Recent developments in road traffic control

Source of text and images: Swarco Drive On magazine, issue 01/18
’Intersection of things’ - development possibilities of signallised intersections

- CAN-based network
- New services supporting the concept of Internet of Things
- Other types of sensors can be connected to signal heads
  - Detectors
  - Air quality sensors
- Make the infrastructure ready for connected and automated driving
  - Send messages to vehicles on the traffic situation
’Intersection of things’ - development possibilities of signallised intersections

- Open interfaces for smooth integration
  - CAN protocol
  - Mandatory commands (e.g., switch on signal head) to guarantee interoperability among different vendors and system integrators
  - Optional commands for project-specific requirements

- Efficient maintenance
  - Retrieve detailed information on critical and non-critical failures
  - Predictive and event-triggered activities instead of periodic maintenance
  - Applying remote service patches via a firmware update
’Intersection of things’ - development possibilities of signallised intersections

- Increase energy efficiency
  - The power loss of the electrical interface between the signal controller and the signal head is minimum 5-6 W
  - It can be reduced to 1-2 W
  - Using LEDs, electrical disturbances can be eliminated

- Increase safety level and up-time
  - The system’s residual failure probability rate is at least below 10^{-7} failures per hour (SIL 3)
  - Handling non-dangerous failures independently
Cooperative ITS with Traffic Light Assistance

Drivers are informed when the next traffic light will turn green or red and get a speed recommendation.

Info is visualised on the dashboard of the vehicle or in an app.

Goals:
- Smooth traffic flow at the intersection
- Reduced emission by avoiding unnecessary stops
- More convenient driving experience

Real-life test with Swarco and Volvo in Trondheim, Norway, in 48 intersections.
New opportunities of traffic signals

- Directing a red light beam to the pavement
  - In order to mark the red light visible for people constantly looking at their smartphones
- Measuring $\text{NO}_x$, $\text{CO}_2$ and other traffic-generated greenhouse gases
  - Helps low-emission zones
- Automatic detection of pedestrians waiting to cross the street

V2X Solutions
Connected and cooperative infrastructure
V2X: Networked and cooperative infrastructure
Summary

- What is V2X or „Cooperative Systems“?
  - Standard messages
  - Standard applications
  - Standard communication technologies

- International innovation competition
  - Connected and highly automated driving can be efficient and safe only with V2X

- Promising benefits
  - Savings in energy and resource consumption
  - User experience for the traveller
  - Safety and efficiency gain in mobility

- Standardized
  - Messages have been defined in worldwide standards
  - Vehicles and infrastructure use the same standard.

- Technology is ready
  - Initial „Day1“ applications defined
  - 802.11p products for vehicles and infrastructure tested several times in laboratory and large field tests.

- Economic
  - Many applications are possible with one technology (often already cheaper than alternatives)
  - Tendency for price decreasing (global mass market)

- Development potential
  - Integration to cellular networks, further applications in research and development
Cooperative Systems in transportation
Future visions

- Real Time Traffic **data is shared** between vehicles, roadside infrastructure, traffic management centres and information services

- **Connectivity and multiple sources overtake classic detection**
  - ‘Cooperative’ functions are required in ‘classic’ products to stay in the market

- **Traffic lights ’see’ vehicles**
  - Distinguished by vehicle type (car, truck, bus, tram, emergency service)
  - Intersection OD-matrices

- **Vehicles and traffic lights cooperate actively:**
  - **Prioritisation** is distinctive. Public transport, emergency services etc.
  - Vehcles take into account **coordinated routes**, green waves and corridors
  - Every intersection is sender & receiver of **safety warnings**
What is V2X / Cooperative Systems
Technology aspects

Three key aspects
I. Defined content – i.e. Standard messages
II. Defined applications
III. Embedding in the existing environment

I. Standard messages

“Basis vocabulary“ for the communication worldwide
“Messages“ and their meaning

- Position, speed, direction of a vehicle: CAM - Cooperative Awareness Message (ETSI EN 302 637-2)
- Warning messages: DENM - Decentralized Environmental Notification Message (ETSI EN 302 637-3)
- Intersection traffic light status [and forecast] per signal group: SPaT - Signal Phase and Timing
- Driving relations through intersection: MAP - Map topology
- IVI: In Vehicle Information (ISO/TS 19321)

…and what is always upcoming
II. Defined applications

- **Roadworks Warning (RWW)**
  - Allow vehicles to “see” warning trailers

- **General (safety) warnings**
  - Mark upcoming area to be driven with care
  - Local Hazards
  - Share information on slippery road, jams ends, accidents,…

- **Cooperative Warning**
  - Is precise ‘on the spot’
  - Injects “electronic knowledge” on risks to our safety systems

- **Intersection safety: red-light violation recognition**
  - Vehicle / intersection can warn others
  - Vehicle safety assistant vehicle can (re-)act
II. Defined applications

Prioritisation

- Standard “CAM” messages are used to track continuously the approaching vehicle. Also R09.16 is part of the EU profile for CAM!

- Allow different specific prioritisation E.g.:
  i) trams & buses,
  ii) police & emergency services,
  iii) heavy goods vehicles

- Use V2X built-in security mechanisms to flexibly add & remove usage permissions; E.g. borrow buses from neighbour city for special event and use them in priority schema

Cooperative Prioritisation

- Saves fuel & reduces pollution
- Saves cost (no further technology added / V2X technology can be used for several use-cases, vendor independent)
- Is based on mass (V2X) technology
- Is flexible
- Comes with state-of-the-art security
II. Defined applications

- **Variable signs:** E.g. speed limits
  ![Image: drive-c2x.eu]

- **Shockwave damping**
  - Avoid creation and propagation of jam ends due to oversaturated traffic flow
  - Already shown in A58, NL
  - To be deployed in C-ROADS, Hessen, Germany

**Shockwave Damping**

*Image: trafficwaves.org*

- **Today:** congestion-wave in oversaturated traffic
- **Tomorrow:** Speed recommendations between signs directly to the on-board assistance systems

**Launch Q4/2018: C-ROADS**

**Hessen**

**Continental**
II. Defined applications

Traffic statistics
Use vehicle based data

Every second a probe:
V2X-CAM messages as source

- Probe data in intersections
  - Stops (per lane; before/after stop line)
  - Waiting and travel times
  - Origin- Destination (turn relations)

- One detector for several 100m
  - Speed / travel time
    on various lanes or ramps simultaneously
  - Congestion / disappearing of a jam

Cooperative traffic data
- Allows traffic analysis in a new dimension, since it is based on precise single vehicle data
III. Embedding in the existing environment

Modular concept

- Expansion of existing controllers with integrated V2X-functions

Separation of aspects

- Further independent development of
  - V2X Communication technology
  - V2X Standard messages
  - V2X Functional integration in dedicated controller

Today

- 802.11p ETIS ITS G5
- Standardised, tested, series-ready
- Free / no provider

In development

- V-LTE / D2D → 5G
- Project existing V2X standards, provider business model

In future:

- several low latency local communication
Further technology development
stable today – what we will have tomorrow?

Communication technology
Mobile network suppliers include connected and highly automated driving requirements into next generation developments

- **Mobile Edge Computing**
  - Low latency
  - Local, fast ‘computing’ resources as ‘cloudlet’

- **V-LTE**
  - Low latency
  - Device-to-Device (D2D) functions allow communication in case no centrally managed network is available

Bild: [http://inside5g.com/mobile-edge-computing-used-to-support-assisted-driving/](http://inside5g.com/mobile-edge-computing-used-to-support-assisted-driving/)

5GAA Meldung [im Handelsblatt](https://www.handelsblatt.com) und [bei Volkswagen](https://www.volkswagen.com)
Bluetooth detection in transportation

Source of text and images:
Swarco BlueDataSystem leaflet, Swarco 'Smart City'
Principle and methodology of measurements

- Sensors are placed to monitor the infrastructure.
- Bluetooth devices’ (e.g. smartphone, smart watch, speaker) unique ID is collected anonymously by the sensors.
- The occurrences of the same device are merged and the route and the time elapsed between bypassing different sensors can be reconstructed.
Stationary and temporary Bluetooth detection

- **Stationary:** for calculating current traffic situation
  - Absolute average speed between 0 and 200 km/h
  - Average travel times or travel speed
  - Dwell times at the intersection per direction
  - OD matrix

- **Temporary:** for planning and forecast
  - Redirections
  - Blockings
  - Traffic guidance
  - Analyse traffic quality and traffic distribution

- **Results are used to**
  - Illustrate the current situation and the control of
    - Traffic signals
    - Green - waves
    - Concierge systems
    - Traffic guidance systems
    - Traffic light prioritisation (active BT)

- **Collect their own data**
  - for simulations and predictions
  - to secure the historical situation
  - to analyse the before / during / after situation
  - for comparative representation
  - as a common basis of argumentation
Private transport analysis

- Level of Service
- Origin-destination

Analysis of waiting times
Public transport prioritisation
- BT recognition and tracking
Dynamic clear way

Special vehicle prioritisation and tracking
Blind persons (pedestrians) prioritisation