



Kapsch TrafficCom.

**We make your
traffic flow.**



Informationstechnisches Kolloquium

Funknetze für die Mobilität der Zukunft

Wireless Communication Networks for Mobility in the Future

Vienna University of Technology, May 17th 2011



5.9 WAVE: Status and Development.



Content

- What is 802.11p usw...
- Standardisation
- Developments
- Connected Vehicle Applications
- Research Projects and Partner
- Conclusion

ITS Wireless Technology for V2V and I2V Communication



Wireless Access Vehicular Environment – 5.9 ITS

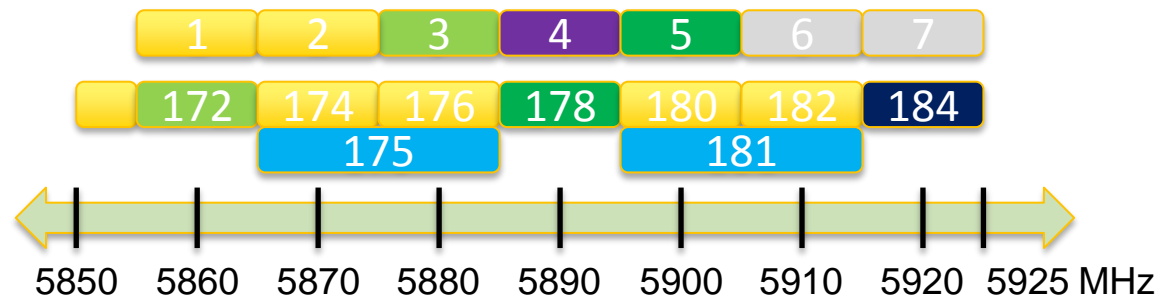
provides a two-way short- to- medium-range wireless communications capability that permits very high data transmission critical in communications-based active safety applications. In Report and Order FCC-03-324, the Federal Communications Commission (FCC) allocated 75 MHz of spectrum in the 5.9 GHz band for use by Intelligent Transportations Systems (ITS) vehicle safety and mobility applications.



ITS Wireless Communication in 5GHz

Wireless technology in 5GHz frequency band for safety (G5A), non-safety (G5B) and future (G5C) ITS applications.

- ITS - G5
- ITS - 5.9



1) ITS...Intelligent Transportations Systems

Physical Layer Characteristics of the Technology

- Based on IEEE 802.11a OFDM based technology
- Frequency band adapted according to local regulations in the 5.9GHz band
- Bandwidth in US 5, 10, 20MHz channels in EU 10MHz channels
- Transmit power in US max. 23/33/44dBm in EU 33dBm based on Channel
- Data rate 3Mbps – 27Mbps for 10MHz channels based on different modulation schemes
- CSMA/CA (Carrier Sense Multiple Access with Collision Avoidance)
- Optimized Access schemes considering low latency access requirements

Standardisation.



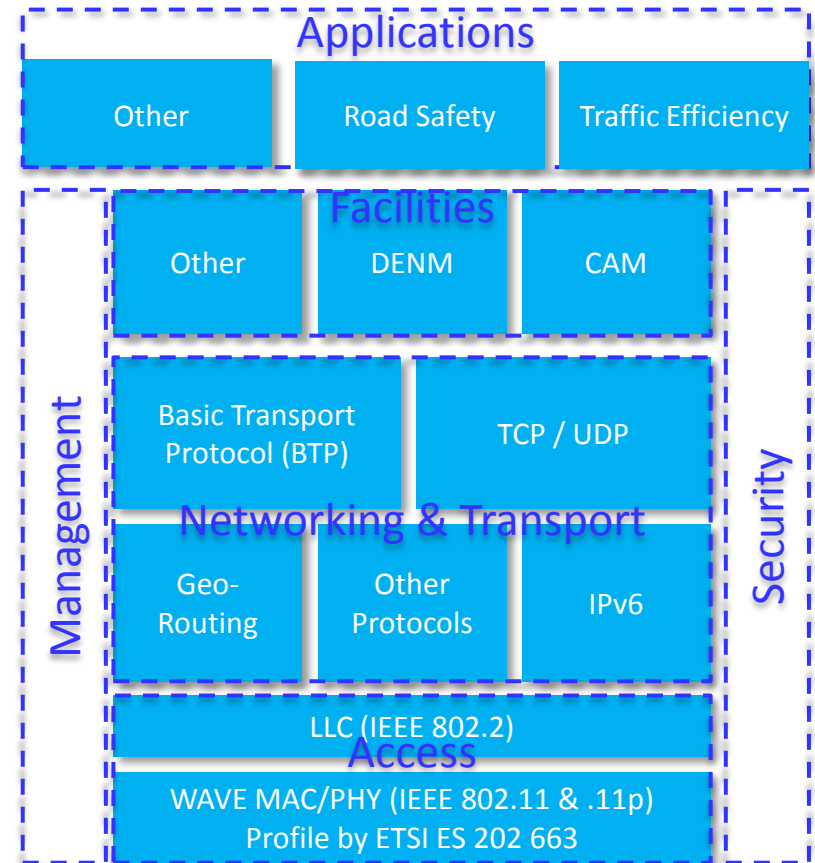
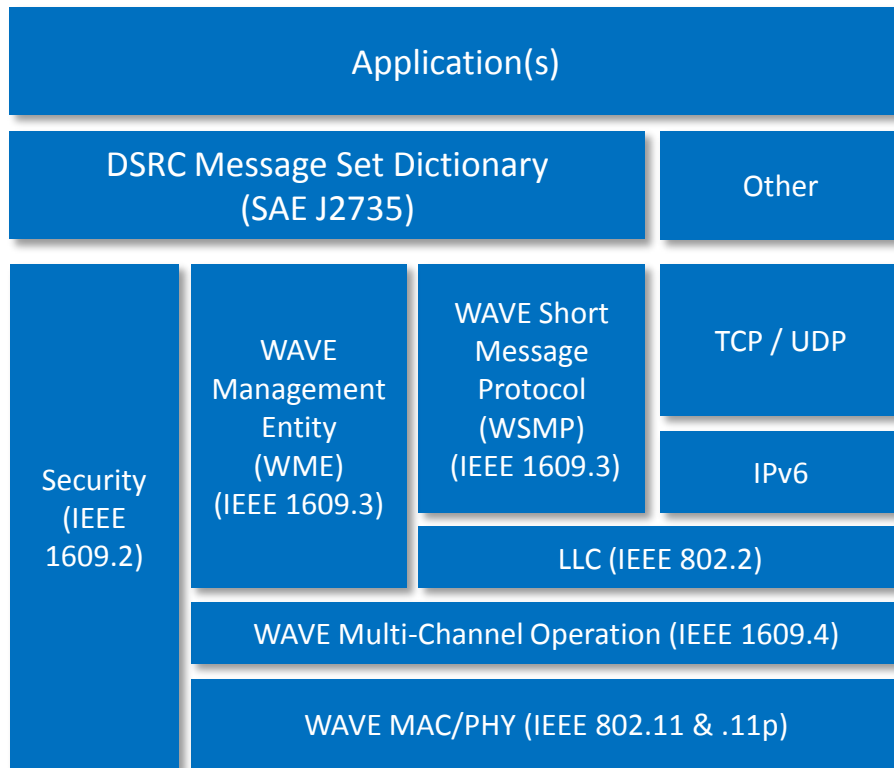
We have been participating, contributing and leading ITS standardisation from the very beginning.
Our products and solutions are standards-compliant .



ITS Connected Vehicle Standardisation Landscape



Wireless 5.9 WAVE vs G5 Protocol Stack



Standards for 5.9 GHz WAVE / DSRC

- **IEEE 802.11p**: Physical and medium access control layers for 5.9 GHz WAVE/DSRC (published, 2010)
- **IEEE 1609.0**: Security for 5.9 GHz WAVE/DSRC (final phase going, publication planned Q1/2012)
- **IEEE 1609.1**: Security for 5.9 GHz WAVE/DSRC (final phase going, publication planned Q1/2012)
- **IEEE 1609.2**: Security for 5.9 GHz WAVE/DSRC (final phase going, publication planned Q1/2012)
- **IEEE 1609.3**: Networking services for 5.9 GHz WAVE/DSRC (published, 2011)
- **IEEE 1609.4**: Multichannel operation for 5.9 GHz WAVE/DSRC (published, 2011)
- **SAE J2735**: DSRC Message Set Dictionary (V2 published, 2009)

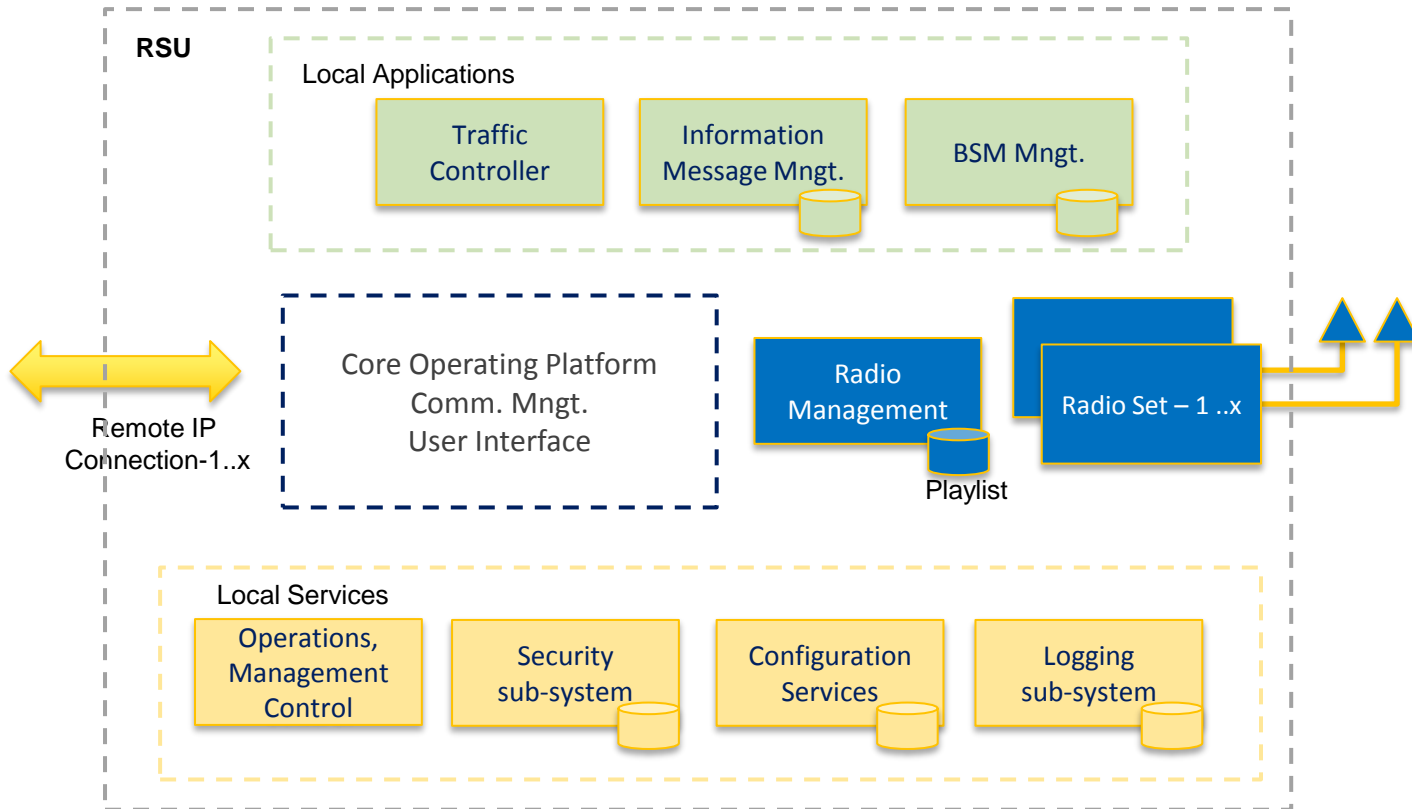
Standards for ITS G5

- **ETSI ES 202 663:** European profile on ITS 5G (IEEE 802.11 and IEEE 802.11p) (published)
- **ETSI EN 302 663:** Profile standard on ITS 5G (June 2012)
- **ETSI TS 102 636:** Geo-Networking
- **ETSI TS 102 636-5-1:** Geo-Networking, Basic Transport Protocol
- **ETSI TS 102 636-6-1:** Transmission of IPv6 Packets over Geo-Networking Protocols
- **ETSI TS 102 637-1:** Basic Set of Applications (Functional Requirements) (published)
- **ETSI TS 102 637-2:** CAM (Common Awareness Basic Service) (published)
- **ETSI TS 102 637-3:** DENM (Decentralized Environmental Notification Basic Service) (published)

Developments.

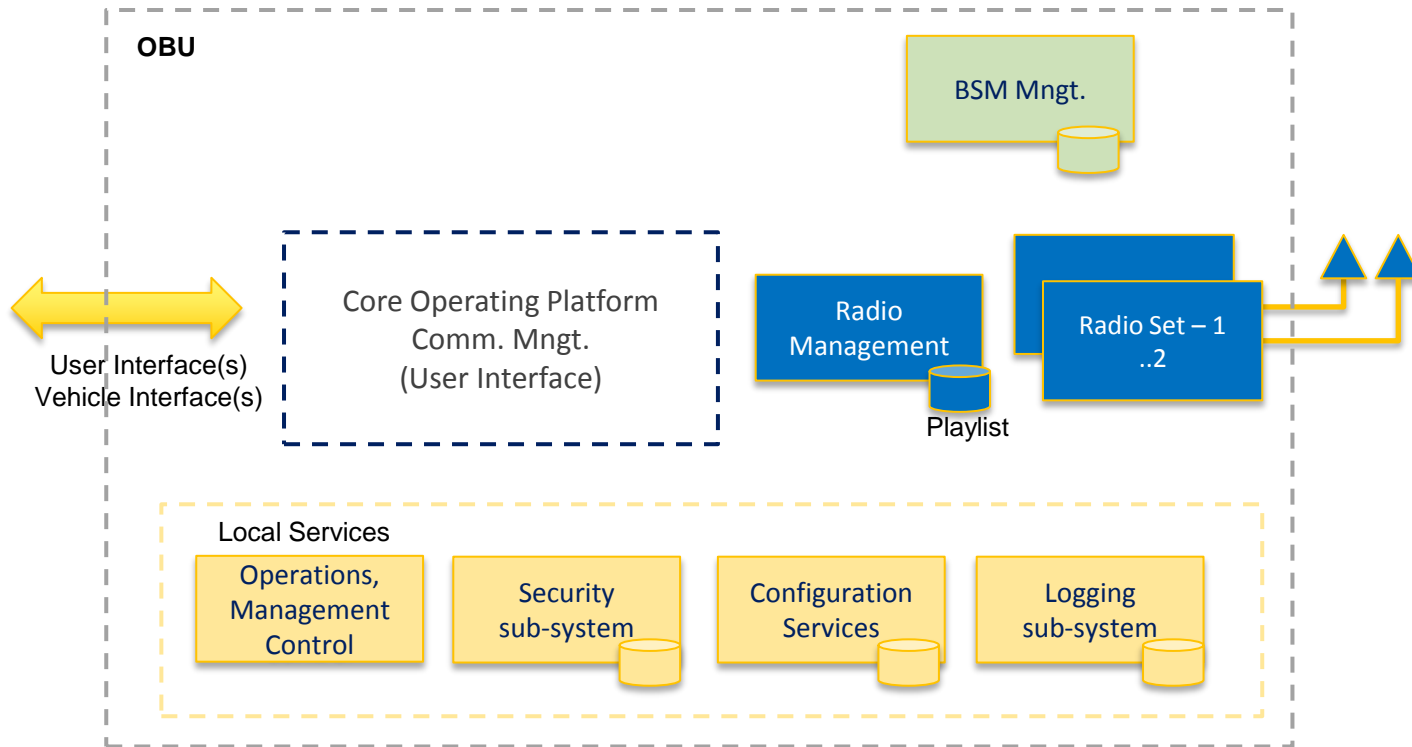


RoadSide Systems



RSU.. RoadSide Unit

OnBoard Systems

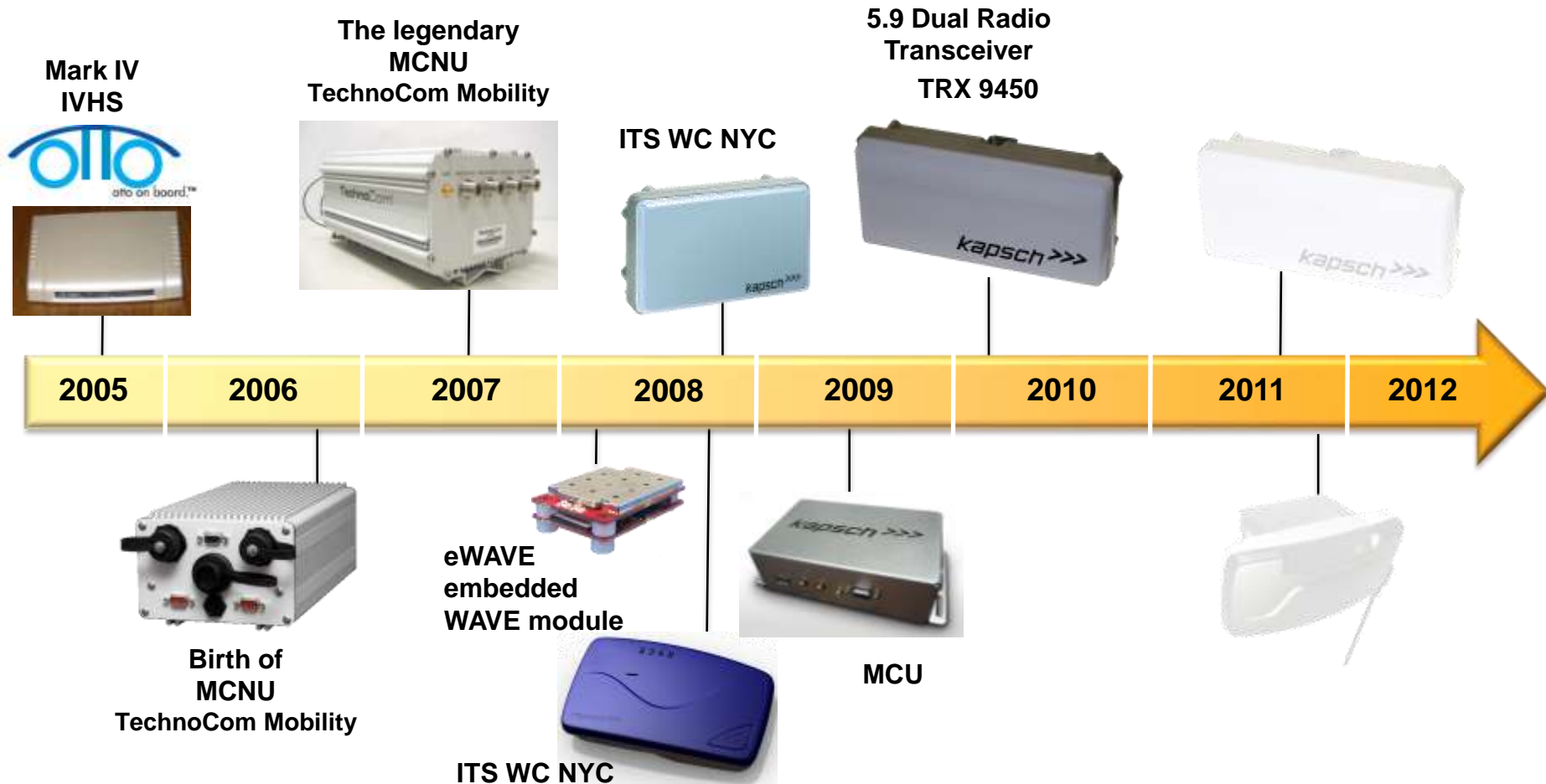


OBU.. OnBoard Unit

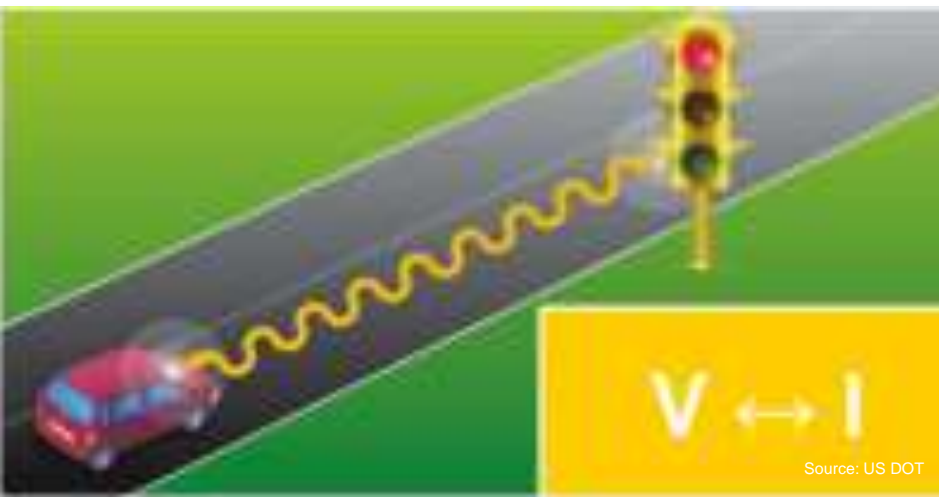
Issues in Focus

- Radio Frequency Channel Characteristics in Vehicular Environment
- Channel Capacity – Congestion / Utilization
- Interference – Co-existing with legacy services
- Security - Economy, Performance, Bandwidth / Channel Capacity
- GPS - Availability, Localization Accuracy

PoCs and Products



Connected Vehicle Applications.



Source: US DOT



Source: US DOT

Basic Safety Message (BSM)

- The basic safety message (BSM) is used in a variety of applications to exchange safety data regarding vehicle state. This message is broadcast frequently to surrounding vehicles with a variety of data content as required by safety and other applications. Transmission rates as 10 times per second is typical. Part I data shall be included in every BSM. Part II data are optional for a given BSM and are included as needed according to policies.
- BasicSafetyMessage ::= SEQUENCE {
.....
-- Part I
msgID DSRCmsgID,
secMark **DSecond**,
pos **PositionLocal3D**, lat Latitude, long Longitude, elev Elevation, accuracy PositionalAccuracy,
motion **Motion**, speed **TransmissionAndSpeed**, heading **Heading**, angle **SteeringWheelAngle**, accelSet
AccelerationSet4Way
control Control, brakes **BrakeSystemStatus**,
basic VehicleBasic, size **VehicleSize**,
-- Part II, Optional
safetyExt VehicleSafetyExtension OPTIONAL,
status VehicleStatus OPTIONAL,
}

Basic Safety Message Operation in Vehicles

- The Basic Safety Message was developed based on analysis of communications requirements for seven high-priority vehicle-to-vehicle application scenarios with significant anticipated safety benefits. These application scenarios and the research implementation of some of the applications are:
 - Intersection Collision Warning
 - Emergency Electronic Brake Lights
 - Pre-Crash Sensing
 - Cooperative Forward Collision Warning
 - Left Turn Assistant
 - Stop Sign Movement Assistance
 - Lane Change Warning

Here I Am Message (HIA)

- **HIA**
Here I Am
- The OBU will be used for identifying vehicle location, trajectory, and speed using the **SAE J2735 Basic Safety Message**. Messages will not include any personally identifiable information.
- Motivation:
increase and improve Safety and Mobility
- Objectives:
Enabling safety and traffic management applications (V2V and / or V2I) getting detailed view on the actual traffic environment.
- Benefits:
 - comprehensive collection of enhanced probe data
 - real-time status of traffic flow



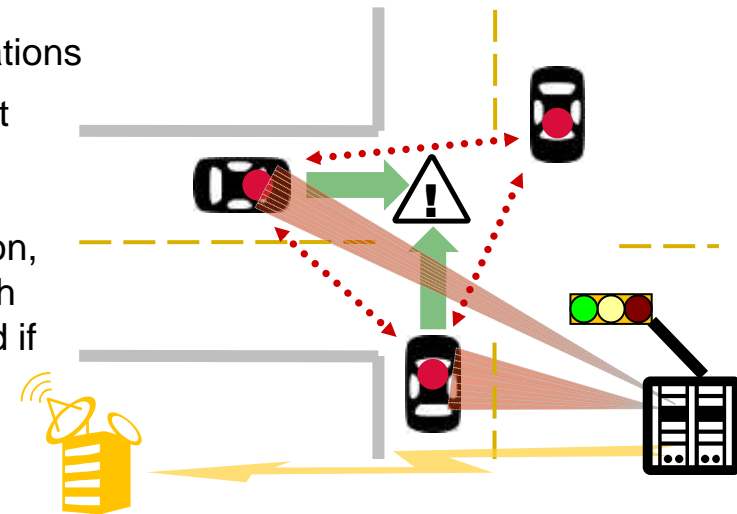
Source: US DOT

Cooperative Intersection Collision Avoidance System – Violations

■ CICAS-V

Cooperative Intersection Collision Avoidance System – Violations

Intersection collision warning systems are designed to detect and warn drivers of approaching traffic at high-speed intersections. The mobile device senses its speed, acceleration and deceleration (including braking) and the vehicle position, determine the approach on a correct lane and combine it with received traffic signal position and status (SPaT), timing, and if available weather conditions and create corresponding indications and warnings to be indicated on the driver-vehicle interface (visual indications, audio alerts)



- Motivation:
 - increase and improve Safety, Environment
- Objectives:
 - Reduction of traffic accidents, fatalities and minimize economical consequences
- Benefits:
 - Avoidance of traffic jams on intersections
 - Reduction of pollution

Traveler Information Message (TIM)

- The Traveler Information message is used to send various types of messages (advisory and road sign types) over the WSMP to vehicles.
- TravelerInformation ::= SEQUENCE {
 - ...
 - frameType TravelerInfoType, // -- (enum, advisory or road sign)
 - roadSignID RoadSignID // an ID to other data
 - startYear DYear OPTIONAL, //-- Current year used if missing
 - startTime MinuteOfTheYear,
 - durationTime MinutesDuration,
 - priority SignPriority,
 - commonAnchor Position3D OPTIONAL, //-- Part II, Applicable Regions of Use, a shared anchorpoint
 - commonLaneWidth LaneWidth OPTIONAL, // -- a shared lane width
 - commonDirectionality DirectionOfUse OPTIONAL, // -- a shared direction of use
 - regions SEQUENCE (SIZE(1..16)) OF ValidRegion,
 - advisory ITIS.ITISCodesAndText, // -- Part III, Content
 - workZone **WorkZone**, // -- typical ITIS warnings , -- work zone signs and directions
 - genericSign **GenericSignage**, // -- MUTCD signs and directions
 - speedLimit **SpeedLimit**, // -- speed limits and cautions
 - exitService ExitService // -- roadside available services

Curve Speed Warning

■ CSW

Curve Speed Warning

- Curve speed warning systems use roadside detectors and electronic warning signs to warn drivers, typically those in commercial trucks and other heavy vehicles, of potentially dangerous speeds in approach to curves.

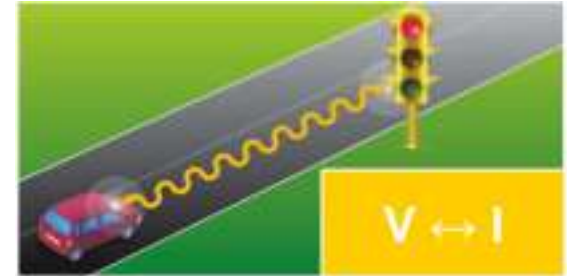
The Curve Over-Speed Warning Application makes use of the SAE J2735 messages, in particular the Traveler Information Message (TIM). The device receives this messages, extract relevant content and creates corresponding information (e.g. curve information, pre-warning, over-speed warning)

- Motivation:
increasing and improving Safety
- Objective:
To provide drivers in advance with useful information about a critical curve ahead encountering also changes in road conditions due to weather situation.
- Benefit:
Less accidents; avoidance of damages to life, infrastructure and goods.



Signal Phase and Timing

- The Signal Phase and Timing (SPAT) message is used to convey the current status of one or more signalized intersections. Along with the MSG_MapData message (which conveys a full geometric layout of the intersection in question) the receiver of this message can determine the state of the signal phasing and when the expected next phase will occur.
- The SPAT message sends the current movement state of each active phase in the system as needed (values of what lights are active and values of for what durations the light is expected to continue). The state of inactive movements (typically all red) is not normally transmitted. Movements are mapped to specific lanes and approaches by use of the lane numbers present in the message. These lane numbers correspond to the specific lanes described in the MAP message for that intersection.
The current signal preemption and priority status values (when present or active) are also sent. A more complete summary of any pending priority or preemption events can be found in the Signal Status message.



Research Projects.



We view our mission as consistently creating competitive advantages and benefits for our customers and partners by research and innovation.



ITS 5.9 Research projects and Partner



Cooperative Vehicle Infrastructure Systems

SPs COMM, FOAM; 2006 - 10



Realsafe

ftw*, ASFINAG, KTC, TU Vienna**, nast consult; 2008 - 09



Roadsafe

ftw*, ASFINAG, KTC, TU Vienna**, fluidtime; 2010 – 11 (ongoing)



Christian Doppler Lab

TU Vienna**, 2008 – ongoing, 802.11p MIMO Testbed



Positionsschätzverfahren für 802.11p

TU Vienna**, 2009 - Institute of Electrodynamics Microwave and Circuit Engineering

*) Forschungszentrum Telekommunikation Wien

***) Vienna University of Technology

Conclusion

- Finalize ETSI Standardisation
- Solve, improve system issues
- More Pilot Projects are needed
- Connected vehicle population must be increased for real experience
- OBU population must increase in order to increase connected vehicle population, After Market Devices are an Option
- Customer / User benefit must be identified and proven
- Less is More, focus must be on main applications at the beginning



R. Tugrul Güner

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Standardisation R&D**

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