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Press release

AI code of ethics: Bosch sets company guidelines for the use of artificial intelligence

February 19, 2020
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▶ AI code of ethics: Bosch gives its associates a set of guiding principles and takes a stance in the public debate about AI.

▶ Leading principle: AI should be safe, robust, and explainable, and people should retain control over AI.

▶ Bosch CEO Volkmar Denner: "Our goal is that people should trust our AI-based products"

▶ Alliances and partnerships designed to build confidence in connected and intelligent products.

Stuttgart and Berlin, Germany – Bosch has established ethical "red lines" for the use of artificial intelligence (AI). The company has now issued guidelines governing the use of AI in its intelligent products. Bosch's AI code of ethics is based on the following maxim: Humans should be the ultimate arbiter of any AI-based decisions. "Artificial intelligence should serve people. Our AI code of ethics provides our associates with clear guidance regarding the development of intelligent products," Bosch CEO Volkmar Denner said at the opening of Bosch ConnectedWorld (BCW), the company's annual IoT conference in Berlin. "Our goal is that people should trust our AI-based products."

AI is a technology of vital importance for Bosch. By 2025, the aim is for all Bosch products to either contain AI or have been developed or manufactured with its help. The company wants its AI-based products to be safe, robust, and explainable. "If AI is a black box, then people won't trust it. In a connected world, however, trust will be essential," said Michael Bolle, the Bosch CDO and CTO. Bosch is aiming to produce AI-based products that are trustworthy. The code of ethics is based on Bosch's "Invented for life" ethos, which combines a quest for innovation with a sense of social responsibility. Over the next two years, Bosch plans to train 20,000 of its associates in the use of AI. Bosch's AI code of ethics

governing the responsible use of this technology will be part of this training program.

AI offers major potential
Artificial intelligence is a global engine of progress and growth. The management consultants PwC, for example, project that between now and 2030, AI will boost GDP in China by 26 percent, by 14 percent in North America, and by around 10 percent in Europe. This technology can help overcome challenges such as the need for climate action and optimize outcomes in a host of areas such as transportation, medicine, and agriculture. By analyzing huge volumes of data, algorithms are able to reason and make decisions. Well in advance of the introduction of binding EU standards, Bosch has therefore taken the decision to actively engage with the ethical questions that the use of this technology raises. The moral foundation for this process is provided by the values enshrined in the Universal Declaration of Human Rights.

Humans should retain control
Bosch's AI code of ethics stipulates that artificial intelligence should not make any decisions about humans without this process being subject to some form of human oversight. Instead, artificial intelligence should serve people as a tool. Three possible approaches are described. All have the following in common: in AI-based products developed by Bosch, humans should retain control over any decisions the technology makes. In the first approach (human-in-command), artificial intelligence is purely an aid – for example, in decision-supporting applications, where AI can help people classify items such as objects or organisms. In the second approach (human-in-the-loop), an intelligent system autonomously makes decisions that humans can, however, override at any time. Examples of this include partially automated driving, where the human driver can directly intervene in the decisions of, say, a parking assistance system. The third approach (human-on-the-loop) concerns intelligent technology such as emergency braking systems. Here, engineers define certain parameters during the development process. Here, there is no scope for human intervention in the decision-making process itself. The parameters provide the basis on which AI decides whether to activate the system or not. Engineers retrospectively test whether the system has remained within the defined parameters. If necessary, these parameters can be adjusted.

Building trust together
Bosch also hopes its AI code of ethics will contribute to public debate on artificial intelligence. "AI will change every aspect of our lives," Denner said. "For this reason, such a debate is vital." It will take more than just technical know-how to establish trust in intelligent systems – there is also a need for close dialogue among policymakers, the scientific community, and the general public. This is

why Bosch has signed up to the High-Level Expert Group on Artificial Intelligence, a body appointed by the European Commission to examine issues such as the ethical dimension of AI. In a global network currently comprising seven locations, and in collaboration with the University of Amsterdam and Carnegie Mellon University (Pittsburgh, USA), Bosch is working to develop AI applications that are safer and more trustworthy. Similarly, as a founding member of the Cyber Valley research alliance in Baden-Württemberg, Bosch is investing 100 million euros in the construction of an AI campus, where 700 of its own experts will soon be working side by side with external researchers and startup associates. Last but not least, the Digital Trust Forum, a committee established by Bosch, aims to foster close dialogue among experts from leading international associations and organizations. Its 11 members are meeting up at Bosch ConnectedWorld 2020. "Our shared objective is to make the internet of things safe and trustworthy," Bolle said.

More than 170 speakers and 80 exhibitors
Bosch ConnectedWorld (February 19–20, 2020) brings together more than 80 exhibitors showcasing the latest trends and developments in the connected world. Among the more than 170 speakers are Bosch CEO Volkmar Denner and Bosch CDO/CTO Michael Bolle, as well as Roland Busch (the deputy CEO of Siemens), Axel Stepken (the chairman of the board of management of TÜV Süd), and Scott Guthrie (executive vice president of Microsoft's cloud and AI group). The event's main features include keynote speeches, a major exhibition, and a hackathon. This year marks the seventh time Bosch ConnectedWorld has taken place. It is one of the world's largest international conferences devoted to the internet of things.

At a glance: The guidelines in Bosch's AI code of ethics
- All Bosch AI products should reflect our "Invented for life" ethos, which combines a quest for innovation with a sense of social responsibility.
- AI decisions that affect people should not be made without a human arbiter. Instead, AI should be a tool for people.
- We want to develop safe, robust, and explainable AI products.
- Trust is one of our company's fundamental values. We want to develop trustworthy AI products.
- When developing AI products, we observe legal requirements and orient to ethical principles.

Press materials: Text, images, videos, and other press materials will be available starting 09:30 CET on February 19, 2020, at www.bosch-press.com

Press photos: #959035, #2898173, #2912520, #1402989, #988670 #2719170

Contact person for press inquiries

Christiane Wild-Raidt,

Phone: +49 711 811-6283

Twitter: @WildRaidt

The Bosch Group is a leading global supplier of technology and services. It employs roughly 403,000 associates worldwide (as of December 31, 2019). According to preliminary figures, the company generated sales of 77.9 billion euros in 2019. Its operations are divided into four business sectors: Mobility Solutions, Industrial Technology, Consumer Goods, and Energy and Building Technology. As a leading IoT company, Bosch offers innovative solutions for smart homes, smart cities, connected mobility, and connected manufacturing. It uses its expertise in sensor technology, software, and services, as well as its own IoT cloud, to offer its customers connected, cross-domain solutions from a single source. The Bosch Group's strategic objective is to deliver innovations for a connected life. Bosch improves quality of life worldwide with products and services that are innovative and spark enthusiasm. In short, Bosch creates technology that is "Invented for life." The Bosch Group comprises Robert Bosch GmbH and its roughly 440 subsidiary and regional companies in 60 countries. Including sales and service partners, Bosch's global manufacturing, engineering, and sales network covers nearly every country in the world. The basis for the company's future growth is its innovative strength. At 125 locations across the globe, Bosch employs some 72,000 associates in research and development.

The company was set up in Stuttgart in 1886 by Robert Bosch (1861–1942) as "Workshop for Precision Mechanics and Electrical Engineering." The special ownership structure of Robert Bosch GmbH guarantees the entrepreneurial freedom of the Bosch Group, making it possible for the company to plan over the long term and to undertake significant upfront investments in the safeguarding of its future. Ninety-two percent of the share capital of Robert Bosch GmbH is held by Robert Bosch Stiftung GmbH, a charitable foundation. The majority of voting rights are held by Robert Bosch Industrietreuhand KG, an industrial trust. The entrepreneurial ownership functions are carried out by the trust. The remaining shares are held by the Bosch family and by Robert Bosch GmbH.

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Press release

BOSCH

Bosch.IO: new company pools the Bosch Group's IoT and digital expertise

February 17, 2020
PI 11098 RB Fi/af

► Bosch.IO GmbH employs more than 900 IoT and digital experts.
► Bosch CDO Michael Bolle: "Bosch.IO is bringing the internet of things to everything from roads and factory floors to homes and fields.
► Interdisciplinary customer support teams possess broad sector and software expertise.
► The focus is on the retail, energy, building, manufacturing, consumer goods, agriculture, and mobility sectors.

Berlin, Germany – Bosch has consolidated its activities centered on the internet of things in a new subsidiary. With some 900 associates, Bosch.IO GmbH is now one of the driving forces for IoT (internet of things) solutions, covering everything from consulting to implementation and operation. "With Bosch.IO, we are strengthening our position as a leading IoT company," says Bosch board of management member Michael Bolle. What sets this new Bosch subsidiary apart is that its software and hardware developers work with cloud specialists and user experience designers on IoT projects of future importance. "With Bosch.IO's new setup, we are combining the I and T in IoT to bring the internet of things to everything from roads and factory floors to homes and fields," says Bolle. The core element of the Bosch subsidiary's product portfolio is the Bosch IoT Suite. It is the central technical platform for IoT solutions.

Bosch.IO is a new Bosch subsidiary created by combining the former Bosch Software Innovations GmbH with other specialized IoT and digital teams at Bosch. Its executive management comprises Dr. Stefan Ferber, Dr. Aleksandar Mitrovic, and Yvonne Reckling. The company is headquartered in Berlin. Further locations are in Germany, Bulgaria, China, Japan, Singapore, Spain, and the United States.

Even closer to the customer

By creating Bosch.IO, Bosch has, for one, adopted a more sector-centric stance in its IoT business. For the other, customers' requirements figure even more prominently. "Our goal is to realize IoT projects faster and more efficiently," says Dr. Aleksandar Mitrovic, member of the Bosch.IO executive management. To this end, the company relies on interdisciplinary and agile teams that work together in ever-changing constellations. These include hardware and software developers, cloud specialists, solution architects, project managers, UX designers, business model innovators, and trainers. "We bring together people with the right skills for each IoT and digitalization project to meet customer requirements in the best possible way," says Mitrovic. These associates also have extensive experience in various sectors such as retail, energy, building technology, agriculture, manufacturing, consumer goods, and mobility. For its projects, Bosch.IO collaborates with Bosch's roughly 30,000 software developers and AI experts. "Together, we develop sustainable digital business models, seamless technical integration, and connected ecosystems for and with our customers," says Mitrovic.

Alongside highly specialized solutions for individual segments, certain services of the Bosch IoT Suite can be used for a multitude of applications. This increases efficiency in development and operation, since complex and labor-intensive basic tasks need only be performed once. This includes, for example, a service to connect and manage devices as well as update software and firmware over the air, which enables everything from vehicle fleets and security cameras to machinery to stay continuously up to date.

IoT projects with the help of artificial intelligence

With the new Bosch subsidiary and Bosch engineers collaborating closely, AI technologies are set to feature more prominently in future IoT and digital projects. One example is the use of data mining methods to derive rules for machine learning from big data. The knowledge gained can serve to conveniently and securely control different manufacturers' household appliances, among other things. Image comparison tools also benefit from AI: Bosch.IO uses them as part of Secure Product Fingerprint, an anti-counterfeiting solution. It identifies product surfaces, which offers consumers and business customers effective protection against counterfeit goods. AI-assisted methods also reliably detect when a two-wheeler has been involved in an accident and can automatically trigger an emergency call.

More than 10 million connected things

Bosch.IO can draw on many years' experience gained in more than 250 IoT projects for international customers. The core product of Bosch.IO is the Bosch

IoT Suite. It already connects more than ten million sensors, devices, and machines with their users and business applications, and it is Bosch's central software platform for IoT solutions.

Press photos: #2944460, #2944461, #2944462

Contact person for press inquiries
Annett Fischer,
Phone: +49 711 811-6286
Twitter: @Annett__Fischer

Bosch.IO GmbH combines the full set of consulting and implementation skills to deliver IoT and digital projects, focusing on the retail, energy, building, industry, consumer goods, agriculture, and mobility sectors. Bosch.IO has 900 experts on board, including consultants, coaches, cloud software developers, digital marketers, UX and business model designers, solution architects, and project managers. The interdisciplinary team works together at locations in Germany, Bulgaria, Spain, Japan, China, Singapore, and the U.S. to serve customers around the world. Drawing on a broad base of industry knowledge and a deep well of software expertise, this Bosch company has proven its merits in more than 250 IoT projects.

Learn more at www.bosch.io, www.bosch-iot-suite.com, www.blog.bosch.io

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Bosch IoT Suite connects cars, mobile machinery, and baby buggies
More and more enterprises are opting for the Bosch open IoT platform

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- ▸ From automakers to energy providers, businesses use the Bosch IoT Suite.
- ▸ Analysts confirm the open source platform's high quality.
- ▸ IoT edge functions and AI will grow in significance.

Berlin − What do cars, mobile machinery, an energy provider's data platform, and baby buggies have in common? Their connectivity comes courtesy of the Bosch IoT Suite, the core product of Bosch.IO, the new wholly owned Bosch subsidiary. The subsidiary has already deployed its IoT platform to carry out more than 250 IoT projects jointly with customers in the retail, energy, building, manufacturing, consumer goods, agriculture, and mobility sectors. "Bosch.IO projects epitomize the efficient development of scalable and secure IoT solutions using the cloud and the open-source-based Bosch IoT Suite," says Dr. Stefan Ferber, a member of the Bosch.IO executive management. The Bosch IoT Suite services customers opt for are then integrated into the cloud environments the customers prefer for their projects.

Versatile and proven
The Bosch IoT Suite is the core enabler of **Daimler's** firmware over-the-air updates. Some four million car owners already receive new versions of vehicle software − for example, infotainment system updates − conveniently and securely via the cellular network. This means they no longer have to visit their dealer solely to get a software update. The Bosch IoT Suite is the communication hub for vehicles on the receiving end of wireless updates.

For the Swedish baby buggy manufacturer **Emmaljunga**, Bosch has developed an assistance system with an extensive set of comfort and safety features. Called eStroller, it comes with powered push and automatic brake assist

functions, as well as a link to a smartphone app. Based on the Bosch IoT Suite, this app puts added features such as an alarm function at users' fingertips.

The energy provider **EWE** uses the Bosch IoT Suite to manage power consumption data in an efficient way. This also opens the door to value-added services. For example, the data can be used to analyze consumption and provide detailed, clear information about the biggest electricity consumers in the home. This helps users save energy.

The Bosch IoT Suite is not only used by customers such as Daimler, Emmaljunga, and EWE, but is also the central software platform for Bosch IoT solutions. For example, the Suite connects smart cameras from **Bosch Building Technologies** with the cloud and existing backends. This connection provides a cost-effective means of managing cameras throughout their life cycles and updating devices' and gateways' software and firmware.

A use case at **Bosch Rexroth** illustrates how the Bosch IoT Suite can be adapted to the requirements of the manufacturing sector. This Bosch subsidiary, which specializes in drive and control technology, used the Bosch IoT Suite to build BODAS Connect, its solution for mobile machinery. Open and scalable, this solution for end-to-end connectivity affords access to specific machine information. After-sales services such as software updates can be delivered at the touch of a button, even without service staff present on site. **Reform**, a manufacturer of municipal and agricultural vehicles, has also adopted BODAS Connect to quickly troubleshoot malfunctions in its mobile machinery.

Focus on edge computing and AI
The Bosch IoT Suite already connects more than ten million sensors, devices, gateways, and machines with their users and enterprise systems. And as Bosch IoT solutions increasingly feature artificial intelligence (AI), these systems will become more and more intelligent in the future. Bosch uses AI and the internet of things (IoT) to make people's lives easier and as safe as possible. Connecting devices directly to the cloud is one way to go, but more and more use cases are incorporating edge computing to great benefit. An edge device is internet-enabled, but can process its data locally. These devices send less data to the cloud to make the most of IT resources available across the network. The local logic enables these devices to respond faster and automatically to events. "More than 33,000 edge devices are now compatible with Bosch IoT Suite and connected via many protocols, both locally and over the internet," Ferber says.

In the future, Bosch.IO will also focus on pre-configured service packages that allow customers to implement IoT solutions more efficiently. To make these

packages, experts combine various Bosch IoT Suite service modules. One such module is the Bosch IoT Hub, an upscalable service for directly connecting (edge) devices via a gateway to the Bosch IoT Suite. It supports connections using standard and customer-specific protocols. "From device to cloud, customers can use our new portfolio to make their own integrated IoT applications," Ferber says.

Rated positively by analysts

The Bosch IoT Suite is based on open-source software developed jointly by experts from Bosch and other companies in the Eclipse IoT working group. That makes the platform unusually versatile. In its latest report, PAC – a consultancy that is part of the teknowlgy Group, the leading independent European research and consulting firm for IT companies – rated the Bosch IoT Suite as the best in class among all open-source-based IoT platforms. "We are delighted with this excellent rating for the Bosch IoT Suite," Ferber says. "Over the medium term, we expect the market for IoT platforms to consolidate. Of the estimated three to five platforms that will prevail, one will be open-source-based."

Press photos: #2718967, #2944459, #2892370, #1856470

Contact person for press inquiries

Annett Fischer,

Phone: +49 711 811-6286

Twitter: @Annett__Fischer

The company was set up in Stuttgart in 1886 by Robert Bosch (1861–1942) as "Workshop for Precision Mechanics and Electrical Engineering." The special ownership structure of Robert Bosch GmbH guarantees the entrepreneurial freedom of the Bosch Group, making it possible for the company to plan over the long term and to undertake significant upfront investments in the safeguarding of its future. Ninety-two percent of the share capital of Robert Bosch GmbH is held by Robert Bosch Stiftung GmbH, a charitable foundation. The majority of voting rights are held by Robert Bosch Industrietreuhand KG, an industrial trust. The entrepreneurial ownership functions are carried out by the trust. The remaining shares are held by the Bosch family and by Robert Bosch GmbH.

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Second Open Bosch Award goes to Poka and NextNav
Awarded startups develop solutions that empower factory workers and save lives

February 20, 2020
PI 11103

▶ Open Bosch Award honors outstanding open innovation projects
▶ Bosch CDO and CTO Dr. Michael Bolle: „Collaboration between Bosch and startup companies is a win-win situation for everyone involved"
▶ Several hundred partnerships between startups and Bosch in 2020

Berlin, Germany – Bosch recognizes Poka Inc. and Bosch Power Tools as well as NextNav LLC and Bosch Sensortec with the "Open Bosch Award" for best startup collaboration. The mutual benefit, best practice character and business impact of Bosch's partnerships with these two companies were exceptional. Poka, a Canadian startup, provides a mobile application for factory workers, empowering them to learn continuously, solve problems and share knowledge in real-time directly from the production floor. The technology developed by NextNav from California enables the three-dimensional location and positioning of mobile phones, autonomous vehicles and IoT devices. "Bosch has a long history of partnering with external startups," emphasizes Dr. Michael Bolle, Chief Digital and Technology Officer at Bosch. "Innovation through collaboration is not only our history, it is also our future."

Partnerships are a win-win situation for everyone involved
Recent research involving 340 international companies shows that partnerships with startups are expected to impact their total revenues by up to 19 percent in the three years following the start of the collaboration.[1] Especially in the high-tech industry, innovation through collaboration is key to sustained corporate success, as another report called "Status of Open Innovation in Europe" by Mind the Bridge and Nesta indicates. For this reason, Bosch is currently running several hundred startup collaborations across all of its business areas, with the majority focusing on the mobility sector.

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[1] Report "The age of collaboration II" by matchmaker ventures and Arthur D. Little

The ability to rapidly and continuously innovate is a core competency of Bosch. In a technology-fueled world with accelerating innovation cycles, Bosch is fusing ideas and competencies beyond company borders to best serve its customers. Startups play an important role as they are also often first-movers, taking high risks and being equipped with significant resources. At the same time, leading startups can benefit from Bosch assets and competencies, e.g. industrialization, market access or branding.

The combination of a startup and the industrial power of Bosch results in a benefit for all parties involved: customer, startup and Bosch. A partnership can create new challenges as well: Sometimes startups pivot and sometimes Bosch innovation projects change their direction. "All things considered, a great collaboration between Bosch and startup companies is a win-win situation for everyone involved," says Bolle.

Poka: Connecting Workers to Drive Performance

One of the awardees is Poka, a Canadian startup based in Quebec, which won together with a team from the Bosch Power Tools business division. Poka has designed an app especially for manufacturers. It supports on-the-floor training, knowledge building, and communication with all relevant colleagues – not only at one's own respective plant, but all over the world. Over the course of a six-month pilot, a Bosch Power Tools plant in Malaysia used Poka to streamline collaboration around production issues, including support for photo and video content. The team reported an impressive eight percent direct productivity improvement and is now in the process of rolling out the solution to all plants globally in the division.

"Poka has quickly become part of the plant's daily operations and is helping to capture best practices in a centralized, easy-to-access knowledge base," explains Arne Smolarz, Head of Manufacturing IT at Bosch Power Tools. Reflecting on the success of the partnership with Bosch, Alexander Leclerc, CEO from Poka says: "Poka was designed specifically to address the challenges and needs of large global manufacturers – many of whom are clients of Bosch. Our partnership with Bosch gives us tremendous credibility within our target markets."

NextNav: Invented for Life

Another Open Bosch Award goes to NextNav and Bosch Sensortec. The team has been collaborating since 2013. It has developed an innovative solution: a platform that localizes smartphones vertically and indoors by applying barometric pressure sensors in the phones and NextNav's MBS (Metropolitan Beacon System) technology. This makes it possible for rescue forces to identify the precise altitude or height position of people in buildings making an emergency call and to find them more quickly.

According to a recent report by the Federal Communications Commission (FCC), wireless providers will soon be required to meet an increasingly stringent series of vertical location accuracy benchmarks. NextNav and Bosch Sensortec successfully worked together to ensure the technology was consistent with guidance from the FCC. By 2021, the 25 largest cities in the US will benefit from their technical cooperation and later European cities as well, as NextNav is expanding its operations. "The long-term collaboration between Bosch Sensortec and NextNav is a great example of what is possible together: Making use of pressure sensor technology in smartphones, we offer an IoT service which can ultimately help to save thousands of lives,"[2] says Dr. Peter Weigand, Vice President Marketing at Bosch Sensortec. Dr. Arun Raghupathy, NextNav's Vice President of Engineering adds: "High quality sensors are important to determine altitude precisely. We are very pleased with our collaboration with Bosch, whose market-leading expertise in sensing solutions has been essential to providing floor-level altitude information to smartphones."

About the award

The Open Bosch Award values the importance of open innovation through close collaboration between startups and Bosch. The award is organized by Robert Bosch Venture Capital GmbH (RBVC). RBVC invests in startups and connects them to the Bosch group. To support early engagement RBVC established a venture client unit called "Open Bosch" that systematically enables partnerships.

Press photos: #2949726, #2949727, #2949728, #2943923, #2943922

Contact person for press inquiries:
Aron Bahnmüller
phone: +49-711-811-47950

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[2] Page 26, item 55 of FCC FACT SHEET - Wireless E911 Location Accuracy Requirements, Fifth Report and Order and Fifth Further Notice of Proposed Rulemaking - PS Docket No. 07-114

About RBVC GmbH

Robert Bosch Venture Capital GmbH (RBVC) is the corporate venture capital company of the Bosch Group, a leading global supplier of technology and services. RBVC invests worldwide in innovative start-up companies at all stages of their development. Its investment activities focus on technology companies working in areas of business of current and future relevance for Bosch, above all, automation and electrification, energy efficiency, enabling technologies, and healthcare systems. RBVC also invests in services and business models that are relevant to the above-mentioned areas of business.
Additional information is available at: www.rbvc.com

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About Poka Inc.

Poka provides a performance support application designed to give factory workers real-time access to work instructions, troubleshooting solutions and on-the-job training. The company's platform connects workers to digital manufacturing operations, and enables a culture of continuous improvement.
Contact: VP Marketing Andrea Masterton
741 de la Commune W. Montréal, QC, H2Y 2C6 Canada
amasterton@poka.io
Further information is available at www.poka.io

About NextNav LLC

NextNav's Metropolitan Beacon System (MBS)-based services enable mobile phones, autonomous vehicles and IoT devices to reliably provide position, navigation and timing services (PNT). They also serve as a backup to GPS in indoor and urban metropolitan environments. Delivered over a managed terrestrial network with carrier-grade dependability and metropolitan-wide coverage, NextNav's services are designed for public safety applications, E911, PNT services for critical infrastructure, as well as a multitude of consumer, IoT and commercial applications that require reliable 3D geolocation and timing services indoors and in urban areas.
Contact: VP Corporate Strategy Chris Gates
484 Oakmead Parkway Sunnyvale, CA 94085 United States
cgates@nextnav.com
Further information is available at www.nextnav.com

Connected vehicles, homes, factories:
Bosch smart solutions make everyday life easier
Highlights at Bosch ConnectedWorld 2020

▶ Connected mobility: more safety and convenience on the road

▶ Connected industry: self-learning machines as partners in manufacturing

▶ Connected buildings: intelligent assistants for apartments, houses, and commercial buildings

▶ Connected fields: higher agricultural yields and improved quality

Berlin, Germany – From sensitive AI robots in manufacturing and powerful computers for connected, automated mobility to smart homes: at Bosch ConnectedWorld 2020, the IoT industry event taking place February 19–20 in Berlin, Bosch will be demonstrating what the internet of things is already making possible today and what solutions will be making everyday life easier in the future – on the road, at home, and at work.

In motion: solutions for the mobility of today and tomorrow

Powerful computing for the electronics architecture of the future – vehicle computers: Increasing electrification, automation, and connectivity are placing ever higher demands on vehicles' electronics architecture. One key to the vehicles of the future lies in the new high-performance vehicle control units. Bosch vehicle computers will increase computing power in vehicles by a factor of 1,000 by the start of the next decade. The company is already producing these kinds of computers for automated driving, the powertrain, and the integration of infotainment systems and driver assistance functions.

Full power – services for electromobility: Bosch's Battery in the Cloud prolongs the life of batteries in electric cars. Smart software functions analyze the status of the battery based on real-time data from the vehicle and its surroundings. It recognizes stress factors for the battery, such as high-speed charging. On the basis of the data collected, the software then calculates measures to counter cell

aging, such as optimized recharging processes that mean less wear and tear for the battery. Convenience Charging, Bosch's integrated recharging and navigation solution, allows for a precise range forecast, route planning that includes recharging stops, and convenient recharging and payment.

E-mobility for the long haul – fuel-cell system: Mobile fuel cells offer long ranges, short refueling times, and − with hydrogen produced using renewable energy − emissions-free vehicle operation. Bosch plans to commercialize a fuel-cell stack that it has refined together with the Swedish company Powercell. In addition to the stack, which converts hydrogen and oxygen into electrical energy, Bosch is developing all the essential fuel-cell system components to a production-ready stage.

Connected products that save lives – Help Connect: Someone who has had an accident needs help fast − regardless of whether they are at home, on a bicycle, doing sports, in a car, or on a motorcycle. For these and any other emergency situations, Bosch offers a guardian angel in the form of Help Connect. Available as a smartphone app, this connectivity solution transmits lifesaving information to emergency services via Bosch service centers. The solution requires automated accident detection, for instance via the smartphone sensors or the vehicle's assistance systems. For this purpose, Bosch has added a smart crash algorithm to the acceleration sensors in its MSC motorcycle stability control system. Should the sensors detect an accident, they report the crash to the app, which immediately sets the rescue process in motion. Once it has been registered, the lifesaving solution can be activated at any time, in any place − automatically in connected devices or at the push of a button.

In development: solutions for the factory of today and tomorrow

Higher transparency and efficiency in manufacturing and logistics − Nexeed: The Nexeed Industrial Application System for Industry 4.0 provides all manufacturing and logistics process data in a standardized format and highlights any potential for optimization. This system has already helped individual Bosch plants achieve efficiency gains of up to 25 percent. Nexeed Track and Trace can optimize logistics as well: it monitors and tracks loads and load carriers by instructing sensors and gateways to regularly report their location and status to the cloud. This means logistics specialists and planners know where their box pallets, say, or production materials are at all times, and whether they will arrive at their destination on time.

Getting the right spare part fast − visual object recognition: In industrial manufacturing, as soon as one machine breaks down, the entire operation might

grind to a halt. Getting the right spare part quickly saves both time and money. Visual object recognition can help: the user takes a photo of the broken part on their smartphone and an app helps to rapidly identify the right spare. The basis for this process is a neural network trained with a wide range of image data. Bosch developed this system to cover all steps of the process: simply recording an image of the spare part, the algorithm for training the network with the image data, the app, and everything in between.

Sensitive robots − AMIRA research project: In the factories of the future, smart industrial robots will play an important role in manufacturing. The AMIRA research project employs machine learning and artificial intelligence methods in a bid to teach robots how to perform challenging tasks that require great dexterity and sensitivity.

In touch: solutions for buildings and infrastructure

Highly efficient supply of clean energy − stationary fuel cells: For Bosch, the solid-oxide fuel cell (SOFC) plays an important part in security of supply and energy-system flexibility. One intended use for the technology is as small, distributed power stations in cities, factories, data centers, and charge points for electric vehicles. Bosch recently invested 90 million euros in the fuel-cell expert Ceres Power, increasing its stake to some 18 percent.

The thinking building − Connected Building Services: How can an office building make the best possible use of its space? When should the air conditioning switch on in a particular part of the building? Are all of the attached lighting fixtures working? Bosch's sensor- and cloud-based Connected Building Services provide answers to these and similar questions. Based on data from a building, for instance regarding occupancy or air quality, these services support efficient building management. Users can adjust room climate and lighting in line with demand, increasing efficiency and reducing energy consumption. In addition, real-time data on the condition of elevators makes it easier to schedule and even predict maintenance and repairs, thus avoiding unplanned downtimes.

Expanded platform − Home Connect Plus: Home Connect, the open IoT platform for all things relating to Bosch and third-party household appliances, is extending from kitchen and laundry room to the rest of the home. Starting in mid-2020, the new Home Connect Plus app will let users operate other areas of the smart home regardless of manufacturer, including lighting, shutters, heating, entertainment, and gardening equipment. This will make life at home even more comfortable, convenient, and efficient.

<u>Apple pie with AI – ovens combine sensors and machine learning:</u> Crispy roasts, juicy pies – Series 8 ovens ensure premium results with the help of patented Bosch sensor technology. Thanks to artificial intelligence, certain appliances can now learn from their prior experience of roasting or baking. The more frequently a household uses the oven, the more precisely it can meet the predicted finishing time for whatever is cooking.

In the field: solutions for agricultural machinery and farms

<u>Digital ecosystem for smart agriculture – NEVONEX:</u> NEVONEX is an open and manufacturer-independent ecosystem that brings digital services to agricultural machinery, enabling the seamless connectivity of workflows and machines. It also serves as a platform where providers of agricultural technology or equipment can offer their services. Such services can be performed directly on existing or new agricultural machinery, provided it has a NEVONEX-enabled control unit. Connecting sensors already included in or retrofitted to the machine opens up further efficiency potential – for instance, to optimize the dispersal of seeds, fertilizer, or pesticides, or to automate workflows.

<u>An eye on freshness, growth, and the weather – smart sensor systems:</u> Bosch's connected sensor systems help farmers keep a constant eye on external influences – and respond in good time. With Deepfield Connect Field Monitoring, users receive data about, for instance, the weather and plant growth, directly on their smartphones. The Smart Irrigation system helps optimize water use in olive growing. Connected sensors in the tank allow the Deepfield Connect Milk Monitoring system to measure the temperature of milk, enabling dairies, dairy farmers, or tanker drivers to intervene before milk spoils. Another smart sensor system is the Greenhouse Guardian, which enables early detection of any plant diseases. Data on factors such as humidity or CO_2 levels is collected in the greenhouse, processed in the Bosch IoT Cloud with the help of artificial intelligence, and the infection risk analyzed.

Press photos: #2068019, #29444471, #2236620, #1369004, #1846404, #1453365, #2726726, #2828508

Contact person for press inquiries:
Caroline Schulke
Phone: +49 711 811-7088
Twitter: @BoschPresse

The Bosch Group is a leading global supplier of technology and services. It employs roughly 403,000 associates worldwide (as of December 31, 2019). According to preliminary figures, the company generated sales of 77.9 billion euros in 2019. Its operations are divided into four business sectors: Mobility Solutions, Industrial Technology, Consumer Goods, and Energy and Building Technology. As a leading IoT company, Bosch offers innovative solutions for smart homes, smart cities, connected mobility, and connected manufacturing. It uses its expertise in sensor technology, software, and services, as well as its own IoT cloud, to offer its customers connected, cross-domain solutions from a single source. The Bosch Group's strategic objective is to deliver innovations for a connected life. Bosch improves quality of life worldwide with products and services that are innovative and spark enthusiasm. In short, Bosch creates technology that is "Invented for life." The Bosch Group comprises Robert Bosch GmbH and its roughly 440 subsidiary and regional companies in 60 countries. Including sales and service partners, Bosch's global manufacturing, engineering, and sales network covers nearly every country in the world. The basis for the company's future growth is its innovative strength. At 125 locations across the globe, Bosch employs some 72,000 associates in research and development.

The company was set up in Stuttgart in 1886 by Robert Bosch (1861–1942) as "Workshop for Precision Mechanics and Electrical Engineering." The special ownership structure of Robert Bosch GmbH guarantees the entrepreneurial freedom of the Bosch Group, making it possible for the company to plan over the long term and to undertake significant upfront investments in the safeguarding of its future. Ninety-two percent of the share capital of Robert Bosch GmbH is held by Robert Bosch Stiftung GmbH, a charitable foundation. The majority of voting rights are held by Robert Bosch Industrietreuhand KG, an industrial trust. The entrepreneurial ownership functions are carried out by the trust. The remaining shares are held by the Bosch family and by Robert Bosch GmbH.

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