BMW GROUP

Corporate Communications

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BMW Forschung und Technik GmbH & EURECOM. Intelligent information and communication technologies for future vehicles.

Sophia Antipolis, France. Cooperation between business and science is beneficial to both sides. Companies are seeking new ideas from young academics and can recruit them more easily at the start of their professional careers. On the other side, students and postgraduates can gain experience in the field and establish contacts with potential employers. As early as 2006, the research company BMW Forschung und Technik GmbH has been collaborating with the institute EURECOM on the fast and efficient development of intelligent information and communication technologies for use in the automotive sectors.

EURECOM as an established partner in the BMW Forschung und Technik GmbH international research network.

The BMW Group owes its status as the world's most successful maker of premium cars to its outstanding competence in developments in all sectors relevant to sheer driving pleasure, sustainability, and safety. For over a quarter of a century, BMW Forschung und Technik GmbH has been paving the way. The researchers working at this think tank develop technologies and concepts for individual mobility. For the BMW Group, this research subsidiary is today the only competence centre in the world that serves as a source of innovation for safeguarding and advancing its lead in the fields of technology. Presently with about 200 employees at the Munich location, BMW Forschung und Technik GmbH operates as a single source of far reaching competence in the fields of automotive engineering, alternative drive and energy management concepts, active safety and driver assist systems, and information and communication technologies in the vehicle. Additionally it runs branch offices in the USA: the BMW Group Technology Office USA in Silicon Valley, Mountain View, California, and the Liaison Office Clemson, South Carolina. These branch offices foster close contacts with institutes of higher education like Stanford University or the Massachusetts Institute of Technology, high tech companies in other sectors, and other research facilities for the purpose of translating innovative trends and technologies to the automotive sectors. On both the German and European level there is likewise an

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intense exchange with research facilities and institutes of higher education. With a holding in the German Research Center for Artificial Intelligence (DFKI) in Saarbrücken, BMW Forschung und Technik GmbH advances the automation of intelligent behaviour and hence the “car of the future”. At the Munich Center of Automotive Research (CAR@TUM) set up jointly with the Technische Universität München, this BMW Group subsidiary has also secured for itself permanent contacts with young academics of potentially high calibre and with key findings from basic scientific research.

The pan-European university network EURECOM, a school of engineering and research centre in information and communication systems, has been an integral constituent of the BMW Forschung und Technik GmbH research network since 2006. Operating since 1991, this institute is headquartered in the high tech location of Sophia Antipolis, near Nice in the south of France. With the objective of integrating intelligent information and communication technologies quickly and efficiently in the car of the future, BMW Forschung und Technik GmbH and EURECOM join forces on interdisciplinary teams as soon as new developments emerge in networking technologies, broadband wireless networks, mobility, and security – true to the conviction that vehicle IT is the enabler for innovative functions that customers value in their cars, e.g. for entertainment or driver assist systems.

Triangular cooperation with Technische Universität München.

Following their successful work together over the last five years, BMW Forschung und Technik GmbH and EURECOM will continue to expand this cooperation. Specifically, the specialists have drawn a bead on the sector of next generation mobile networks for use in the networked vehicle. A mutual, intensified exchange of information between students, postgraduates, and employees will give rise to further promising ideas and in turn augment knowhow in vehicle IT, telecommunications, and microelectronics on both sides. This will go hand in hand with the training of highly qualified young recruits. Also TU München, for years an established partner of the BMW Group, will be included in future in the cooperation between BMW Forschung und Technik GmbH

and EURECOM. The research subsidiary of the BMW Group will then promote and concentrate interdisciplinary collaboration in teams from business and science.

BMW X5 research vehicle for EURECOM.
As a symbol of this cooperation's significance, BMW Forschung und Technik GmbH is donating a BMW X5 research vehicle to EURECOM. This vehicle, which is fitted with a prototype Software Defined Radio platform as part of the funded PROTON-PLATA project (programmable telematics onboard radio), is the product of work by both sides in recent years. Now it will be handed over to EURECOM for further research activities.

Two research projects introduce themselves.
The increasing use of heterogeneous radio standards and the growing networking capabilities of vehicles between each other and the traffic infrastructure (Car2X communicationc) require new ways towards realising a flexible and reliable communication architecture in the vehicle. The researchers are pursuing two new approaches with differing objectives in the projects PROTON-PLATA (programmable telematics onboard radio) and EVITA (e-safety vehicle intrusion protected applications).

PROTON-PLATA (programmable telematics onboard radio).

In the research project PROTON-PLATA (programmable telematics onboard radio), the specialists are developing a programmable telematics unit based on SDR (software defined radio) that allows for a flexible exchange of wireless radio standards via dynamic software updates. PROTON-PLATA is a project of DEUFRAKO, a Franco-German cooperation in traffic research conducted by BMW Forschung und Technik GmbH and Technische Universität München on the German side and by EURECOM, Thales, and INRETS on the French side. Launched in September 2008 and ending in June 2012, this project is funded by the German Federal Ministry for Economics and Technology and, on the French side, by the Agence Nationale de la Recherche (ANR) and the automobile cluster Mov'eo.

Today: many radio standards – many different control unit.

Today, we are faced with an ever growing number of new radio standards, for both digital broadcasting (e.g. DAB, DAB+, DVB-T, etc.) and mobile telecommunications (e.g. GSM, UMTS, LTE, WLAN, etc.). In the meantime, a diverse range of digital standards and radio frequencies have become established in each market. For the vehicle architecture, this means a large number of different electronic control units and special equipment variants for each country. Moreover, the field of digital standards is characterised by extreme volatility: virtually every two years, the prevailing radio standards are superseded by the next, improved generation. In contrast, the product lifecycle of a car is far longer, and therefore car drivers are not able to immediately enjoy the additional functionalities and services offered by these new radio standards.

In the future: ONE control unit for ALL radio standards.

In the PROTON-PLATA research project (programmable telematics onboard radio), software defined radio or SDR has been identified as a key technology that enables the implementation of co-existent wireless communication systems within one identical hardware. The application of one single hardware unit for multiple radio standards appears as an attractive solution to ease hardware cost and integrational complexity, in particular for automotive use cases. Due to its flexibility, adaptivity and re-configurability, SDR technology thus allows for reducing the number of control units and variants needed for a vehicle architecture and enables faster time-to-market for next-generation wireless radio standards and services. The use of SDR therefore promises an appealing solution with the advantage that car drivers can perform a simple software update – without a visit to the workshop – for fast and low cost integration of the latest radio standards at any time.

Enhancing traffic safety with ONE flexible telematics unit.

The combination of Software Defined Radio and telematics is a innovative approach: Based on SDR technology, telematics messages that are either transmitted over digital broadcast systems (FM/TMC, DAB/TPEG) or over dedicated communication channels

(e.g. between vehicles via Car2Car communications) can be received with only one electronic control unit. This is made possible by dynamically switching between the specific radio standards based on software.

A main objective of the project is the combination of local telematic data (via Car2X communications) and global traffic data (via digital broadcast standards). In particular, the use of Car2X communications that enables an extensive access to local telematic data, such as cross traffic information or local danger warnings, would increase the overall road traffic safety significantly in the future. The findings returned by PROTON-PLATA will therefore also benefit the research project “Safe and Intelligent Mobility – Test Field Germany (sim^{TD})”. Within a national alliance of various car manufacturers, this nationally funded project investigates Car2X communication scenarios in a field test in Friedberg, Hessen.

Experiencing the coexistence of multiple radio standards on one control unit.
In order to demonstrate the coexistence of different radio standards on an SDR platform, the researchers first integrated an example application in the trial vehicle in the form of a traffic light assistant. The traffic light assistant utilises Car2X communications to analyse the current traffic light status and the length of each individual signalling phase. The driver can therefore look a little further into the future and adjust his driving style with supreme ease to the traffic light phases – for reduced stress levels. Additionally the specialists opted to realise the reception of regional traffic news based on the digital broadcasting standard DAB, which informs the driver of the current traffic and congestion situation.

Investigations into further cost cuts.
As a means to fulfil the complexity, power consumption, and flexibility requirements of modern SDR systems, so called FPGAs are used as reconfigurable hardware devices. At the Institute for Integrated Systems at the Technische Universität München, the PROTON-PLATA project investigated a method for the time-multiplexed hardware reuse of FPGA resources by means of dynamic partial reconfiguration. The

objective of this investigation was to realise complex signal processing chains that have increased resource requirements on low cost FPGA modules.

EVITA (e-safety vehicle intrusion protected applications).

In the research project EVITA (e-safety vehicle intrusion protected applications), researchers are developing special security and privacy mechanisms for the exchange of information inside the vehicle, between vehicles, and between vehicles and the infrastructure, e.g. in Car2X communications. Sponsored by the European Commission within its Seventh Framework Programme, the research project was launched in July 2008 and will end in December 2011. Besides BMW Forschung und Technik GmbH and EURECOM, other partners to the project are the Fraunhofer Institute for Secure Information Technology (Germany), Robert Bosch GmbH (Germany), Continental Teves AG & Co. oHG (Germany), ESCRYPT GMBH EMBEDDED SECURITY (Germany), INFINEON TECHNOLOGIES AG (Germany), FUJITSU, MIRA LIMITED (Great Britain), TRIALOG (France), GROUPE DES ECOLES DES TELECOMMUNICATIONS (France), and KATHOLIEKE UNIVERSITEIT LEUVEN (Belgium). The predecessor projects were SeVeCom (2006 – 2009) and PRECIOSA (2008 – 2010).

EVITA – For reliable and efficient Car2X communications.

Thanks to the progress made with active and passive vehicle safety, the number of road fatalities has been constantly on the decline. Nevertheless, every accident that occurs is an accident too many. In order to reduce the number of traffic accidents even further, the specialists at BMW Forschung und Technik GmbH never cease to develop innovative and perfected safety systems. The development of these driver assistance systems assigns a special role to the so called Car2X communications, or the targeted exchange of information between vehicles and between vehicles and the traffic infrastructure. This ad hoc communications can then be used to send early and almost immediate warnings from one vehicle to other road users in the vicinity of accidents, building sites, and tailbacks. Some examples here are the intersection assistant and local danger warnings (e.g. obstacle warning, emergency vehicle warning, etc.).

Mastering the complexity of the vehicle IT architecture.

The increased use of these driver assistance systems introduces a growing level of complexity in the vehicle IT architecture. Today, depending on the vehicle class and equipment level, this architecture consists of a large number of sensors, actuators, and controllers that can be as many as seventy heterogeneous software and hardware components for the maximum installed range of equipment. In a modern vehicle, up to five different bus systems including CAN, LIN, MOST, and FlexRay operate and cooperate in parallel and via gateways for the transport of data. The growing level of a vehicle's external networking capabilities via wireless interfaces, e.g. Wi-Fi or the WLAN based standard 802.11p, means even greater exposure to the outside, making it more susceptible e.g. to attacks by hackers on in-vehicular communication and hence on the onboard network architecture.

The research project EVITA (e-safety vehicle intrusion protected applications) tackles this sensitive issue. The safe and reliable exchange of information – also between the driver assistance systems utilising Car2X communications – must be safeguarded everywhere and at all times. Therefore the research project EVITA is developing efficient and reliable security algorithms for the hardware. In the BMW 5 Series test vehicle, the researchers installed special security mechanisms for the Car2X function "Electronic Braking Light".

Security mechanism for safeguarding communication.

The EVITA project focuses on safeguarding the communication between a vehicle's controllers so that Car2X information sent by the vehicle enjoys a particularly high level of trustworthiness with respect to the environment. Here, the efficient and secure transmission of Car2X information utilises digital signature methods in the hardware. Rapidly changing pseudonyms effectively protect the customer's privacy at all times. For the efficient and reliable reception of Car2X information, the signatures are verified and manipulated data is detected. In the vehicle receiving the data, these are

forwarded safely and efficiently to the controllers and actuators over secure communication channels on the vehicle's bus systems.

Such secure communication chains can be consistently realised only when cryptographic algorithms are used for the digital signature and data encryption. The key material needed for this is initialised in each vehicle's electrical system and updated on a regular basis. When data are communicated from one controller to another, a key provides the digital signature and if necessary encrypts them for the required security level within the resource constraints. As a measure to maintain this security level at all times, despite restricted resources, the key material is updated on a cyclic basis by means of secure protocols.

In order to fulfil the requirements for secure external communication, the researchers have developed security mechanisms based on efficient hardware cryptography that quickly generate and verify signatures for the exchange of Car2X information. This takes the form of hardware accelerated cryptography based on elliptic curves (ECC). The customer's privacy is therefore protected by pseudonyms used to sign Car2X messages for external communication.

In the BMW 5 Series test vehicle, the researchers realised secure communication between controllers, sensors, and actuators in the form of the Car2X function "Electronic Braking Light". In a line of traffic, the Electronic Braking Light responds to sudden unforeseeable braking manoeuvres by the vehicle ahead and communicates this by means of the ultra fast EVITA hardware security module to the vehicles behind.

Privacy mechanism for the protection of personal data.
Besides the pseudonym protection of privacy, the customer's personal details must also be protected in the vehicle. In the EVITA project, the specialists demonstrate how personal information can be protected with secure storage and access control in the vehicle. Here, the EVITA hardware security module protects the key used to control

access to these data in the vehicle. These sensitive data cannot be decrypted and read out until authentication has been verified and the access regulations evaluated.

In the BMW 5 Series test vehicle, the researchers realised the protection of personal details based on the “valet parking” scenario. So that sensitive personal details, e.g. “Recent destinations” in the satnav, are not visible to strangers, these data are placed in secure storage when the driver leaves the vehicle. When he returns, only the owner of the vehicle can access these data following authentication and access control.

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