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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. Since 2006, the 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.

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 assistance systems.

BMW X5 research vehicle for EURECOM.

As a symbol of this cooperation's significance, BMW Forschung und Technik GmbH was 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 we will donate it to EURECOM for further research activities." (Karl-Ernst Steinberg, Manager Projects IT Drive at BMW Forschung und Technik GmbH)

Triangular cooperation with Technische Universität München.

Following their successful work together over the last six 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 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 the Technische Universität 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.

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Two current research projects of the cooperation.
The increasing use of heterogeneous radio standards and the growing networking capabilities of vehicles between each other and the traffic infrastructure (Car-to-X communications) 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 developed 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. In the future: ONE control unit for ALL radio standards.
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 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 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.” (Dr. Peter Fertl, PROTON-PLATA project leader at BMW Forschung und Technik GmbH)

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 Car-to-X communications) and global traffic data (via digital broadcast standards). In particular, the use of Car-to-X 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 Car-to-X communication scenarios in a field test around Frankfurt am Main, Hessen.

EVITA (e-safety vehicle intrusion protected applications).
In the research project EVITA (e-safety vehicle intrusion protected applications), researchers developed special security and privacy mechanisms for the exchange of information inside the vehicle, between vehicles, and between vehicles and the infrastructure, e.g. in Car-to-X communications. Sponsored by the European Commission within its Seventh Framework Programme, the research project was launched in July 2008 and ended 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, Infineon Technologies AG, Fujitsu, Mira Limited, Trialog, Groupe des Ecoles des Telecommunicatons and Katholieke Universiteit Leuven. The predecessor projects were SeVeCom (2006 – 2009) and PRECIOSA (2008 – 2010).

EVITA – For reliable and efficient Car-to-X communications.
The increasing application of connected driver assistance systems induces a higher level of complexity in the vehicle IT on-board architecture. Today, depending on the vehicle type and equipment, the vehicular on-board architecture can consist of a plethora of sensors, actuators, and up to 70 Electronic Control Units (ECUs) with numerous hardware and software configurations. 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 transmission of data. The increasing vehicle's external networking capabilities via wireless interfaces, e.g. Wi-Fi or the WLAN based standard 802.11p, implies greater exposure to the outside.
The research project EVITA (e-safety vehicle intrusion protected applications) tackles this crucial issue. The safe and reliable exchange of information – also for Car-to-X communication enabled driver assistance systems – 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 have installed special security mechanisms for the Car-to-X function "Electronic Braking Light".

Security mechanism for safeguarding communication.
The EVITA project focuses on securing the communication between a vehicle's Electronic Control Units so that Car-to-X information sent by the vehicle can be particularly trusted by the receivers. For the efficient and secure transmission of Car-to-X information, hardware-based digital signature methods are applied. Rapidly changing pseudonyms effectively protect the customer's privacy at all times. For the efficient and secure reception of Car-to-X information, the signatures are verified and manipulated data is detected. In the vehicle receiving the data, these are forwarded securely and efficiently to the Electronic Control Units and actuators over secure communication channels on the vehicle's bus systems.

In order to establish such end-to-end security chains, cryptographic security measures are used for signing and encrypting data. The required key material is initialised in every vehicle's on-board system and updated on a regular basis. When data are communicated from one Electronic Control Unit to another, a key is used for digitally signing and if necessary also encrypting the data transmitted. This is done in order to fulfil the required security level while considering the resource constraints of the embedded environment. As a measure to maintain this security level at all times, despite the 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 generates and verify signatures for the exchange of Car-to-X information. In order to accomplish this goal, special cryptographic hardware modules have been engineered. Such hardware accelerated cryptography is for example used for operations used in elliptic curve cryptography (ECC). With the application of changing pseudonyms, used to sign Car-to-X messages for external communication the customer's privacy is protected

Privacy mechanism for the protection of personal data.
Besides, the pseudonym-based privacy-protection for external communication, the customer's personal details must be protected within the vehicle, as well. 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 policies evaluated.

In the BMW 5 Series test vehicle, the researchers realised the protection of personal details based on the "valet parking" scenario. In order to prevent, that sensitive personal information, e.g. "Recent destinations" in the navigation system, are not accessible by others, these data are stored securely when the driver leaves the vehicle. Only the driver of the vehicle can access these data upon successful authentication when she returns to the vehicle.

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