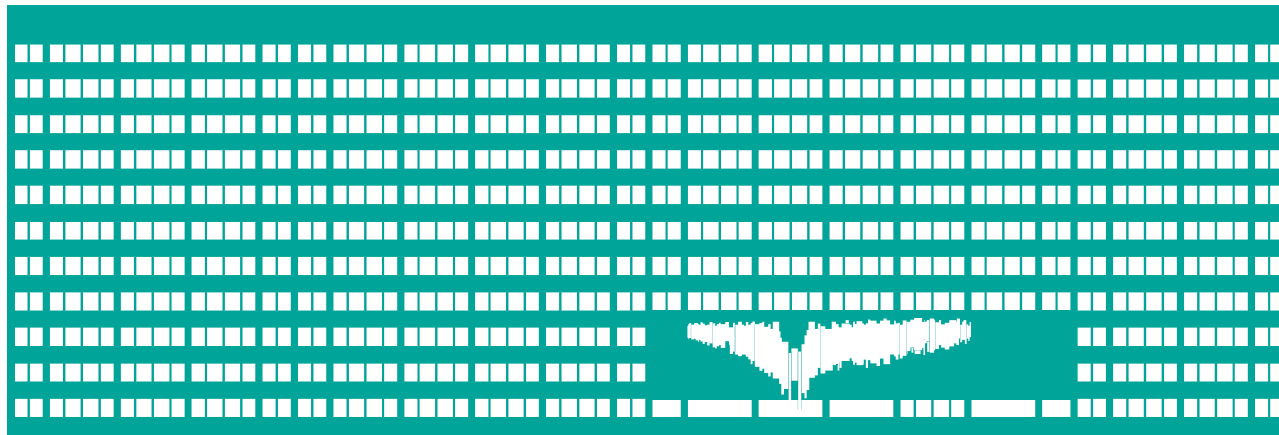


Mobile vehicular systems

Wearable devices



MS (Mobile Computing)
Lecture 12

Intelligent transportation systems

ITS adds information & communications technology to transport infrastructure and vehicles to improve safety & reduce vehicle wear, transportation times, and fuel usage. Key components are:

- Vehicular communication system (wireless)
- Embedded computational technologies – RTOS, embedded systems → ubiquitous, AI, model-based process control
- Sensing technologies
 - Inductive loop – inside roadbed, vehicle counting + more
 - Video vehicle detection – congestion, registration plates
 - ...
 - RFID-based systems
- Localization/speed/direction of travel/time data, e.g. floating car (or cellular) data – traffic flow from cellular networks, toll-collection systems or GPS.

ITS applications

- Payment services, especially electronic toll collection
- Emergency vehicle notification systems
- Automatic road enforcement
- Traffic optimization + Intelligent road signs, e.g.:
 - variable speed limit
 - dynamic traffic light sequence
- Collision avoidance systems
- Cooperative driving systems on the road
- Location-based services

Vehicular communication systems (1)

VCS – advanced communication systems, providing mainly localization, path selection & collision avoidance services. Communication can be divided into:

- Vehicle-to-vehicle or inter-vehicle (V2V)
- Vehicle-to-infrastructure (V2I)
- Vehicle-to-home (V2H)

Typically cellular & mesh networks are being used, but more often embedded HW & SW component emerge as well in following categories:

- On-board unit (OBU)
- Road-side unit (RSU)

Vehicular communication systems (2)

The communication has evolved to:

- Vehicle-to-Everything (V2X) – aim to dramatically improve traffic safety and efficiency. Infrastructure and all road-users and in the future pedestrians, securely exchange messages in order to indicate their location, speed, direction and other properties.
 - Vehicle-to-Motorcycle (V2M)
 - Vehicle-to-Pedestrian (V2P)
 - Vehicle-to-Device (V2D) – to e-bikes, e-scooters, ...
- V2X Evolution – V2X application phases “Day1” (simple sensors) → “Day3” (negotiations between road users).
- V2N (Vehicle to Network) – cellular network

Vehicular communication systems (3)

Additional components and technologies:

- Smart Intersection – Intersection with a V2X system and one or more vision sensors
- Dedicated Short Range Communication (DSRC) - direct communication between vehicles and other road users, mainly based on IEEE 802.11p with 5.9 GHz band
 - ETSI EN 302 663 draft – Intelligent Transport Systems (ITS); ITS-G5 Access layer specification for Intelligent Transport Systems operating in the 5 GHz frequency band
- C-V2X (Cellular V2X) – direct communication link between vehicles using cell networks, defined by 3GPP.
 - 5GAA (5G Automotive Association plays a role, too)

eCall

- Project intended to bring rapid assistance to motorists involved in a collision inside EU.
- Based on E112 which adds location information to 112 emergency calls. Autonomous function necessary.
- Hardware black box in vehicle sends wirelessly airbag deployment & impact sensor information together with accident location (preferably GPS, Galileo).
- Mandatory for all new cars (since 04/2018).
- Different prototypes have been successfully tested:
 - GPRS & in-band signaling over cellular networks.
 - This is the present implementation, as well.
 - Proprietary eCall solutions that rely on SMS

Car-2-Car communication consortium

- Car-2-Car communication (vehicle-to-vehicle)
- Car-2-X (vehicle-to-infrastructure)

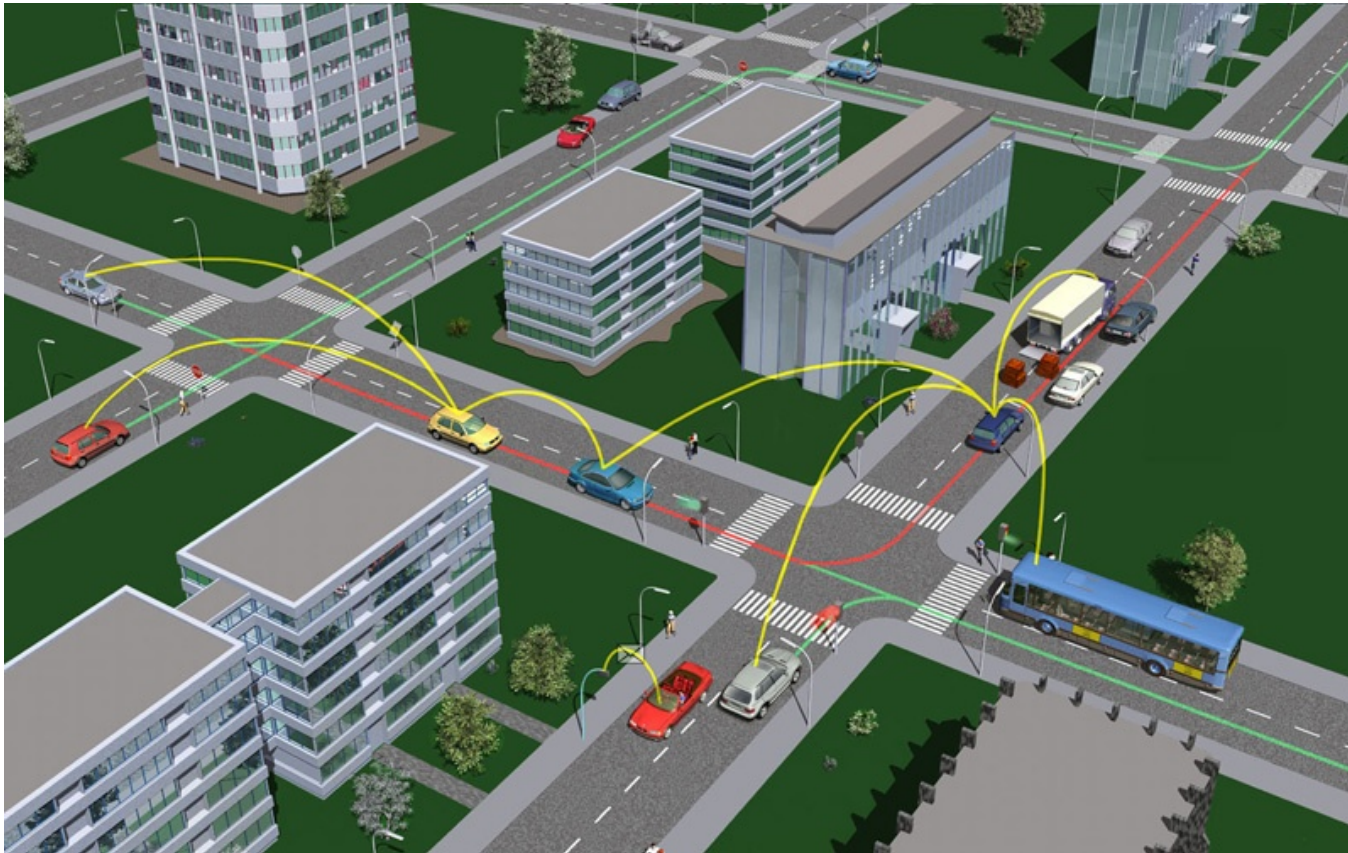


Image source: http://www.car-2-car.org/uploads/pics/BMW_3D_Car2Car_CityScenario.jpg

Car2Car CC goals

- Cooperation between manufacturers
- Establishment of open European standard
- EU-wide communication band allocation request
 - 5855-5925 MHz for all applications
 - 5875-5905 (5925) MHz protected – used for road safety
- Protocol stack & reference model definition
 - IPv6 based, support for MIPv6, NEMO for non-safety apps
 - 802.11p for Car2Car network
- Integration/cooperation with existing EU projects & worldwide activities
- Communication security issues

Car2Car applications

- Critical safety applications requiring a dedicated frequency band: intersection assistance, traffic merging, forward collision warning/avoidance
- Safety + other public applications, e.g. traffic flow improvement
- Commercial applications: infotainment, generic Internet connectivity
- Proprietary applications: telemetry, telediagnosics

Car2Car security

- Tests indicate, that 3 attackers were able to influence ~80 cars, 10 attackers ~200 in a city scenario (out of 400)
- Attack types:
 - In-vehicular infrastructure – physical access, wireless – must be prevented
 - External communication – at least detected & contained before influencing applications
- Security baselines:
 - Trustworthiness – Integrity, Authenticity, Availability, Non-repudiation, Access control, Confidentiality (?)
 - Privacy – Identity concealment – person/location privacy
 - Multiple identity management – vehicle IDs – telco, C2C, legal framework, driver ID (?)

Car2Car scenarios

1. Safety

- (a) Cooperative forward collision warning
- (b) Pre-Crash Sensing/Warning
- (c) Hazardous Location V2V Notification

2. Traffic efficiency

- (a) Enhanced Route Guidance and Navigation
- (b) Green Light Optimal Speed Advisory
- (c) V2V Merging Assistance (on-ramp, 2 lanes → 1 lane)

3. Infotainment + other applications

- (a) In-car Internet access
- (b) Point of Interest Notification
- (c) Remote Diagnostics

Wearable computers

Computers that are worn on the body. Sometimes this definition is extended to devices implanted inside of the body, such as RFID tags.

- Constant interaction with user is expected (always on).
- Application areas include:
 - Behavioral modeling
 - Health monitoring systems
 - Support systems for disabled people
 - Augmented reality
 - Media development
 - Access/ID systems

Wearable system examples

- Historical systems:
 - Some authors indicate that first WS was pocket watch
 - Systems for cheating in casinos – roulette, blackjack
- Head- & helmet-mounted displays, eye-glasses, visors
 - CGI-only image → virtual reality
 - Real-world image + CGI → augmented reality
- Forearm consoles, wrist computers, multi-function watch
- Belt computers
- Virtual keyboard, input devices in clothes
- US Army: parts of land warrior proj. use w.s. concept
- Now mainly fitness bands and smart watches
 - If we do not consider smartphones on hand holder, and similar.