conjunction with existing rearview mirrors and as a result further enhance safety.

Cameras instead of rearview mirrors, a display replaces the interior mirror.

BMW i8 Mirrorless incorporates two insignificant looking cameras, accommodated in aerodynamically optimised holders, which replace the existing exterior mirrors. They are supplemented by a third camera mounted on the upper edge of the rear windscreen. All images are merged and displayed as a single image on a high-resolution display suspended in the position of the rearview mirror. The image of the traffic behind the car covers a greater viewing angle than could be observed using the interior and exterior mirrors. No adjustment of the cameras is necessary. Even relatively small and very dynamic road users like motorcyclists are recorded either by the camera or directly in vision from the side window. Dangerous blind spots have been consigned to the past.

When there are hazards: warning alerts in the display.

The display is around 300 millimetres wide and 75 millimetres high. This is rather bigger than the holder of a standard modern interior mirror today but it has a more appealing look. The casing is rounded at the side and this conveys a natural panoramic perception of the traffic behind the car. A further special feature of this system is that it evaluates the camera images and responds situatively to imminent hazards. If, for example, drivers signal with their indicator that they are about to overtake, although a car is coming up behind which is travelling much faster, a striking yellow warning icon immediately flashes on the display and this increases in size as the hazard intensifies. Or if a driver is about to turn right at traffic lights, the system recognises that the vehicle is turning a corner by the indicators flashing or the steering wheel being turned sharply, and the image in the display automatically swivels

further to the right and extends the area being displayed. If a cycle rider approaches from the rear, a warning signal is illuminated in the display as well.

Passengers also benefit from the mirrorless system.

However, the mirrorless camera display system also offers additional advantages. The cameras replacing the exterior mirrors are smaller than the existing wing mirrors and permit a more open view to the front and side of the car. The display prevents the driver from being subject to direct glare and the contrast can be optimally adjusted to suit the light conditions. Overlaid trajectory lines also provide support for drivers when they are parking. Moreover, passengers can similarly use the new mirrorless system. Like the driver, they can always see the traffic in the display, and when they are getting out they can see whether pedestrians or cyclists are in danger before they open the door.

Optimised aeroacoustics reduce wind noise.

The cameras mounted at the sides of the BMW i8 Mirrorless record the traffic travelling behind the car and they are positioned in wing-like holders at the same height as conventional exterior mirrors. The holders are optimised aerodynamically and aeroacoustically so BMW i8 Mirrorless not only has a c_w value like a BMW i8 without exterior mirrors – with the equivalent positive effects on consumption – but also generates a similarly low amount of wind noise. Moreover, the holders channel rainwater round the side windows. The lens of the two side cameras is made of Gorilla Glass Type 2, a thin and robust glass which is frequently used for displays of electronic devices with touchscreens and features particularly high scratch resistance and braking strength. The protective glass on the camera lens is provided with a dirt-repellent coating, is heatable and does not require servicing so as to be able to always provide a reliably high image quality under all traffic conditions, during any weather and in all lighting conditions. The holders are also designed so that spray water is conducted around the lens. The absence of an exterior mirror reduces the overall width of the BMW i8 Mirrorless to 1,942 millimetres because the camera holders finish at the width of the rear wings of the BMW i8.

BMW i3 Extended Rearview Mirror: improved rear view.

Camera display systems can also be used in conjunction with conventional exterior mirrors to improve the view behind the car. This is demonstrated by the BMW i3 Extended Rearview Mirror. The interior mirror is particularly important in this vehicle. It overlays the usual mirror view with very precise images from a camera in the antenna foot on the roof of the vehicle. This mix of mirror and camera view significantly extends the driver's field of vision to the rear. At the same time, the reference to the surroundings is retained and it

is easier to assess the extent to which other vehicles are still far away or how quickly they are approaching.

8. New Control Concepts from BMW. Intuitive connection to the vehicle.

The spread of mobile devices is contributing to new forms of control in all areas of everyday life. In the new BMW 7 Series, numerous functions can be controlled using the touch-sensitive surface of the Control Display or by BMW gesture control, in addition to iDrive or voice control. A new fully integrated tablet in the rear of the new BMW 7 Series provides new freedoms with BMW Touch Command for controlling information, entertainment and comfort functions.

BMW gesture control: operation with finger or hand movements.

The antiglare, high-resolution 10.25 inch screen is installed in the new BMW 7 Series as a touch display. This is used to control the functions displayed on the screen surface by lightly touching the screen similar to the way users routinely operate smart phones or tablets. Familiar operation using the iDrive Controller is retained. The new BMW gesture control represents an even more consistent further development for operation of vehicle functions. Gesture control is being used for the first time in a series automobile in the new BMW 7 Series. Hand movements by the driver or passenger such as “swipe”, “point” or “rotate” are recognised by a 3D sensor. This 3D sensor is positioned in the area of the front interior lighting and recognises gestures which are carried out between the gear lever and the instrument panel. The appropriate gestures are used for a number of functions including adjustment of the loudness of the audio programme, and for accepting or rejecting incoming phone calls. A defined gesture with an individually selectable function can also be linked up.

New convenience for rear-seat passengers.

The multifunction control unit BMW Touch Command in the new BMW 7 Series has been perfectly tailored to the needs of passengers sitting in the rear of the car. The tablet with seven-inch display is integrated in the central armrest and can be taken out. This means that BMW Touch Command can be used on all seats as well as outside the vehicle. BMW Touch Command permits control of the information, entertainment and communication system, as well as comfort functions like air-conditioning, seat adjustment and interior lighting. It can also be used to surf the Internet, play back external audio and video files, or as a games console. Networking is carried out using a WiFi hotspot integrated in the vehicle.