Car-2-X Challenges – Dreams and Nightmares

20.02.2008

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Car-2-X Challenges - Dreams and Nightmares

Agenda

- Dreams
- Reality
- Nightmares
- Mission
Car-2-X: Dreams

Definition: “Car-2-X” in this presentation

In scope:
- Short range ad hoc radio communication
  - Vehicle ↔ Vehicle
  - Vehicle ↔ Infrastructure

Out of scope:
- Communication backed by cellular networks
- “Telematics”-like use-cases
Motivation: Safety

- Fatalities 2005:
  - Germany: 5,361
  - France: 5,339
  - EU25: 41,274
- Lives saved

Can Car-2-X fill this gap?
Car-2-X: Dreams

Motivation: Traffic efficiency

- Congestion costs 1% of EU GDP
- Germany
  - 160,000 traffic jams per year
  - 288,000,000 l of fuel
  - 714,000 tons of CO2

Can Car-2-X reduce this?
Motivation: Comfort

- Point-Of-Interest notification
- Roadside advertising
- Wireless payment

Can Car-2-X create new businesses?
Car-2-X: Dreams

Motivation: Assumptions on system

- Simplicity
  - No need for infrastructure
  - Self-organizing nodes
  - Low latencies
- Cost efficiency
  - No communication fees
  - Cheap consumer-like hardware
- Security
  - PKI-based approach
  - Privacy preserving additions

Market introduction seemed within sight
Car-2-X Challenges - Dreams and Nightmares

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Dreams
Reality
Nightmares
Mission
Car-2-X: Reality

Diversity of projects
Immediate consequence: Use-case explosion

- Traffic signal / Stop sign violation warning
- General in-vehicle signage
- Left-turn assistant
- Intersection collision warning
- Pedestrian crossing information
- Emergency vehicle approaching warning / signal pre-emption
- Vehicle safety inspection
- Electronic licence plate
- Electronic driver’s licence
- In-vehicle Amber alert
- Stolen vehicle tracking
- Post-crash / breakdown warning
- SOS services
- Pre-crash sensing
- Event data recording
- Work zone warning
- Curve-speed warning
- Vehicle-based / Infrastructure-based road condition warning
- Safety recall notice
- Just-in-time repair notification
- Wireless diagnostics
- Software update / flashing
- Cooperative forward collision warning
- Emergency electronic brake lights
- Blind spot warning / lane change warning
- Wrong way driver warning
- Rail collision warning
- Highway merge assist
- Visibility enhancer
- Cooperative adaptive cruise control
- Cooperative platooning
- Cooperative glare reduction
- Adaptive drivetrain management
- Intelligent traffic flow control
- Road surface conditions to TOC
- Crash data to TOC
- Parking spot locator
- Enhanced route guidance and navigation
- Map download / update
- GPS correction
- Cooperative positioning improvement
- Instant messaging
- POI notification
- Internet service provisioning
- Mobile access to vehicle data
- Fleet management
- Area access control
- Electronic payment
- Rental car processing
- Hazardous material tracking
Car-2-X: Reality

Predicted penetration rates - Germany

- Growth model
- All new vehicles equipped, not only new types

Top-Down introduction not feasible

Cooperation among OEMs is vital

Legislation may help

Generation driven design is feasible

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In-vehicle cost explosion

- System complexity
  - Positioning
  - Navigation
  - CAN
  - Various means of connectivity

- Cryptographic hardware
  - Tamper proof / evident devices
  - Bursts of messages to verify
Car-2-X: Nightmares

Operational issues

- Security
  - No safety without security
  - Active intervention being maliciously hacked
  - Artificial breakdowns

- Operation and funding of infrastructure
  - Certificate Authority
  - Along the roadside
Overacting legislation in private transport sector

- Vehicle safety inspection
- Electronic licence plate
- Electronic driver’s licence
- Cloaked introduction of a “drive recorder”

Transparent drivers highly undesirable

Executive authorities must not hide

Exception: Commercial transportation
Car-2-X Challenges - Dreams and Nightmares

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Mitigate use-case explosion

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The Audi use-cases

- Improve mobility
  - Decentralized floating car data
  - Traffic light and signage assistance
- “Soft”-Safety
  - Obstacle warning
  - Vehicle-based road condition warning
- “Hard”-Safety
  - Pre-Crash sensing and preparation
  - Intersection collision warning

Single hop broadcast – Store and forward

Single hop connection between entities
Car-2-X: Mission

Single Hop Broadcast – Store and forward

- Simple, yet powerful

- Different events can be disseminated
- Very low requirements on penetration rates (2% - 5%)
- For relatively delay tolerant use-cases
- Overload conditions can be completely avoided

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Conclusion – How to fight nightmares

- Keep the customer in mind
- Always remember initial motivation
- Do not use Car-2-X just for the sake of it
- Standardise, where there is the need to
- Keep the system simple

Simple systems tend to be more robust and less expensive
Thank you for your attention!