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Full version

Piloted driving: taking the fun of driving to a new dimension

Audi pioneered piloted driving and has repeatedly documented technical progress in spectacular demonstrations. A TTS* without a driver grooved the brand's four rings into the surface of a salt lake and sped up Pikes Peak in drift mode without a driver. On a race track, an RS 7 Sportback* with an empty driver's seat drove at the limit of driving dynamics. Audi has demonstrated the next steps in piloted driving on public roads as well. The most recent highlight is a piloted journey spanning two day under real-life traffic circumstances on the highway from the West Coast all the way to Las Vegas.

Piloted driving in traffic jams

The function for piloted driving in traffic jams, which Audi is currently developing, builds on the Audi adaptive cruise control system including congestion assistance. In the future, the congestion assistant will provide support to the driver in slow-moving traffic on expressways, taking over the steering between 0 and 65 km/h and also automatically accelerating and braking. When the system reaches its limits, such as when the traffic jam dissolves or at the end of a divided highway, it will prompt the driver to take over the wheel again. Should he not do so, the system will bring the car into a state of minimum risk, that is to say to a standstill.

An important sensorics component is the radar system. Just as does the current adaptive cruise control with stop&go function, it will monitor the area ahead of the car A video camera with a wide angle of aperture detects the lane markings as well as pedestrians and objects, such as other vehicles and guard rails. Up to twelve ultrasonic sensors monitor the car's perimeter.

A new addition to the sensor portfolio is the laser scanner, which delivers highly precise data at a distance of up to 80 meters *(262.5 ft)*. Every second, its laser diode emits nearly 100,000 infrared light pulses invisible to the human eye. The controller computes a highly detailed perimeter profile from the light reflections. The laser scanner covers a 145-degree field on four levels.

The laser scanner has great strengths: thanks to its wide opening angle, it will very quickly detect cars merging in ahead. It is also fully functional in the dark and detect any kind of objects, even ones such as fences presenting a regular pattern or ones, such as white walls, that have no visible structure.

Piloted driving and parking

Parking maneuvers in tight situations are unpleasant – conventional parking spaces or narrow garages often make it difficult for the driver to get in and out of the car. Audi's "parking pilot" system enables a drivers to get out of the car and park it remotely using the radio key fob or a smartphone. The system uses twelve ultrasound sensors, four top-view cameras and a laser scanner to monitor the car's perimeter, securing the parking process with multiple redundancy.

As soon as the perimeter sensors detect a suitable parking space or garage, the parking pilot will offer the piloted parking function to the driver. If the driver then gets out of the car, all he or she needs to do is to press the key fob or the corresponding button on the smartphone to initiate the process, the driver retaining responsibility for the entire parking process until the car comes to a safe and complete stop.

The system requires the key to be in the immediate vicinity of the car, thus ensuring that the driver is close enough to the car to assess the situation at any time. If the car's onboard sensors detect obstacles in the car's path, the system will interrupt the parking process until the obstacle has been removed. The system will lock the car's doors at the beginning of the parking process and maintain them locked until the car has reached its final position. On reaching its parking position, the system will shut down the engine, secure the car against unintentional motion and provide the driver with a confirmation message. Leaving the garage or parking space is just as simple.

Audi first demonstrated fully functional piloted parking in garages at 2013 CES. This involved dropping off a car at the entrance and using a smartphone to send it to its parking space. An app enabled the driver to retrieve it later or to select a time at which to pick up the car at the garage's exit.

Functional centerpiece: the driver assistance master control unit (zFAS)

Today's driver assistance systems mostly are managed by discrete controllers. In the future, Audi will deploy a centralized domain architecture in which all available sensor information converges in a central driver assistance controller (zFAS). This computes a comprehensive model of the car's perimeter which is then served to all assistance and all piloted driving systems.

The zFAS board uses cutting-edge multi-core processors which taken together achieve a processing power equal to that of the entire electronical architecture of a well-equipped medium-segment automobile The new board currently is about the size of a tablet PC, but its form factor is set to shrink further. Its modular concept means the board is flexibly scalable and thus protected against obsolescence. Audi will introduce the central driver assistance control module to production along with the systems for piloted driving before the end of this decade.

Interaction with Audi connect enables Audi's piloted cars to gather information while driving. The data generated by the zFAS is routed to an IT backend in the Cloud via the mobile phone network, using LTE where available. In the backend, the data is processed using machine learning and artificial intelligence algorithms and then transmitted back to the car. The car thus continuously expands its ability to master complex situation. Every situation Audi's piloted cars experience adds to their intelligence.

2015: Silicon Valley – Las Vegas

In conjunction with CES, Audi will demonstrate the advanced capabilities of its future technologies for piloted driving. The brand will be organizing a long-range journey involving the Audi A7 piloted driving concept completing a piloted voyage from Stanford in Silicon Valley to CES at Las Vegas. Participating journalists received appropriate training a few weeks ahead of the event at Volkswagen's testing track in Arizona. Drivers will take turns on the trip from the West Coast to Las Vegas. A professional test driver from Audi will be sitting in the front passenger seat to provide added safety.

The journey is an event jointly organized by Volkswagen's Electronics Research Laboratory (ERL), Volkswagen Group research and development and Audi. It consists of two day-long stages. Bakersfield, California, will serve as a midway stop. The journey will see the Audi A7 piloted driving concept covering a distance of more than 550 miles (round about 900 kilometers).

The system deployed in the A7 Sportback* represents the most recent level of technology and is capable of assisting a driver even in higher speed ranges. The car is capable of managing lane changes and overtaking, it can also automatically accelerate and brake. Before switching to the lane on the left or – as is permissible in the United States – on the right, the system will align the car's speed with that of surrounding vehicles. If it determines that distance and available time are sufficient, it will initiate a swift and assured change of lanes.

This experimental vehicle uses various series and close-to-series sensors. The long-range radar sensors that are part of the adaptive cruise control (ACC) and Audi side assist (ASA) systems monitor the area ahead of the car and behind it. Two mid-range radar sensors at the front and rear, oriented left and right, complement the 360-degree surround vision. Laser scanners with close-to-series technology are installed in the singleframe grille and in the rear apron. They provide redundant information to facilitate fine-tuning of static and dynamic objects during piloted driving.

A high-resolution 3D video camera, a prototype of the upcoming device generation made by Audi's partner Mobile Eye, looks ahead across a wide angle. Four small cameras at the front, the rear and in the side mirrors observe the car's perimeter. Navigational data provides general orientation.

For safety reasons, when the system comes up against its limits – In urban areas, say – it will prompt the driver to press two keys on the multifunction steering wheel. This returns the driver to active control of the car's longitudinal and lateral motion. The prompt is issued in due time before the car reaches the relevant zone.

Several warning signals act together in these cases: colored LEDs in the windshield base, messages in the driver information system and in a special display, the Central Status Indicator (CSI) and an acoustic prompt to take control. If the driver should ignore all these warnings, the system will activate the hazard flashers and bring the car into a status of minimum risk, in this case, standstill in its current lane.

2014: Hockenheimring

Piloted driving can be extremely dynamic and thrilling, for example Audi's demonstration drive on Hockenheimring speedway in the fall of 2014. At the season's finale of the German Touring Car Masters (DTM), the Audi RS 7 piloted driving concept completed a lap at racing speed without a driver present. Its designers named the car "Bobby," a tribute to ex-Audi driver Robert William "Bobby" Unser who won at Pikes Peak, Colorado, in 1986.

The 412 kW (552 hp) Audi RS 7 piloted driving concept used in this demonstration had specifications broadly identical with series production. However, the car automatically controlled its electromechanical power steering, its brakes, its throttle valve and the eight-speed Tiptronic automatic gearboxes feeding the power to the mechanical quattro drive.

This experimental vehicle used specially corrected GPS signals for orientation on the 4.6 kilometer *(2.9 mi)* track with its 17 turns. Accurate down to a centimeter, these differential GPS data were transmitted to the vehicle via automotive-standard WLAN and redundantly via high-frequency radio. In parallel, a rapid image-processing software constantly matched current 3D camera images with image information stored onboard.

Comprehensive networking and ultraprecise control of all systems relevant for driving allowed Audi's engineers to drive this technology carrier to the limits of vehicle dynamics. The world's sportiest piloted driving car completed its lap at Hockenheim following an extremely precise racing line, going full throttle on the straightaways, accurately braking ahead of curves, all with exact steering and perfectly measured accelerator actuation at the end of a curve. Deceleration forces exceeded 1.3 g, while lateral acceleration in curves was up to 1.1 g. Top speed was 240 km/h *(149.1 mph)*, while lap time was just over two minutes, or about what it would be with a professional race driver at the wheel.

2014: piloted driving in Florida and California

Audi is rapidly expanding its competence in piloted driving in the USA. In Florida, the brand became the first vehicle manufacturer to be granted a testing license for piloted driving in this state. In the summer of 2014, the brand was once again the world's first automobile maker to conduct a public test with government representatives and journalist on Lee Roy Selmon Expressway outside Tampa, Florida. In fall, the company obtained the first testing license under new regulations in California.

2013: Nevada and Las Vegas pioneer piloted driving

In 2012, Audi became first automobile maker to receive permission to operate piloted driving cars in public traffic from authorities in the US state of Nevada. In January 2013 and 2014, Audi unveiled new systems for piloted driving in traffic jams and for piloted parking at the International Consumer Electronics Show (CES) in Las Vegas.

2012: piloted driving dynamics at Thunderhill Race Track

In 2012, Audi garnered its initial experience with the Audi TTS on a race track – Thunderhill Race Track north of Sacramento, California. The lap time on the roughly three-mile (nearly five kilometers) course was under 2 minutes and 30 seconds. The tests were focused on how a piloted driving car behaves under high strain and in extreme conditions.

2010: piloted ascent – the Pikes Peak Climb

In 2010, “Shelley”, a piloted vehicle, completed the legendary Pikes Peak mountain race course in Colorado, USA. The Audi TTS covered the 20 kilometer *(12.4 mi)* course with a total of 156 corners in roughly 27 minutes, attaining a top speed of 72 km/h *(44.7 mph)*. It used differential GPS for navigation, which achieves considerably higher accuracy as compared to the conventional system,with margins of error down to a few inches.

2009: Bonneville Salt Flats – how did the Audi rings get onto a salt lake?

In the fall of 2009, Audi sent a driverless Audi TTS concept car onto Bonneville Salt Flats in the US state of Utah. This white coupé then went on to draw the brand’s Four Rings in perfect circles onto the salt lake. It also set a new speed record of 210 km/h *(130.5 mph)* for piloted driving cars.

As an homage to former Audi rally driver Michèle Mouton, the technology platform was dubbed “Shelley.” Its specific data technology was developed jointly by Audi, Volkswagen and the Volkswagen Automotive Innovation Laboratory (VAIL) at Stanford University in California.

Autonomous Driving Cup

To generate as many ideas as possible and to create enthusiasm for the subject among budding engineers, Audi created a contest known as the Autonomous Driving Cup. This is aimed at computer science, electrical engineering and mechanical engineering majors. They are invited to develop fully automatic driving functions including the necessary software architectures and to demonstrate them in larger-scale (1:8) model cars.

The teams then compete against each other with their models on a circuit. In assessing the teams' showing, the jury evaluates on-track performance, but also the respective solution's technological elegance and its presentation by the team. The three winners share a total of 16,000 euros in prize money.

Controls and displays – the key interface to the driver

A search function that is as intuitive as that on a smartphone. Voice command that will understand everyday terms. A virtual tachometer needle with an absolutely smooth motion because it is recalculated 60 times per second – Audi breaks new ground in the design of controls and displays in its cars. The most recent highlights include the new MMI interface concept, the Audi virtual cockpit and a voice command which will obey natural language.

Controls and displays in the new Audi Q7

The new Audi Q7*, to be marketed from 2015, will set new benchmarks in terms of its interface concept, infotainment, Audi connect and in its driver assistance systems. The car will come with the new generation of the Audi MMI with a large central display and the newly developed MMI all-in-touch control unit featuring a large touchpad, a natural-speech voice command and the Audi virtual cockpit. Other innovations include the Audi smart phone interface and the Audi tablet for rear-seat passengers.

Playfully easy: the new MMI operating concept

The new generation of the Audi MMI interface makes using the numerous functions of the Audi Q7 especially easy. Operation follows a flat hierarchy geared to the driver’s needs MMI displays appear on the central monitor, which rises up from the instrument panel when the system is started and also enables the passengers to use the Audi MMI system in the familiar way.

The innovative MMI search with intelligent suggestions makes it easy to find specific song titles and to input telephone contacts or navigation destinations. This significantly reduces the number of steps in operation. Writing just a few letters on the touchpad will cause the system to display initial results taking into account the car’s position. When searching for a restaurant, for instance, the driver only need enter its name and the first letters of the city, and a list of hits throughout Europe appears together with the addresses. Audi once again sets a benchmark here.

Nearly all entries can be completed in just a few steps. Two supplemental menus offer up intelligently linked functions and options. One of them allows the driver to change the frequency band in radio mode or to call up traffic information in map mode. The driver can also use context-sensitive options and settings to navigate to an entered destination he or she entered, display parking places nearby or save the destination to a list of favorites.

Haptic feedback: MMI all-in-touch

In terms of operating, the newly developed MMI all-in-touch control unit with a full touch surface stands out. Each input is followed by an acoustic and a haptic confirmation – a click that is also felt on the finger. The driver can enter characters on the large touchpad or perform multi-finger gestures to zoom on the map, for example. The main functions can be accessed using the high-quality rotary pushbutton and two rocker switches. The driver can also assign personal favorites, such as navigation destinations, telephone numbers or radio stations, to eight freely programmable buttons.

“Where can I fill up?”: new natural-speech operation

Another highlight in the new Q7 is the voice control system. It has become much simpler. Drivers no longer need to conform to predefined commands. The system will understand phrases from everyday speech, meaning that hundreds of command variations are possible for each function. In the telephone menu, for example, the driver can call up a contact simply with the words “I want to make a call to John Smith” or “Connect me with John Smith”.

In navigation, simple commands will help such as "Where can I get gas?" or "Where is the nearest Italian restaurant?". Natural-speech control such as "Listen to iPod" is also integrated into radio and media menu entries. This allows comfortable operation of the system thanks to end-to-end voice operation.

To provide a perspective, Audi is also showing online-based natural-speech voice operation, which incorporates the onboard database, but also Audi connect services. This will allow a customer, for instance, to easily find out about the weather at his destination or to locate a nearby gas station with bargain prices.

The Audi virtual cockpit

In the Audi Q7, the optional MMI Navigation plus can be ordered with the Audi virtual cockpit: a 12.3-inch TFT screen with a resolution of 1,440x540 pixels displaying ultracrisp and detail-rich graphics. The driver can switch between a classic view with high-quality rendered dial instruments and an infotainment view with an extended display area for lists and the map – all conveniently from the steering wheel. The display's high flexibility enables the driver to have navigation information, onboard computer data and, for instance, the media list within view in the central area.

The essential control logic of the Audi MMI is also reflected in the new multifunction steering wheels. The keys on the left spoke control the menus as via the MMI while those on the right spoke operate audio output and actuate the voice dialog system. What is new is express operation of the telephone and a practical skip function for quick changes of the radio station or the music title.

New Audi TT: Audi virtual cockpit with integrated MMI operation

Audi has fully made over the new TT*'s driver-oriented operational concept. The TT now comes with two of the brand's innovations – the new MMI Multi Media interface and the Audi virtual cockpit digital instrument combination.

Audi virtual cockpit

In the new TT, the Audi virtual cockpit replaces analog instruments and the MMI monitor. On this 12.3-inch fully-digital combination instrument, the driver can switch between a classic view with dial instruments rendered in high quality and an infotainment view with an extended display area for lists and the navigational map.

In addition, the driver can choose certain values of the onboard computer for permanent display. The display's high flexibility enables the driver to have navigation information, onboard computer data and, for instance, the media list within view in the central area. In the TTS model, an additional display option assigns a central position to the tachometer, highlighting the car's affinity to motorsports.

MMI touch control unit

The Audi virtual cockpit MMI can be controlled from the steering wheel, but also from the center tunnel. In the TT, the MMI Navigation plus comes with the MMI touchwheel. This allows the driver to use the touchpad on the top of the rotary pushbutton to zoom into the navigational map and to enter characters. All key functions can be reached with just a few clicks, and the buttons on the side provide access to intelligently linked functions and options.

Free-text MMI search

A major highlight of the new system is MMI search, which is available for all basic menus and uses free text entry like an internet search engine. It generally answers queries after just a few letters, taking into account the car's current location. When searching for a restaurant, for instance, the driver only need enter the name and the first letters of the city and a list of hits throughout Europe appears together with the addresses. Searching for songs, albums and radio stations works similarly.

Intuitive: the new natural-language operation

Voice operation has also been intensively reworked and expanded. It will now understand many phrases from everyday speech. To call a contact, a command such as "I want to call John Smith" will be enough. A multifunction steering wheel is available as an additional control instrument. Other than touch gestures, the driver can use control keys and cylinders to perform the same steps as with the MMI terminal, all without taking his eyes off the road.

Infotainment – more than just entertainment technology

Infotainment has been driving technology development for years, presenting automobile manufacturers with ever-new challenges. Customers have come to expect innovations in mobile and home entertainment to be available in their own car as well. Audi recognized this development early on and responded by developing the Modular Infotainment Matrix (MIB). This opens up new options such as the Audi tablet, navigation using Google Earth and Google Street View, 3D sound for concert hall atmosphere, the Audi phone box as well as the smartphone interface for perfect in-car integration of Google Android Auto or Apple CarPlay.

The Audi tablet

In launching the Audi tablet in the new Audi Q7 in 2015, Audi once again breaks new ground in infotainment. The tablet is a mobile infotainment system opening up all-new options in in-car use.

The Audi tablet features a 10.1-inch display and is expressly designed for use in the car. It will withstand high or very low temperatures with no issues. Its mounting makes it highly crash-resistant. Its brushed-aluminum chassis provides optical confirmation of its high-class character. At its heart is the new superfast Tegra 40 processor from NVIDIA.

The Audi tablet uses WLAN to establish a connection to MMI Navigation plus, thus obtaining access to the radio, media, navigation and car functions as well as to the internet via the in-car WLAN hotspot. The Audi tablet can also be controlled by the driver or front-seat passenger via the rotary pushbutton. Among other things, this allows front-seat occupants to start playback of a DVD or to switch on a previously selected radio or TV program for backseat passengers.

A 32 GB memory means the device can be used as a jukebox for audio and video files. This will let occupants watch Youtube videos and films from online streaming providers such as Watchever, Netflix etc. and play the audio via the car’s first-class sound system, alternatively using headphones connected to the Audi tablet via the aposite jack or via Bluetooth.

In addition, the Audi tablet supports NFC (Near Field Communication) technology. The driver can transfer a route planned on a mobile phone to the car using the NFC beam by simply holding the phone close to the Audi rings on the Audi tablet. The route will then be used by the navigation system. The NFC beam can also serve to transfer internet addresses and contacts stored on a mobile phone.

Finally, the Audi tablet extends travel planning to the rear-seat passengers who can now suggest routes and send them directly to the MMI. The driver can then accept or reject these routes.

A click on the “more” button in the main menu creates a connection to the Android operating system with all its functions. The user can access the Google Play Store and the Android App Store for a total of about a million apps and games, films and music, audiobooks, ebooks and office applications. An integrated full-HD camera means the Audi tablet can also be used for video calls via Skype.

Once arrived, the user can remove the Audi tablet from its holder on the back of the front seat and use it offline or on an external WLAN network.

Audi Navigation – always on the right track

Navigation based on Google Earth and Google Street View facilitates orientation considerably. Street View uses 360° panoramic images to provide the driver a street view of the destination. The navigation map is backed with images from Google Earth. Map zoom down to 30 meters *(98.4 ft)* is a unique feature.

An all-new offering in Audi Navigation is the option to display two complete maps in parallel. Besides on the familiar central display, maps can now be called up on the combination instrument as well.

Drivers can now update maps directly in the car via Audi connect. When new map material becomes available in the Audi Cloud, the customer will be provided with a notification. The car will determine which regions and countries the driver has visited frequently since the last update and suggest current versions of the respective map material. The system will then download and update the data for the selected countries via the customer’s installed SIM card using an LTE connection during the journey. Alternatively, Audi customers can use their computer to download the data from the myAudi platform and transfer it to their car using an SD card.

The navigation function will remain fully available during the updating process. Besides "learning" routes visited, the navigation system can also be configured to remember routes a driver travels every day. For instance, the system can register that the driver leaves home every Monday at 7 o’clock to drive to work, and note the driver’s work address. Many drivers do not use navigation on their daily commute because they are exactly familiar with the route.

However, this can make them miss current information on traffic disturbances along the way. Thanks to the new technology, when a driver now starts his car around 7 o'clock on Monday morning, the navigation can show the three most frequent destinations and expected times of arrival without the need to activate route guidance. In addition, the congestion tracking activates itself in the background to monitor these "learned" routes. If there is a significant disturbance on one of the routes, the system will alert the driver and ask whether it should calculate an alternate route – all without the need to activate route guidance beforehand.

Enhanced listening pleasure: 3D sound

Another Audi innovation in the new Q7 is 3D sound available in the Bose Sound System and in the B&O Advanced Sound System. Both play music in a novel format with additional speakers in the A pillars mapping height as a spatial dimension. In all, the B&O Advanced Sound System with 3D sound plays back music with 1,920 watts of amplifier power via 23 speakers including the subwoofer. This turns the automobile into a great virtual stage.

Using a sophisticated algorithm, the system extracts a third dimension from conventional stereo or 5.1 recordings and processes it for reproduction via the speaker array. This is to say that Audi implements the new technology currently being introduced in cinemas and living rooms for an all-new sound experience in the car. While the Bose Sound System uses proprietary algorithms, the B&O Advanced Sound System relies on technologies developed by Germany's Fraunhofer Institute for Integrate Circuits (IIS).

The Audi phone box

In some models, Audi offers the Audi phone box as an option for easy connection of cell phones to the car. Its centerpiece is a universal planar antenna integrated into the storage tray in the center armrest. The phone uses close-range coupling to communicate with the flat planar antenna, which transmit the signals to the car antenna via an amplifier.

A new feature in the Audi phone box is cordless charging based on the so-called Qi standard. Power is transferred via induction from a coil at the bottom of the Audi phone box to the receptive coil in the smartphone. This can be integrated in the battery, in a retrofittable foil or in the phone cover. The phone will remain fully operational during charging and can be controlled via the MMI system without restrictions.

Audi smartphone Interface

Another first is the Audi smartphone interface which includes Google Android Auto and Apple CarPlay. When an iOS or Android mobile is connected to the car's USB port, corresponding icons appear in the main menu, and the driver can call up the respective application with one click. Both are tailored for use in the car. All functions can be controlled via the MMI system's rotary pushbutton and via voice. The new Audi Q7 is one of the first cars worldwide to offer these functions from 2015.

The Modular Infotainment Matrix

The basis for integrating these functions into the car is the Modular Infotainment Matrix (MIB) and Audi's own technology network enabling the brand to set new standards. Thanks to its revolutionary approach to the electronics architecture, Audi is approaching the short cycle times of the consumer electronics industry.

The MIB's structure is key factor in this development. Its modular concept enables Audi to ensure the MMX board (MMX = multimedia extension) is always up to date, thus ushering consumer electronics trends into the car early.

The central computer in the MIB brings two primary components together in a tight space: the Radio Car Control Unit and the MMX board designed as a plug-in module. Besides the operating and flash memory, the board integrates a super-fast processor from Audi's partner NVIDIA controlling all online, media, voice control, navigation and telephone functions.

At 2014 CES, Audi exhibited a pre-series variant of the MIB's second generation just a year and a half after the launch of the first (MIB1). MIB2 went into volume production in summer of 2014 with the new Audi TT* and the facelifts to the A6* and A7 Sportback*. It uses an NVIDIA T 30 processor, a Tegra 3 series quad-core chip. It has a frequency of one GHz and a fast graphics board enabling it to control two displays simultaneously. The T 30 processor works together with a graphics program from specialist maker Rightware capable of rendering fascinating three-dimensional graphics.

The next generation of processors is ready for deployment in the Audi tablet. It is the quad-core technology NVIDIA Tegra 40. As in the previous chip, its power requirements are minimal – which fits in with Audi's efficiency strategy. The brand is also uncompromising with respect to manufacturing quality. The processors are rigorously tested for the harsh operating conditions in a car.

NVIDIA has scheduled a rapid succession of ever more powerful chips for the years to come. Audi will integrate them into the respective models very soon after their launch, as it has done in the past. This is how Audi drives the integration of innovative high-performance components across the board.

Audi connect

Most of us today aspire to be “always on” in everyday life, including in our cars. The Audi connect solutions are Audi’s response to this. Whether it is Facebook or Twitter, music streaming or an online update of the navigational map, Audi offers its customers a broad selection of cloud-based applications, all supported by ultrafast data transfer based on the LTE standard. A smartphone can be used in the familiar way. In addition, it can now open and lock the car via the Audi mobile key function.

Audi connect broadband Internet module

Audi ranks among the pioneers in the field of mobile networking. The brand began an intense cooperation with leading suppliers of hardware and software in 2005. Four years later, Audi connect in-car internet services became available. In 2010, Audi became the first manufacturer to introduce broadband internet access via an integrated UMTS (Universal Mobile Telecommunications System) module throughout its model range. In 2013, the brand presented a fully integrated LTE (Long-Term Evolution) module.

Today, the Audi connect module with broadband internet access combined with a mobile WLAN hotspot is available in many Audi models, enhancing the brand’s top-of-the-line MMI Navigation Plus and marking a great step for Audi in terms of mobile high-speed internet. The integrated WLAN hotspot allows the car’s passengers to connect as many as eight personal mobile devices.

LTE – a wireless standard five times as fast

The fully integrated LTE module supports data rates of up to 100 Mbit/s downstream, 50 Mbit/s upstream, making for very short response times and permitting exchange of large amounts of data. Passengers in the new Audi A3 can run different applications at the same time on their mobile devices.

For example, one passenger might participate in a video conference while another watches a movie. The driver, too, benefits greatly from LTE technology, such as when using Audi connect services, among them navigation based on Google Earth and Google Street View, which load extremely quickly. Full integration of LTE will permit further expansion of the Audi connect offering, starting with cloud-based music and social media all the way to car-to-X services such as wireless payments and exchange of information with traffic lights.

Audi connect in the new Audi Q7

Audi will expand the connect portfolio further in the new Q7 to be launched this year. MMI Navigation plus will come with a pre-installed LTE module.

Briefly after market launch, the Audi Q7 will offer new services beyond the current Audi connect portfolio “Audi connect Emergency Calling & Service” will become available, offering emergency calling, online calls in case of a breakdown and online booking of Audi service appointments. The “Audi connect vehicle management” package includes vehicle status report, remote locking and unlocking, park position as well as remote operation of the optional auxiliary heater. “Audi connect Emergency Calling & Service” will be free of charge for 10 years.

On the launch of this new SUV, Audi will add another gem to its Audi connect portfolio as Apple Car Play and Google Android Auto become available via the Audi smartphone interface. Audi has been in contact with Apple since early 2013 and with Google since 2014 to ensure its customers benefit quickly and widely.

Connect an iOS or Android cellular phone is connected to the USB port (iOS from version 7.1; Android from version 5.0 Lollipop) and the respective environment will open in the Audi smartphone interface. Both are tailored for use in the car. A the core of this feature is online music. This opens up the gigantic offering of Google Play Music and iTunes to Audi drivers.

In addition, both platforms offer navigation functions, missed call/appointment reminders and messaging functions. Functions can be controlled via voice, the rotary pushbutton and via the multifunction keys on the steering wheel. In the future, numerous 3rd-party applications such as Pandora, Spotify and Whatsapp will complement the offering. Audi will be demonstrating the new Audi smartphone interface at 2015 CES in an S3* concept car and other technology exhibits.

Audi connect services

Audi connect brings many customized services into the car, such as online traffic information. These services provide real-time data on current traffic. If the route chosen by the driver has free-flowing traffic, it is shown in green; orange indicates dense or slow-moving traffic, and red signifies a traffic jam. In this case, the service identifies the problem and suggests an appropriate alternate route. The online traffic information service includes not only expressways, but also interurban roads and cities and covers most European countries.

The newest service, parking information, displays parking lots and parking garages at the current location, the destination or at any other location. Whenever possible, it also indicates the number of available spaces and parking fees. Drivers can select the parking location as a navigation destination for display as a Google Earth map section and in Google Street View on the onboard monitor.

The fuel price services will list discount gas stations, with some models taking into account the required fuel variety.

Flight and train information from Audi connect can be used to check departure times, track and gate numbers, and also obtain information on any delays. Users can enter an individual flight number into a direct search.

City Events is an Audi connect service which provides information on a multitude of events at the current location, a travel destination or a freely selectable location. Customers can filter according to various categories such as arts or sporting events. Online news and travel and weather information round off this offering.

In some models, Audi connect services can be used via a convenient read-aloud function, while the myAudi customer platform offers online customization to personal preferences.

Music – a wide selection ready to play

Audi music stream is the Audi connect web radio. With this app and UPNP (Universal Plug and Play) technology, the user can receive broadcasts from more than 3,000 Internet radio stations, save personal favorites to a cell phone and play them via the MMI navigation plus system. The app also provides access to the media library stored on the user's smartphone.

Audi music stream comes both as an independent smartphone app and integrated into Audi MMI connect. This application is available for Audi's A3*, TT*, A6*, A7 Sportback* and Q7 models and will offer additional services on the mobile device and in MMI Navigation plus via a WLAN connection. This will make services such as PPOI search, City Events or Picturebook Navigation even more versatile, enabling search results or photos to be sent directly to the car.

Another new option in the Audi MMI connect app is the new Online Media Streaming with access to the Napster music subscription service and Aupeo radio service. Audi customers can now use MMI Navigation plus to access almost 20 million music

tracks and several thousand audio books in MP3 format. As with all Audi connect services, the user interface is fully integrated into the familiar operating environment.

Another service from Audi connect is Picturebook Navigation. Here, the driver can store pictures of destinations coupled with geo navigation (GPS) data in the MMI Navigation plus' Picturebook. They can be personal photos as well as Google Street View motives. Images can be imported from an SD card or via a myAudi account. Photos can be searched via Cover Flow, while GPS data serve to turn them into navigation destinations.

Community – always connected

Audi connect also integrates Facebook and Twitter online community services in the infotainment system in vehicle-specific versions. In addition to the text-to-speech function, drivers can also use a text function to send predefined text modules, optionally combined with data such as the car's current position. In models such as the Audi A3, A6 and A7 Sportback as well as the new Audi TT and the new Audi Q7, drivers can transfer e-mails from their smartphone to the car and have them read out aloud. Conversely, drivers can also dictate and send text messages (SMS). A server in the Cloud will convert the sound file into data packets.

Key Audi connect functions, including the point-of-interest (POI) search, can be controlled via voice commands,. Here, again, voice commands will be translated into a data packet and sent to the Google search engine. An innovation is the personal POI search (PPOI) enabling Audi customers to copy interesting destinations or current hazard locations from third-party databases to their myAudi account and from there to the car's navigational map.

Audi mobile key for convenient vehicle access

Audi's existing comfort key is a very convenient solution for access to the car and engine-starting privileges. The next logical step is the Audi mobile key, permitting vehicle access based on a smartphone. The data required for access will be stored in a safe place, either on the SIM card or in the smartphone's Secure Element. Audi IT will securely manage all access events.

When the driver holds the smartphone to the door handle, information will be transferred to the car via near-field communication (NFC) broadly as it would be in a cashless payment system. Once inside the car, the driver can stow the phone and start the engine by pressing the start-stop button. Upon arrival at destination, the driver can lock the car using the smartphone again. This functionality requires only a small amount of energy, which is drawn from the car's inductive field. This

means the NFC-based exchange of data will be possible even when the smartphone is switched off or its battery is empty.

The Audi mobile key is not designed to replace the classic key, but to supplement it in the future. This will permit online transfer of permission to use the car. Audi customers may use their myAudi account to grant friends or family members access to their car. The new technology is also ideally suited to car rental, car sharing and future mobility services.

Smart devices and their connection to the car

In the future, besides via smartphone functions, interaction with the car will be possible via a smartwatch app. Audi customers thus might use their smartwatches to access, lock and start their cars. They can also display up-to-the-minute vehicle information on their smartwatch and make configuration changes.

For instance, a driver can call up the car's remaining range or obtain directions back to his car. The car's auxiliary heater can also be activated in this way. This means a smartphone or smartwatch owner of a vehicle equipped with MMI Navigation plus will always have access to relevant information about his car.

Audi connect – outlook

The role of the car in society is changing, evolving from a status symbol to a mobile device enabling users to be always online even when travelling. Fast LTE mobile communications networks will provide a strong push to topics such as "data in the cloud" (the use of online data) and car-to-X communication.

Car-to-X communication

Car-to-X communication opens up many new opportunities for making driving safer, more relaxed and more economical. Networked cars can warn one another about hazards such as slippery roads or cross-traffic at intersections, for example. Car-to-X communication is also extremely well suited for the dissemination of traffic information data.

Among Audi's new car-to-X applications is traffic-light information online traffic light information. It networks the car with the central traffic control computer controlling traffic lights in a city displaying information enabling the driver to select the correct speed so as to reach the next traffic light during a green phase. At a red light, the system will display the time remaining until the light turns green.

Audi developed this new technology in-house and has tested it extensively over the years. Field trials have shown that the traffic-light information online traffic signal service both helps drivers and benefits cities and the environment. According to Audi's calculations, CO_2 emissions can be reduced by up to 15 percent. If deployed throughout Germany, this would correspond to a savings of roughly 900 million liters *(240 million US gallons)* of fuel.

Farsighted: tomorrow’s lighting technologies

Audi further extends its lead in automotive lighting technology with a worldwide innovation, the Audi Matrix LED headlight. This involves three main aspects: in the future, car lighting will react even more sensitively to environmental conditions, it will communicate in various ways with its surroundings, thus helping to further increase active safety.

Light of the future: Audi’s matrix laser technology

Introduction of high-resolution matrix laser technology is Audi’s next development step in automotive lighting technology. At CES, Audi will be exhibiting the Audi prologue piloted driving show car which has the new solution on board. In addition, the technology will be on display in a dedicated exhibit.

For Audi, matrix laser technology opens up all-new possibilities. Compact projectors coupled with mirrors generate a high-resolution laser light which can be finely tuned to illuminate the entire roadway. The projectors are discrete from the headlights and installed deep inside the engine compartment. From there, glass fiber strands route the light to lenses forming the headlights’ pupils. Set below these are five additional lenses enclosed in a delicate lightweight structure. Fed via glass fibers themselves, they further enhance forward illumination.

Matrix laser headlights are yet slightly more energy-efficient than matrix LED headlights. The principle of discrete light sources offers new avenues in the packaging and design of the headlights. Also, this solutions simplifies thermal management in the headlights.

Light rails: construction area lighting

Construction area lighting is a future new function of matrix LED and matrix laser technology. It projects two light strips about 15 meters *(49.2 ft)* in length denoting the car’s width. When passing through construction areas or other such narrow segments, the new lighting function will help the driver estimate available clearance to the left and right.

The most recent highlight: a laser spotlight for the highbeam

The new laser highbeam spotlight consists of a light cone generated by a laser module in each headlamp with a range of several hundred meters *(over 500 ft)*. Each module employs four powerful laser diodes a mere 300 micrometers in diameter generating a monochromatic and coherent blue laser beam with a wavelength of 450 nanometers. A phosphorus converter turns it into traffic-compatible white light with a color temperature of 5,500 kelvin. The laser spotlight is active at speeds of 60 km/h (*37.3 mph*) and higher and provides the driver with significantly improved sight and safety.

The laser spotlight for the highbeam saw its world debut in the Audi R8 LMX high-performance sports car, the exclusive edition model of the dynamic Audi R8 model line, in the summer of 2014, Ahead of its launch in series production, the spot premiered in the Audi R18 e-tron race car at the 24h race in Le Mans, another instance of Audi first proving its new series technologies in racing, the world's toughest testing ground.

Intelligent light: matrix LED headlights.

Matrix LED headlights as available in several model lines are symbolic of Audi's knowhow in modern automotive lighting technology. Their light always delivers excellent illumination without blinding other road users. To ensure this, each headlamp is divided into up to 25 segments, one for each light diode.

When the light switch is set to automatic and the high beams are on, the system will be activated outside urban areas at speeds of 60 km/h *(37.3 mph*) and above. As soon as the connected camera detects other traffic, which includes cyclists, for instance, the controller will immediately switch off selected LEDs or dim them in up to 64 steps, making several million light distributions feasible in the A8*. The headlights blank out oncoming vehicles and vehicle driving ahead while providing continued full illumination of the areas between and beside them. As soon as oncoming cars have moved past, the headlights will automatically switch back to full power.

The LEDs in the Matrix LED headlights include cornering light functionality, which selectively brightens or dims to shift the focal point of the light along a curve. This is done just before the steering wheel is turned based on predictive route data provided by the MMI navigation plus.

Powerful and highly efficient: LED headlights

LED headlights from Audi produce a light with a color temperature of around 5,500 kelvin, making it resemble daylight. The LEDs are maintenance-free and designed to last the life of the car. The low beams consume only around 40 watts per unit, somewhat less than the already highly efficient xenon plus headlights. The LED headlights have special features for the city, intersections and interurban roads as well as for freeway driving, left-hand traffic and poor weather.

LEDs do not become particularly hot, with red light-emitting diodes reaching about 120 and white ones 150 degrees centigrade *(250 and 300 degrees Fahrenheit)* – much less than halogen headlights, which generate temperatures of up to 400 degrees centigrade *(750 degrees Fahrenheit).* Fans direct heat generated by the LEDs against the headlight cover to keep it free of condensation and snow in winter.

LED headlights are pure hightech: in the A3 series for instance, eight high-performance LEDs in the matte aluminum trim provide the high beams; nine high-performance LED chips in two free-form reflectors generate the low beams. Cornering and all-weather lights are housed in a dedicated module. Daytime running lights, parking lights and turning signals, which are fed via glass fiber, run around the headlamps at the top and on the inside as a small strip.

In some larger models, LED headlights cooperate with the optional night vision assistant to enable an additional safety function. When the night vision assistant detects a person in the critical area in front of the car, individual LEDs blink three times in quick succession. This highlights the person against the background, warning both them and the driver.

Showing the way: dynamic turning signals

Dynamic turning signals are available for numerous models, giving clear and unambiguous indication about the direction in which the car is about to turn. This enables other traffic participants to recognize them even in low visibility or on approach from the corner of the eye, as it were, significantly contributing to safety in road traffic.

The turning signal consists of individual LEDs and LED blocks. When the driver activates the turn signal, individual LEDs light up sequentially from the inside out. After 150 milliseconds, all segments will be fully lit up and remain so for another 250 milliseconds. The LEDs then go dark before repeating the lighting sequence.

Distinctive looks: LED daytime running lights and LED taillights

Daytime running lights consisting of white light emitting diodes are available in different designs for every Audi. The Audi A1, for example, uses two LEDs per headlight. They emit their light into a transparent polymer tube, the light guide. This generates a uniform contour. The LED and matrix LED headlights in the new Audi TT project daytime running lights via three bars structuring the headlamp like a grille. Thick-screen optics ensure homogeneous illumination.

Rear lights using LED technology are available either standard or as an option for all Audi models. They produce a distinctive light pattern which in many cases also creates three-dimensional effects. The LEDs are extremely long-lasting and practically maintenance-free. The most important thing, however, is how extremely quickly they reach their full luminosity, providing the driver of a following car with precious fractions of a second in the event of a sudden unexpected emergency stop. In addition, many Audi models come with adaptive brake lights which pulse at high frequency in emergency braking.

Versatile: adaptive light

The adaptive light’s control unit governs the swiveling of the xenon plus modules to consistently provide optimum illumination whether traveling on city streets, country roads or expressways. Drivers can configure the swivel characteristics via the Audi drive select.

A particularly attractive component of the adaptive light is the variable headlight range control. A video camera detects preceding and oncoming vehicles by their lights. The control module then adapts the car's lighting to the distance to the other vehicles – via a soft transition that always maximizes the amount of illumination.

Networking with the MMI navigation plus system makes the adaptive light even more capable as the navigation system relays route data to the light controller, activating expressway lighting while still in the approach lane, for example. The system automatically switches on the cornering lights before entering an intersection; in countries such as the United Kingdom or Japan, it will automatically switch the headlights from right-hand driving to left-hand driving.

Interactive: Audi's light exhibits at CES

At 2015 CES, Audi uses the virtual engineering terminal, an interactive platform on which the visitor can move vehicle models with his hands, to present innovative lighting functions. This includes construction area lighting, cornering lights, marking light, dynamic turning signals, matrix LED headlights and laser technology. Light distributions evolve depending on how the cars move. These distributions are clearly visible both directly and on a large monitor.

Another CES exhibit is the Audi Matrix OLED. 16 platelets made up of organic light-emitting diodes (OLEDs), each 40 by 40 millimeters (1.6 x 1.6 inches) in size make up a three-dimensional pixel surface. A visitor looking on directly will see the Audi logo appear in homogeneous red while one looking on from the side will see the Four Rings. This exhibit is symbolic of Audi's creative treatment of light as a subject and the close interplay between design and technology.

Electric mobility

Under the e-tron name, Audi has been resolutely driving electrification of the powertrain. Audi's technology matrix contains numerous options to create an ideally tailored solution for each customer The matrix begins with the new 48-volt onboard network enabling highend technologies such as the electric biturbo in the RS 5 TDI concept, continuing via hybrid and plug-in hybrid models up to sports cars and future top-of-the-line models with pure electric traction and high ranges. For these designs to be successful, the charging process needs to be both simple and convenient. The Audi wireless charging (AWC) system fulfills both of these demands. All it requires is that the car be parked over an induction plate inserted into the ground which then proceeds to charge the battery.

The way forward: plug-in hybrid technology

For Audi, plug-in hybrid technology is an excellent path to the mobility of the future. Cars using two powertrains flexibly depending on the situation bring together the best of both worlds, the combustion engine and the electric motor, achieving range, sportiness, safety and everyday convenience as well as local avoidance of emissions.

The interaction of the combustion engine with an electric motor opens up new avenues for engineers in that it enables deliberate shifting of load points to achieve an operating situation where the combustion engine runs at low consumption and low emissions. In urban traffic, the electric motor enables local absence of emissions. This is a requirement in many urban areas of the world and thus especially important.

Since the launch of the A3 Sportback e-tron* last year, Audi has been successful in plug-in hybrid technology. This technology is now being continually deployed throughout Audi's model range with the medium and upper segment next in line. Audi is committed to introducing a new e-tron model every year. Samtidigt håller Audi på att utveckla helt eldrivna fordon med högkapacitetsbatterier och kraftfulla motorer som inte kommer att ha några begränsningar när det gäller räckvidd och användningsområde.

Refueling in maximum comfort: Audi wireless charging

Mobility for the future as being developed by Audi has many aspects. One of them is convenient supply of electricity for e-tron models. Audi has been working intensely on contactless charging via induction, known as Audi wireless charging (AWC).

In AWC technology, energy is fed from a plate in the ground which is connected to the power grid and can sit on the tarmac or be embedded in it. A primary coil and an inverter (AC/AC converter) are integrated into this plate. When the coil becomes active, it creates an alternating magnetic field. Based on the technology's current status, Audi at present has a 3.6 kW charging plate working like a conventional socket with 16 amperes. In the future, however, higher power versions may become feasible.

When an Audi e-tron comes within a few feet of the plate, a positioning process begins in which the ground plate and the car establish contact via radio. A symbol in the display informs the driver of the plate's exact position. Once the car is correctly sited above the plate, its symbol will turn green and the system will suggest initiating the charging process.

The charging process begins as soon as the car comes to a stop above the plate The charging process can, however, be interrupted at any time. The ground plate's alternating electromagnetic field induces an alternating current across the air gap in the secondary coil integrated into the car. At about 25 centimeters *(9.8 in)* long and wide, this is fairly compact and sits in the front area of the car's underside.

An AC/DC converter then rectifies the induced alternating current and feeds it into the high-voltage onboard network, where it can charge the battery and at the same time power devices such as the heater or the air-conditioned. The driver can interrupt the charging process at any time. Charging stops automatically when the battery is fully charged.

Efficiency in Audi's AWC technology as measured from the grid to the battery is more than 90 percent. Adverse weather conditions such as rain, ice or snow will not affect operation of the magnetic field. Because the magnetic field is only generated when an automobile comes to a stop overhead and the coil is activated, it is harmless for humans and animals.

Audi believes that this highly convenient charging technology will significantly raise the share of electric driving in plug-in hybrid models. As a first deployment step, AWC is ideally suited for a residential garage or a company parking lot. In later deployment steps, the technology could also be integrated into the public infrastructure.

Electronic architecture for fast-paced innovation and reliability

80 percent of innovations which Audi implements in its cars directly or indirectly depend on electronics and hence on semiconductor technology. Even today, Audi models contain between 6,000 and 8,000 semiconductors, without which the rapid increase in networking and new functions would not have been possible. This trend is set to continue upward because more sensors, more networked systems and more calculation operations will require more high-performance semiconductors.

The result is that technology cycles in semiconductor development are coming to determine innovation opportunities in the automobile industry. While an average of seven years elapse between two vehicle generations, the product cycle in the semiconductor industry is a mere 15 to 18 months. Audi makes every effort to react quickly and flexibly in order to harness the potential of new chip generations with a view to creating ever more customer benefit.

Thanks to its close cooperation with leading companies especially in consumer electronics, Audi has become able to rapidly deploy new in-car technologies.

One of its most notable partners is NVIDIA. Cooperation with this company based in Santa Clara, California, began as early as 2005. The most recent result is the Tegra 40 chip powering the new Audi tablet. Audi's MIB (modular infotainment matrix) permits updating of hardware in short cycles, thus continuously ensuring that the system reflects the state of technology. For example, Qualcomm, another close cooperation partner of Audi's, is the supplier of the LTE module for a fast onboard online connection.

A key factor for innovation: the Progressive SemiConductor Program (PSCP)

Audi places extremely stringent requirements on semiconductors to be installed in its car, particularly regarding criteria such as durability, long-term quality and function across a wide temperature range. It is against this background that Audi operates the Progressive SemiConductor Program (PSCP), which is a key factor for future innovation.

Under PSCP, which Audi initiated in late 2010, the supplier of system components continues to be an important contact. In addition, Audi's engineers directly interface with the semiconductor makers, leading to high efficiency and effectiveness as well as enabling innovations at intervals that come closer and closer to the high pace of the consumer electronics industry.

In software, too, Audi has been resolutely driving development of its own solutions. As early as 2009, Audi founded e.solutions GmbH to serve this purpose. The company is a joint venture of Audi Electronics Venture GmbH, a wholly-owned subsidiary of AUDI AG, and Elektrobit Automotive GmbH. e.solutions GmbH buys function software, such as for navigation or telephony, on the world market and proceeds to integrate it into its modular software suite developed in-house and running on NVIDIA's Tegra chips. A current example is the online update of the navigational map.

Audi models on display at CES

Besides lots of electronics highlights and exhibits, Audi will also show sophisticated innovations in series production cars and studies at CES. The Audi prologue piloted driving showcar provides a glimpse of the future, while the Audi TT Roadster*, Audi RS 7 Sportback* and Audi R8 LMX* demonstrate high-tech solutions available today. In addition, CES visitors can experience the interface concept and the connectivity of the new Q7 which will see its world premiere one week later in Detroit.

Heralding a new design era: the Audi prologue piloted driving showcar

The Audi prologue piloted driving show car is a focus at CES. It not only stands for a new design era, but also integrates many innovations in the areas of connectivity, infotainment and user interface which Audi will be showing at 2015 CES. In this connection, this show car's laser matrix headlights and perimeter sensorics will demonstrate how the car of the future will become ever more of an assistant to its occupants. After all, the Audi prologue piloted driving stands for the state of technology, which includes piloted driving.

A novel laser scanner, several video cameras, ultrasound sensors mounted out of sight and front and rear sensors, themselves invisible, all cooperate in data capture. The central controller known as zFAS (zentrales Fahrerassistenzsteuergerät, central driver assistance controller) is the keystone of piloted driving. This compact master unit calculates a comprehensive impression of the car's perimeter based on the signals provided by the scanners, the camera and the sensors.

At a length of 5.10 meters *(16.7 ft)*, a wheelbase of 2.94 meters *(9.6 ft)*, a width of 1.95 meters *(6.4 ft)* and a height of 1.39 meters *(4.6 ft)* the large luxury-class two-door coupé the Audi prologue is somewhat shorter and lower than today's production A8*. A single frame integrated into the vehicle architecture and bearing the Four Rings dominates its low-slung front end. The large radiator grille has been widened significantly, and it is positioned lower than on today's production models.

The headlights – shaped like wide, flat wedges – are located with their tips above the Singleframe. High-resolution matrix laser technology is yet another instance of Audi breaking new ground in design and function.

In side profile, the Audi prologue's flowing silhouette expresses the car's forward-moving character. It balanced proportions equally emphasize the front and rear wheels – a clear reference to the quattro DNA of Audi. The mighty wheels are set in widely flared wheel arches; they are 22 inches in diameter and are fitted with tires sized 285/30.

The rear section of the Audi prologue also breaks with conventions. It is reminiscent of the side and rear appearance of a luxury yacht. Its separate tailgate means the Audi prologue piloted driving marries the practical strengths of a sedan with the aesthetic advantages of a coupé.

Its LED taillights made from 3D glass have also been designed anew yet are still characteristic of Audi. The taillight runs across the car's entire width, illuminating the frame of the recessed glass volume, as fine lines seem to hover amid the lamps. The brake light is set deeply inside the lamp. When it is activated, it appears to be approaching the viewer to attract even more attention. The play on different levels and the switch between two- and three-dimensional effects endows the taillights with a very special dynamic.

Innovative: the interior and control concept

On boarding the car, this grand coupé's passengers are greeted by an "electronic butler." An intelligent software identifies the user by his or her smartphone or smartwatch and adjusts the seats and the air-conditioning to suit. The system also makes recommendations for music and route planning that are oriented towards the owner's preferences. The Easy Slot system, an advanced development of the Audi phone box, is located under lids in the console on the central tunnel. It can mechanically draw in and store smartphones, connect them with the onboard infotainment and simultaneously charge them

Generous space: the interior

Tautly stretched lines and slender geometric forms give the interior a bright and clear ambiance. The instrument panel has a light and elegant appearance with its strictly horizontal layout that is not interrupted anywhere, and it emphasizes interior width.

It slopes down towards the interior on two levels. The upper level is positioned like a roof above the Audi virtual cockpit future – an evolution of the Audi virtual cockpit – and above the line of air vents. It is part of a wrap-around concept encompassing the driver and the front-seat passenger.

A second wrap-around connects the front and rear zone of the interior. On activation of the sound system, a novel sound spoiler emerges from the hat rack to create Audi's typical premium sound.

Full-width display: the Audi virtual interior

Embedded in the elegant architecture is a radically innovative display and control concept, the cockpit of the future, which completely does away with switches.

Across its full width, the front of the instrument panel is designed to be a display surface which integrates three touch displays. The display to the left of the steering wheel controls the lighting and assistance systems functions. The driver-oriented operating unit to the right contains media controls.

The Audi virtual cockpit future offers a glimpse into the future of the digital cockpit: High-resolution displays and three mirrors generate a virtual stage on three levels – a fascinating view with visual depth. Staggering information at different levels makes it better structured and easier for the driver to comprehend. The content and colors of the Audi virtual cockpit future change as a function of driving style – in sporty driving for instance, the display switches to Sport mode with especially vivid presentation of information such as engine speed, temperatures and charger pressure.

The front passenger faces a widescreen display integrated into the full surface of the instrument panel; it is used to operate the entertainment features with utmost convenience, enabling digital interaction with the driver for the first time. It is operated via gestures. A brief swipe by the copilot is all the driver needs to accept and transfer a preconfigured route into the Audi virtual cockpit future.

On the center tunnel console sits a fourth flexible touch display for climate control, handwriting input and other car settings. This display consists primarily of an extremely thin, bendable OLED film (OLED: organic light emitting diodes) and displays extremely sharp images rich in contrast. When not in use, the OLED display is integrated flush to the center console and is nearly invisible. When the car is started, the flexible display stands up. Its curved shape ensures a constant distance to the hand, making for better ergonomics. When operating the display, the wrist rests on the low-positioned gear selector lever of the eight-speed e-tiptronic.

Sporty, convenient and efficient: the technology

The technology of the Audi prologue is as sophisticated as its interior is thrilling. Its hybrid powertrain with a combined output of 505 kW (677 hp) and 950 Nm (*700.7 lb-ft*) of torque, delivers breathtaking performance. It takes this two-door coupé from 0 to 100 km/h (*62.1 mph*) in 3.5 seconds. Fuel consumption as measured under the New European Driving Cycle is just 7.9 l/100 km (*29.8 US mpg*) on average. This is equivalent to CO_2 emissions of 185 grams per kilometer (*297.7 g/mi*).

The biturbo V8 with direct fuel injection puts out 445 kW (597 hp) and 700 Nm (*516.3 lb-ft*) of torque. Another 50 Nm (*36.9 lb-ft*) are available in overboost mode, which the driver can actuate for about 15 seconds at a time. The 4.0 TFSI is meshed with a disc-shaped e-motor integrated into the eight-speed-e-tiptronic gearbox. The automatic transmission transfers both kinds of torque to the quattro permanent all-wheel drive system. The electrical energy of the hybrid drive comes from a rear-mounted lithium-ion battery with a capacity of 2.6 kWh. This enables a pure electric range of about three miles.

For the best networking experience: Audi connect

The Audi prologue piloted driving show car features the connect portfolio including an integrated LTE module. The Audi smartphone creates an onboard connection to Apple Car Play and Google Android Auto. If an iOS or Android cellular phone is connected to the USB port, the respective environment opens in the Audi smartphone interface. Both are tailored for use in the car.

Interaction with the Audi prologue piloted driving is possible via a smartwatch app enabling the user to access, lock and start the car. Users can also display up-to-the-minute vehicle information on their smartwatch and make configuration changes. For instance, a driver can call up the car’s remaining range or obtain directions back to his or her car.

Light technologies in the Audi prologue piloted driving show car

The car’s headlights feature Audi’s high-resolution matrix laser technology. Matrix laser technology opens up not just new avenues in design, but enables all-new possibilities.

The headlight’s pupils consists of a projection lens with a laser as its source of light. This generates a high-resolution matrix which illuminates the entire roadway. Set below this element are five synthetic lenses enhancing the headlights. They are fed via a glass-fiber strand and are optically encased in a delicate lightweight structure. Thanks to the new laser technology, light designers have been able to create a light, compact and elegant shape which provides the eyes for the "face" of the Audi prologue piloted driving. At CES, a dedicated exhibit will demonstrate the showcar’s matrix laser technology in all its details.

Light functions will be digitally animated. The car "greets" its driver on unlocking by switching on daytime running lights and taillights in a rapid movement from the car’s center to the edges. Subsequently, the matrix laser headlights’ reference cycle activates itself. These pupil-shaped headlight segment seem at first to move right, then left, after which all segments light up fully.

In designing the taillights, designers eschewed conventions and used 3D glass making the taillights benefit from all of the advantages of the new design leeway and run across the entire width of the car. Fine lines in the 3D glass appear to hover inside the lamp. The brake light is located deep inside the lighting unit. When braking, the bottom of the 3D imprint is also illuminated, which makes the light appear to move towards the observer.

The dynamic turning signal runs through the three-dimensional glass volume in a 200-millisecond sequence from inside to outside. The reversing light also makes an appearance from the car's center to the edges, another first. Though it is transparent and sits below a chrome strip, rendering it almost invisible, it will create a significantly increased level of attention in drivers following behind on activation. This configuration on different levels, and the alternation between 2D and 3D lighting provides the taillights with an entirely new dynamic.

Purism in top shape – the Audi TT Roadster.

Purism in its most beautiful shape: Audi presents the new TT Roadster* at CES in Las Vegas. This compact two-door model sets new standards in design, control and display concept as well as driveablility and user-friendliness.

The TT Roadster demonstrates its puristically sporty character from the moment the user opens its door. Switch on the ignition, and the Audi virtual cockpit comes alive. It presents all information in brilliant, vivid graphics, from the navigational map to the digital rev counter in the TT Roadster. Thanks to an all-new operating logic oriented on the concept of modern smartphones and including a free-text search, the MMI terminal requires a mere six fixed keys.

The infotainment program features a modular structure. Its pinnacle is MMI navigation plus with MMI touch featuring the second-generation modular infotainment matrix with the Tegra 30 graphics processor from NVIDIA. Audi connect as a complement operates on the fast transmission standard LTE (Long Term Evolution) and integrates a WLAN hotspot to bring customized Audi connect service into the car. Innovations in this area include an online media streaming offering, where the Audi MMI connect app enables access to services such as Aupeo! and Napster.

The Audi phone box makes it easy to connect a smartphone to the car, while the seatbelt microphone ensures excellent speech quality in telephone calls even with the top down. Another highlight is the simplified voice control system. The system now understands phrases from everyday language, meaning that hundreds of command variations are possible for each function. A special acoustic experience is provided by the optional Bang & Olufsen Sound System with its 680 watts of output power and twelve speakers in the open TT.

The electrically powered cloth top fits in perfectly with the car's athletic design and its philosophy of strict weight reduction. Handling is precise, too. This compact roadster, just 4.18 meters (*13.7 ft*) long, eagerly turns into curves thanks to its sensitive and direct steering.

The newly designed quattro permanent four-wheel drive brings driveability together with stability to create high fascination. The Audi drive select can be set to dynamic mode ant the ESC stability control to "sport" for maximum system dynamics. The new TT Roadster will now purposely steer into curves on lifting the accelerator, permitting controlled drifts under loads with a low friction coefficient. At the end of the curve, the car's front wheels will return the car to a straight line.

All three engines offer ample power even at low rpms. At the top is the 2.0 TFSI in the TTS Roadster* generating 228 kW (305 hp), the engine accelerating dynamically all the way to almost 7,000 rpms with a thrilling sound to match. 0 to 100 km/h (*62.1 mph*) is achieved in 4.9 seconds.

Power and elegance: the Audi RS 7 Sportback

Audi has sharpened the RS 7 Sportback* in many areas. Its 412 kW (*552 HP*) 4.0 TFSI with a torque of 700 Nm (*516 lb-ft*) translates into impressive performance. All this at an average of 9.5 l/100km (*24.8 mpg*) and CO_2 emissions of 221 g/km (*356 g/mi*). An eight-speed tiptronic tuned for sporty performance feeds the biturbo 8-cylinder engine's power to the quattro permanent all-wheel drive. Customers may add the optional sport differential, which actively distributes the power between the rear wheels.

Athletic elegance: the exterior design

Even at first glance, the Audi RS 7 Sportback reveals its dynamic character – its long hood, its sporty and flowing C-pillars and a sharply sloping rear end form an overall impression of athletic elegance. New design details add striking touches.

All lighting functions use light-emitting diodes as standard. The latter are optionally available with Audi's innovative Matrix LED technology and darkened covers. This offer includes turn signals with dynamic display at the front as well. It is standard at the rear in all cases.

In the elegant black interior dominated by the RS sports seats, the designers have unobtrusively reworked some areas. The standard MMI navigation plus with MMI touch uses the latest-generation modular infotainment platform. Its highlight is the high-performance Tegra 30 graphics processor from Audi's partner NVIDIA.

Audi connect also provides tailored Internet services for the driver: from navigation based on Google Earth and Google Street View to Facebook and Twitter. Drivers can also read, create and send text messages and emails. Among the latest Audi connect services are Online Media Streaming – which grants access to millions of music tracks in the car – and a Bluetooth interface to a linked smartphone's voice assistant, such as Siri for the iPhone.

The range of driver assistance systems is equally impressive. Its pinnacle is adaptive cruise control with stop&go function. Audi side assist, which uses radar to secure the rear of the car when changing lanes, now works closely together with Audi active lane assist, which prevents unintended lane changes. Important information can be called up via the optional head-up display.

Der Audi R8 LMX – the brand's dynamic spearhead

419 kW (562 hp), 0-100 km/h (*62.1 mph*) in 3.4 seconds – the Audi R8 LMX offers breathtaking performance and groundbreaking technology. This edition model of the R8 family* is the first series production car in the world to feature laser highbeams. A laser module in each headlamp generates a light cone with twice the range of a full-LED highbeam. The laser spot, which is activated at speeds of 60 km/h *(37.3 mph)* and above, supplements the LED high beam.

Limited run of 99: the Audi R8 LMX edition model

The Audi R8 is the brand's dynamic top model. The R8 LMX is available exclusively as a coupé with a production run limited to 99. Its 5.2-liter aspirated V10 produces 540 Nm (*398.3 lb-ft)* of torque at 6,500 rpm. This hurls the car from 0 to 100 km/h (*62.1 mph*) in 3.4 seconds. Top speed is 320 km/h (*198.8 mph*), and average consumption is 12.9 liters of fuel per 100 kilometers (299 grams CO_2 per kilometer) [*18.2 US mpg/481.2 g/mile*].

Fuel consumption in models above:

Audi TT:
Combined fuel consumption in l/100 km: 7.5 – 4.2**
Combined CO_2 emissions in g/km: 174 – 110**

Audi TTS:
Combined fuel consumption in l/100 km: 7.5 – 6.9**
Combined CO_2 emissions in g/km: 174 – 157**

Audi TT Roadster:
Combined fuel consumption in l/100 km: 7.5 – 4.2**
Combined CO_2 emissions in g/km: 174 – 114**

Audi Q7:
Combined fuel consumption in l/100 km: 10.7 – 7.2**
Combined CO_2 emissions in g/km: 249 – 189**

Audi A7 Sportback:
Combined fuel consumption in l/100 km: 9.5 – 4.7**
Combined CO_2 emissions in g/km: 221 – 122**

Audi RS 7 Sportback:
Combined fuel consumption in l/100 km: 9.5** ;
Combined CO_2 emissions in g/km: 221**

Audi R8
Combined fuel consumption in l/100 km: 14.9 – 12.4**;
Combined CO_2 emissions in g/km: 349 – 289**

Audi R8 LMX
Combined fuel consumption in l/100 km: 12.9
Combined CO_2 emissions in g/km: 299**

Audi A3:
Combined fuel consumption in l/100 km: 8.3 – 3.2**;
Combined CO_2 emissions in g/km: 194 – 35**

Audi S3:
Combined fuel consumption in l/100 km: 7.1 – 6.9**
Combined CO_2 emissions in g/km: 165 – 159**

Audi A6:
Combined fuel consumption in l/100 km: 9.6 – 4.2**
Combined CO_2 emissions in g/km: 224 – 109 **

Audi A3 Sportback e-tron:
Combined fuel consumption in l/100 km: 1.7 – 1.5**
Combined electricity consumption in Wh/km: 124 – 114**
Combined CO_2 emissions in g/km: 39 – 35)**

Audi A8:
Combined fuel consumption in l/100 km: 11.3 – 5.9**;
Combined CO_2 emissions in g/km: 264 – 149**

Audi A1:
Combined fuel consumption in l/100 km: 7.3 – 3.4** ;
Combined CO_2 emissions in g/km: 168 – 89**

**The fuel consumption and the CO_2 emissions of a vehicle vary due to the choice of wheels and tires. They not only depend on the vehicle's efficient fuel utilization, but are also influenced by driving behavior and other non-technical factors.