Kapsch V2X.
Cooperative Systems.
Car connectivity is the keyword to enable a wide variety of information services for drivers, road operators, car manufacturers and public authorities. New communication technologies allow for dynamic real-time information to increase driver safety and traffic efficiency, provide payment services, commercial infotainment and to enable the collection of valuable data for environmental purposes.

Vehicle-to-vehicle (V2V) and vehicle-to-infrastructure (V2I) communication (together referred as V2X) is one core solution in the “connected car” environment. Road operators, infrastructure, vehicles, their drivers and other road users must cooperate to deliver the most efficient, safe, secure and comfortable journey. V2X will be a major contributor to this concept of cooperative mobility.

V2X is based on 5.9 GHz DSRC radio communication, a two-way, short-range wireless communications technology designed especially for moving objects like vehicles. In general it allows vehicles to exchange data with other vehicles and roadside units, sensors and actors similar to Wi-Fi communication, but using efficient ad-hoc networking features.

It all depends on the number of vehicles equipped with DSRC technology. With V2X every car is able to sense its surroundings. It can use information about vehicles in its vicinity to calculate its current and future positions thereby creating situational awareness. This enables a number of safety services for avoiding crashes or predicting dangerous situations.

V2I in particular can improve traffic efficiency and support eco-friendly driving. Depending on the traffic load, V2X roadside units can issue advisories to drivers recommending alternate routes or offering parking facilities near public transportation stations supporting multi-modal transportation. V2X equipped traffic lights can inform drivers about the time until the next traffic signal change or indicate the optimum speed to pass the intersection with green light.
The cooperative nature of V2X involves a number of business related and technical challenges which must be addressed. Accurate vehicle positioning data, a viable security concept, scalability of the overall system to millions of vehicles and fast penetration of the technology into all vehicles are among the major issues. Such a complex and huge system requires a thorough understanding of the underlying technology and system aspects across the entire value chain reaching from in-vehicle equipment, over roadside infrastructure, the security system and the central system to system rollout and the necessary business processes involved.
Kapsch V2X Product evolution.

Kapsch and V2X.

Kapsch TrafficCom is active in the field of 5.9 GHz V2X communication since 2007. Since then we have pioneered the development of standards and 5.9 GHz roadside and in-vehicle products, and have engaged in numerous technology show cases, Proof of Concepts (PoC), field operational tests (FOT) and research projects in Europe, North America and Asia.

The Kapsch V2X product portfolio evolved from the first V2X roadside unit, the MCNU and first RSU and OBU prototypes for the ITS World Congress in 2008, over dedicated trial products (e.g. for Volvo Trucks) to the first final products (e.g. the V2X roadside unit TRX/MTX 9450).

Kapsch V2X history.

Besides the participation in the European research project CVIS Kapsch has been active in several national research projects. In REALSAFE (Real-time Safety-related Traffic Telematics) the project team investigated the performance and developed a realistic non-stationary channel model for the 802.11p wireless link. The aim of the successive project ROADSAFE (Robust and Distributed Safety-Improved Traffic Telematics) was to improve the robustness of the channel according to the identified shortcomings. Our participation in the Christian Doppler labs research program deals also with the analysis and testing of the wireless channel while the new project ITS Evolution will be more focused on scalability, channel congestion and end-to-end service delivery.

In parallel to the research Kapsch was part of several PoC projects involving also commercial applications such as the Commercial Vehicle Operations trials with Volvo Trucks and NYSERDA (New York State Energy Research and Development Authority). In addition Kapsch contributed significantly to the finalization of the IEEE WAVE Standards. Our current activities are dedicated to the further development of an integrated version of V2X products for both the U.S. WAVE and the European ITS-G5 protocol suite with a special focus on in-vehicle on-board architecture and integration. Furthermore we concentrate on standardization, interoperability and the current challenges of a suitable security approach and the critical coexistence issues of ITS-G5 with the European 5.8 GHz CEN DSRC tolling technology.
Kapsch V2X involvement

Kapsch in V2X standardization
- ETSI: TC ITS, TC ERM – WG37
- CEN: CEN TC278 Plenary, WG1, WG12, WG18
- ISO: ISO TC 204 Plenary, WG4, WG5, WG16
- IEEE: IEEE 802.11 / TGp, IEEE 1609
- SAE: J 2735

Kapsch V2X research activities
- Testfield Telematik: A test bed for cooperative services, which aims at the mutual exchange of real-time information between vehicle and infrastructure to improve safety, efficiency and environmentally friendly mobility. 2011 – 2013.
- ITS Evolution: A research project to model the V2V2X radio channel and to enhance the scalability, coverage, and connectivity of V2V2X systems (Partners: ftw, TU Vienna, ASFINAG). 2012 ongoing.
- CVIS: Cooperative Vehicle Infrastructure Systems 2006 – 2010 (60 project partners).
An early adopter of V2X services will be commercial vehicles. Commercial vehicle compliance is a growing problem as freight traffic increases and public resources decrease. Intelligent compliance and efficiency services are needed to ensure safe commercial vehicle operations.

Commercial vehicle V2X is not only used for safety and compliance of commercial vehicles. It can also be used for driver and fleet services such as fleet telematics or traveler information. One key service that is utilized still provides a safety aspect. This is commercial vehicle truck parking availability. Kapsch TrafficCom North America in collaboration with HNTB and the Michigan DOT (MDOT) are delivering a Truck Parking Connected-Vehicle System at five sites along the I-94 corridor in Michigan. The Kapsch solution consists of a 5.9 GHz DSRC in-vehicle unit and roadside equipment with customized application software that together provide drivers with real-time truck parking availability information from MDOT facilities and private truck stops. This system is the first truck parking system to be deployed in North America utilizing 5.9 GHz -- the chosen technology for the US DOT Connected Vehicle Safety Pilot program. The system will be fully delivered in December 2013.

The benefits are multi-faceted. As drivers are planning a route it is critical that they know or identify where along their route there is available parking near the time their daily hours of service limit will expire. Knowing where available parking is will prevent drivers from extending their service day illegally and reducing the threat of a fatigued driver induced accident. Parking in approved parking lots prevents the incidences of private vehicle crashes into parked vehicles.

To support various international V2X pilot programs Kapsch developed the TS3306 aftermarket on-board unit. TS3306 is being utilized in several field and pilot tests and also targeted toward the Austrian research project and FOT “Testfeld Telematik” (telematics field test) and the U.S. Department of Transportation Aftermarket Safety Device (ASD) requirements for the Connected Vehicle Safety Pilot. TS3306 implements WAVE standards including IEEE 802.11p, IEEE1609 (IEEE 1609.2, IEEE 1609.3, IEEE 1609.4, IEEE 1609.11) and SAE J2735. Compliance to the emerging European standards according to ETSI ITS-G5 is currently in progress and has been validated during the ETSI Plugtest in June 2012.
The EVK-3300 is the first release in Kapsch product line of in-vehicle solutions for vehicle-to-vehicle and vehicle-to-infrastructure applications. The EVK-3300 is a fully featured V2X Evaluation Kit supporting several modes of operation that represents different product realizations for linefit, retrofit and aftermarket devices respectively. The EVK-3300 is the perfect platform for various proof-of-concept and feasibility tests within the V2X area utilizing IEEE WAVE® or ETSI ITS G5 protocols. The flexible, scalable and configurable nature of the EVK-3300 makes it an essential tool for the automotive industry in their evaluation of different architectural concepts and corresponding performance measures.

Target V2X Safety and Mobility Use Cases:

**Europe**
- Roadwork Warning
- Traffic Light optimal Speed Advisory (Signal Phase and Timing)
- In-Vehicle Information
- Probe Vehicle Data
- Weather Warning
- Status messages and routing updates
- Information on flight delays

**North America**
- Commercial Vehicle Inspection
- Electronic Toll Collection
- HOT Lanes
- Electronic Payment & Access Control
- Transit Signal Priority
- Traveler Information (SAE J2735 formats)
- Signal Phase and Timing (SAE J2735, CAMP formats)
- Applications for the US DoT Safety Pilot
  - Curve Speed Warning
  - Cooperative Intersection Collision Warning – Violations (CICAS-V)
  - Here-I-Am (Basic Safety Messages)
  - Basic Safety Message vehicle-to-vehicle safety advisories
Kapsch V2X Roadside Units.

The V2X roadside unit MTX-9450 is a compact roadside infrastructure device for wireless communications in the 5.9 GHz Dedicated Short-Range Communication (DSRC) band in compliance with the current status of ETSI ITS G5 and U.S. WAVE standards. The MTX 9450 Transceiver supports various V2I applications for road safety and traffic efficiency including IEEE 1609.2 security protocols.

Additionally, the transceiver supports external antennas and a GPS receiver. The MTX-9450 is a fully FCC certified unit.

Application variants:
- Fixed ITS station on highways for traffic information to vehicles (e.g. Variable Message Signs)
- Portable ITS Station for roadwork or other temporary warnings
- Stand-alone ITS station as generic communication gateway (e.g. in-vehicle signage on secondary roads)
- V2X extension for Traffic Lights
During the last years, the focus in cooperative systems has been in research and the specification of technical requirements. The standardization of requirements will be finalized in the near future. However, some challenges related to legal issues, overall security systems and the definition of common performance criteria for V2X equipment still have to be met.

Standards alone are only one important prerequisite for the deployment and market introduction of V2X. Joint efforts of all stakeholders are needed to establish hotspot areas consisting of roadside infrastructure, back office systems and customer relevant services.

The first real end-2-end field operational test “Testfeld Telematik” is one such hotspot which arouses the idea of Cooperative ITS. The establishment of a telematics testing field for cooperative services aims at the mutual exchange of real-time information between vehicle and infrastructure to raise safety, efficiency and environmentally friendly mobility. Testfeld Telematik aims at the collecting and processing of Floating Car Data (FCD). The data is also shared with other transport carriers and fed back to the drivers via the V2I communication infrastructure. Of particular importance is also that the intermodality with public transport is made attractive and simple, which is achieved by comprehensive co-modal traffic information for all means of transportation. Kapsch TrafficCom as a major project partner contributes with the delivery of roadside units, in-vehicle equipment, system design and implementation know-how to the project.
Most of the day one services are mainly related to driver safety and general mobility. But even today V2X can also provide valuable commercial services which in turn also support road safety and the environment. Commercial Vehicle Operations (CVO) is one key application as shown by the PrePass pilot project. By transmitting vehicle and driver related data of commercial vehicles to the control stations via real-time V2I communication, suspiciously dangerous trucks can be identified immediately and rerouted to the truck control stations. In combination with Weigh-In-Motion sensor systems this allows to efficiently enforce overloaded commercial trucks and improve road safety and the infrastructure.
Once deployed in large scale, cooperative systems will allow for advanced applications related to environmental friendly driving, safety and mobility. Via real time traffic data collected from vehicles it will be possible to define dynamic low emission zones or to operate traffic signal corridors for minimum pollution. V2I enables various payment services for fueling, battery charging and electronic toll collection.

The most ambitious application to date may be automatic cruise control (ACC) or vehicle platooning which eventually will end up in driver assistance and finally driverless driving. In combination with complex vehicle sensor technology V2X can provide the momentary behavior of a single vehicle to all other vehicles in the platoon. Creativity will be the key in the definition of new services for V2X leading to smarter and safer transportation.

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About Kapsch Group.
Kapsch is one of Austria’s most successful technology corporations, specialized in the future-oriented market segments of Intelligent Transportation Systems (ITS), Railway and Public Operator Telecommunications as well as Information and Communications Technology (ICT). Kapsch, headquartered in Vienna, is organized as a group company with the entities Kapsch TrafficCom, Kapsch CarrierCom and Kapsch BusinessCom. The companies of the Kapsch Group employ about 5,000 people around the world. Kapsch. Always one step ahead.