Technical and Commercial Challenges of V2V and V2I networks

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Savari: V2X Experts

- Savari has developed an automotive grade connected vehicle platform for safety and mobility applications
  - Superb outdoor performance rivals all competition
  - Powered by Qualcomm & Intel chipsets

- Proven in various trials in Arizona, California, Michigan, Minneapolis, New York

- Developing technology simultaneously with eight OEMs
  - Selected for US DOT’s largest field operational trial in Ann Arbor, MI
TECHNOLOGY
V2X

V2I
Vehicle To Infrastructure

V2V
Vehicle To Vehicle
DSRC

DSRC – Dedicated Short Range Communications

Advantages

- Licensed Band – 75 MHz of spectrum in the 5.9 GHz band
- Low Latency
- High Reliability
- Prioritization – Safety applications given priority over non-safety applications
- Interoperability
- Security and Privacy
DSRC .. Contd

► Intended to provide a foundation for a variety of applications
  ► Vehicle Safety
  ► Emergency Vehicle Notification
  ► Automated tolling
  ► Enhanced Navigation
  ► Traffic Management
Worldwide Spectrum Allocation

Source: Activities on ITS Radiocommunications Standards in ITU-R and in Japan
V2X Global Standards

- SAE J2735 (U)
- CAM, DENM (E)
- IEEE1609.1-4 (U)
- Geo Networking (E)
- IEEE 802.11p (U)
- ITS G5 (E)

US/Europe
Connected Vehicle Research

- Mobility Applications
- Environmental Applications
- Safety Applications
Dynamic Mobility Applications

- Aimed at improving speed and decision making abilities of infrastructure system managers and system users
- Use frequently collected multisource data
- To enhance operations in general.

- Active Traffic and Demand Management
Environmental Applications

► Generate and capture real-time data to enable environmentally friendly practices
  ► Eco-driving
  ► Alternate Route Planning
  ► Public Transit
► Road Weather Connected Vehicle Applications
  ➢ Improve safety during adverse weather conditions
  ➢ Reduce weather related delays
  ➢ Optimize use of labor and other equipment
Safety Applications

- Emergency brake light warning
- Forward collision warning
- Intersection movement assist
- Blind spot and lane change warning
- Do not pass warning
- Control loss warning
- Weather-related vehicle stabilization activation
V2V Safety using DSRC

On-Board Unit
V2I using DSRC

- Interaction between Roadside Equipment (RSE) and vehicle’s On-Board Unit

- **RSE**
  - Broadcasts MAP and SPaT messages
  - Receives and tracks BSM’s from vehicles
  - Receives Signal Request Messages from Emergency Vehicles and manages signal priority
  - Can be used to collect performance measures
V2I Applications

- Transit Signal Priority
- Emergency Vehicle Preemption
- Work zone alerts
- Real-time Traveler Information Messages
- Pedestrian Assist
- Ramp Metering
- Parking Systems
- Curve Speed Warning
- Dilemma zone
- Freight Signal Priority
TECHNICAL AND COMMERCIAL CHALLENGES
Technical Challenges

- Spectrum Allocation
- Congestion

- Sub-meter
- Differential GPS

- Hierarchical Certificate Authority
- 3rd party

- Certificates
- Verify on Demand
Congestion Control

- Algorithms to control transmit power and/or rate or both with probabilistic approach

- Common Metrics
  - Packet Error Rate
  - Inter Packet Gap
  - Channel Busy Percentage
Scalability Testing

► US
  ► 100 car tests in Alameda (California). 200 car tests at TRC in Marysville (Ohio)
  ► Model deployment of 2700 cars by UMTRI & US DOT

► Europe
  ► SimTD testing of 120 cars in Germany

► Improvements with Congestion algorithms
  ► Improves channel utilization by 50% to 75%
  ► CPU utilization drops to 50%
Positioning

► Application Requirements
  ► WhichRoad (5m, 90% confidence)
  ► WhichLane (0.8m, 90% confidence)
  ► WhereInLane (0.5m, 90% confidence)

► RTK Servers
  ► Differential GPS corrections
  ► Corrections via WiFi/3G/LTE/DSRC
Security Domain

- CERT
- CRL
- CA
- Verify on Demand
Certificates

► OBU
  ► All message certificates (short-term and fall-back message certificates) are imprinted with a linked identifier that allows efficient revocation
  ► Manages certificate pool and certificate revocation lists
  ► Bad actor detection and reporting

► CA
  ► Does detection and revocation
  ► CA talks to Registration Authority and Local Authority

► Need constant connectivity with CA
  ► TCP or UDP
  ► How do we handle mobile scenarios?
Verify on Demand

► Certificate Scalability
  ► Need the OBUs verify every certificate from every message

► Solution
  ► Verify on Demand

► Verify the messages only that results in a warning or an alert or a hint to the driver
Connectivity with CA

► Security Framework Access Device (SFAD)

► A device that manages connectivity to the CA on behalf of the OBU

► Supports 3G/LTE/WiFi/DSRC/Ethernet
► Supports IPV6 router functionality
► Supports VPN tunnels
► Supports dynamic mobility and handovers
► Geocentric Routing
Certificate Management Systems

- PKI certificates are cumbersome and expensive
  - Certificates need to be maintained
  - Someone needs to setup and run the Certificate Authority (CA)
- Who pays for all of this?
  - OEMs
  - Vehicle Owners
- Solution
  - Collaboration between OEMs with regional and global hierarchy.
  - No need for federal funding
Technical Solutions: The BIG Picture

Scalable OBU

Flexible OBU

Communications
- Flexible Spectrum

Positioning
- Sub-Meter
- Differential GPS

Security
- Verify on Demand
- Trusted CA Hierarchy
Business Challenges

- 2013 Decision
- Government Mandate
- Early Deployments
- Aftermarket
- Consumer Demand
- Ubiquitous
- Long Term Trends
- LTE/WiFi Integration
Mandate – Soft or Hard

- Is mandate required? If so, what type? What’s the post mandate scenario?

- US
  - Government mandate decision in 2013
  - V2V first

- Europe
  - Start of voluntary deployment by 2015
  - V2V and V2I
Early Deployments for V2V

► Who is going to be the torch bearer?
► What channels?
  ► Aftermarket
    ➢ What applications will be the driving force?
► Who is the target customer?
  ► Fleet owners
► What target areas?
  ► Airports
► What verticals?
  ► Insurance Industry
Deployments for V2I

► US
  ► RSU
    ➢ 350,000 signalized intersections in US
    ➢ AAHSTO plans for 2020/2030

► Europe
  ► RSU
    ➢ Selected areas like big cities
    ➢ No need to cover the entire continent
SafetyPilot

- SafetyPilot
  - Driver Clinics
    - August 2011 – Early 2012
  - Model Deployment
    - Fall 2012 – Fall 2013

- Research Goals
  - Support the 2013 NHTSA agency decision by obtaining empirical data on user acceptance and system effectiveness
  - Demonstrate real-world connected vehicle applications in a data-rich environment
  - Establish a real-world operating environment for additional safety, mobility, and environmental applications development
  - Archive data for additional research purposes.
TRIALS AND TESTBEDS
V2X Global Deployment

- V2X Deployment is being planned globally
- Harmonization work is underway, but
  - There are still multiple standards in multiple geographic regions
- Trials are underway, but
  - Standards won’t be complete until trial-proven
US Safety Pilot Deployment

Key Site Elements:
- 75 miles of instrumented roadway
  - 29 roadside units
- ~3000 vehicles
  - Cars, trucks, buses
  - Integrated, aftermarket, and retrofit
- 1 year of data collection

Also:
- Exercising security options
- Vetting device certification process
US SafetyPilot - Equipment

- **Vehicle Awareness Device**
  - Capable of only sending the basic safety message (BSM) over a DSRC link with no warnings/alerts

- **Aftermarket Safety Device (ASD)**
  - Capable of sending/receiving the safety messages over a DSRC link. It has driver interface, runs V2V and V2I safety applications, issues audible or visual warnings and/or alerts to the driver of the vehicle

- **Road Side Unit (RSU)**
  - Capable of sending WAVE announcements integrated with V2I messages for road safety
Developments/Trends

► ADAS Integration
  ► Integration of co-operative safety with active safety systems like Cameras and Radars

► WiFi/LTE penetration
  ► More radios and antennas in cars

► Electric vehicle penetration
  ► Mileage Based User Fee… Need to collect road tax

► Current state: Only 2% of vehicles are connected
Coming Tomorrow:
Autonomous & Connected

- Side Blind-Zone Alert
- Long-Range Side/Rear Lane-Change Assist
- Short-Range Radars
- Digital Short-Range Communication + GPS (V2V)
- Forward Vision System
- Ultrasonic Sensors

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