The Future Connected Car

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Is the consumer happy?

Is technology running too fast or being delayed too long?

What should take priority – society or business?
Contents

- What is Cooperative Mobility
- Communications
- HMI
- Road Side Infrastructure
- The Consumer
- The Car (Vehicles in general)
- Conclusions
All vehicles are connected to form a cooperative driving society.
# ITS Application Roadmap

## Dependency on Regulation & Partnering

<table>
<thead>
<tr>
<th>Beyond 2018</th>
<th>2015 - 2018</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Highly Regulated</strong></td>
<td><strong>No Regulation</strong></td>
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<tr>
<td><strong>Cooperative Safety</strong></td>
<td><strong>Commercial, Efficiency &amp; Safety</strong></td>
</tr>
<tr>
<td>- Cooperative Forward Collision Warning</td>
<td>- Eco Vehicle / Eco Assist</td>
</tr>
<tr>
<td>- Contextual Speed Limits</td>
<td>- Truck-height checks</td>
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<tr>
<td>- Cooperative Cruise Control</td>
<td>- Car as a Sensor</td>
</tr>
<tr>
<td>- Fast lane platooning</td>
<td>- Parking Assist</td>
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</tbody>
</table>

**Use Case Highway**

<table>
<thead>
<tr>
<th>Before 2015</th>
<th><strong>Value-Add &amp; Mobility</strong></th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Closed Platform</strong></td>
<td>- Incident Warning</td>
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<tr>
<td></td>
<td>- E-Call</td>
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<tr>
<td></td>
<td>- Stolen Vehicle Tracking</td>
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<td></td>
<td>- Real-time Traffic Information</td>
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<td></td>
<td>- Remote Diagnostics</td>
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<td></td>
<td>- Fleet Management</td>
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</tbody>
</table>

**Beyond 2018**

- Cooperative Safety
  - Incident Warning
  - E-Call
  - Stolen Vehicle Tracking
  - Real-time Traffic Information
  - Remote Diagnostics
  - Fleet Management

- Commercial, Efficiency & Safety
  - Eco Vehicle / Eco Assist
  - Truck-height checks
  - Car as a Sensor
  - Parking Assist
  - Emergency Vehicle Warning
  - Green light Speed Advisory

**Before 2015**

- Cooperative Safety
  - Incident Warning
  - E-Call
  - Stolen Vehicle Tracking
  - Real-time Traffic Information
  - Remote Diagnostics
  - Fleet Management
The elements of a cooperative environment

- The car
  - Multiple communication channels
  - Autonomous functions
    - Speed, braking, steering
  - ADAS functions
    - Motion & status sensors, Heads-up display

- The infrastructure
  - Multiple communication channels
  - Sensor implemented view of roads
  - Autonomous traffic control functions
    - Incident management, flow control
The elements of a cooperative environment

<table>
<thead>
<tr>
<th>Year</th>
<th>Communications</th>
<th>Autonomous Functions</th>
<th>HMI</th>
<th>Applications</th>
</tr>
</thead>
<tbody>
<tr>
<td>2012</td>
<td>GSM</td>
<td>Braking</td>
<td>Navigation Screen</td>
<td>ADAS help</td>
</tr>
<tr>
<td>2014</td>
<td>LTE</td>
<td></td>
<td>ADAS Screen</td>
<td></td>
</tr>
<tr>
<td>2016</td>
<td></td>
<td>Speed</td>
<td>Heads-up Mirror</td>
<td>ADAS + Safety</td>
</tr>
<tr>
<td>2018</td>
<td>WLAN 802.11p</td>
<td></td>
<td>Heads-up Windscreen</td>
<td>Collision avoidance</td>
</tr>
<tr>
<td>2020</td>
<td></td>
<td>Steering</td>
<td></td>
<td>Safe fast platooning</td>
</tr>
</tbody>
</table>

Year of items introduced into mid range market
Contents

- What is Cooperative Mobility
- **Communications**
- HMI
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Communication around Car exploding

Many wireless communication types involved: Broadcast (A+D), Sensor, Wide Area, **DSRC (C2X)**

Broadcasting Type

- **Wide Area (Broadcasting)**
  - FM Multiplex Broadcasting 76~90MHz
  - VICS (Vehicle Information and Communication System):
    - Public Traffic information

Sensor Type

- **Sub-, Millimeter Wave**: 24/26, 76, 79GHz
- **ITS for Pedestrians**: (13.56MHz, 950MHz, 2.4GHz)
- **Radio Beacon**: 2.5GHz, 5.8GHz

Vehicle-to-Vehicle

- **700, 900MHz**
- **5.9GHz**

Vehicle-to-Road

- **Vehicle-to-Road Infrared**
- **Vehicle-to-Road**
  - **ETC / DSRC**
    - ETC: Electronic Toll Collection
    - DSRC: Dedicated Short Range Communication
- **Parking lot (Auto Fee collection)**

Addressed by NXP

Not addressed by NXP
Dependency on Wireless Technology

Safety & Efficiency
- Hazardous Location Notification
- Forward Collision Warning
- Pre-Crash Sensing
- Curve speed warning
- Emergency electronic brake lights
- Traffic signal violation warning
- Lane change warning
- Green Light optimal speed Advisory

Convenience, Security & Online services
- eCall, Stolen Car Tracking
- Remote Smart phone management
- Remote Diagnostic
- Pay As You Drive
- Fleet Management/Car share
- Car as a Sensor
- E-Car - Car Charging
- Road-Tolling
Car Platooning on High Speed Lanes
MK3 – Transparent Truck

Field trial on A2 highway based upon MK3

- MK3 not losing connection
- COTS device losing connection on red color

Safety Message Failure Rate

- 90 km/h highway
- Highway spacing
- MK3 good
- Many COTS failures
- COTS OK when stopped at start, end, and turnaround
On Board Unit Architecture

Communications Unit
- Application Processor
- Interface
- Radio Manager
- Protocols
- SMX
- GPS
- CAN
- 3G
- DSRC

Connection: USB, CAN or Ethernet

Internal Vehicle Network

Requirements eCall, Mobility Services TCU:
GNSS, NFC, SMX, cellular modem, Appl uC

Requirements V2V, V2X TCU:
WLAN-p, high-accuracy GNSS, Link Security

WiFi: Camera Processing, Diagnostics, Hotspot
BT: real-time internet services / hands free

Communications Components

In-Vehicle Unit: UI, Navi, Apps

Display

Application Processor

Audio Power

AM/FM
TMC/RDS
DR

CAN

WiFi

BT

Antenna Unit

APU

AU

AU

Communications Components

In-Vehicle Unit
Overview MK3 platform

- **Antenna module**
- **Maxim Transceiver**
- **MARS PHY LOWER MAC**
- **ARM11 Protocol Engine 1609.1-4 Connectivity**
- **USB Ethernet**
- **ITS Application Engine**

**Use case**

<table>
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<tr>
<th>Use case</th>
<th>MK3</th>
</tr>
</thead>
<tbody>
<tr>
<td>10 MHz single</td>
<td>Green</td>
</tr>
<tr>
<td>10 MHz single diversity</td>
<td>Orange</td>
</tr>
<tr>
<td>10 MHz dual</td>
<td>Blue</td>
</tr>
</tbody>
</table>

**Use cases**:

- Linux based ARM11 for easy integration
  - ETSI based upon IEEE1609.4
  - CALM Fast
- Command line based interface on host to control MK3
- Complete IEEE1609 stack available
Communications Summary

- There is an adequate choice of channels including the technology to implement large scale introduction.
- Important items such as security still need some innovation but this is being addressed in European projects and as deployment grows so will the applied security become more robust.
- Broad spread ADAS could be accommodated today if parties really wanted to.
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Dashboard Display – a less practical position

The display for ADAS applications must be in the normal driving view and not distract the driver especially in critical situations.
Dashboard Display - acceptable

This is better, but the way information is offered to the driver must be improved e.g. by using voice commands and text to speech.
Heads-up Display on Mirror – a good example

This example shows simple ADAS helping the driver. A situation many get into while changing lanes and a contributor to heavy accidents.

Speed & distance of other vehicles imposed on the natural view with indications of critical situations in a glance
Heads-up Display on Windscreen – a good example

This example shows simple ADAS helping the driver with data imposed on the natural view with indications of critical situations always in view.
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Road Side Infrastructure

Absolutely necessary to have a corresponding infrastructure for cooperative mobility

C2C & C2I create the conditions for effective traffic management in cities and on motorways

Fast lanes for platooning, flexible lane usage, incident and traffic flow management

Will enable local autonomous traffic management
Contents

- What is Cooperative Mobility
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- Road Side Infrastructure
- The Traveler and Road User
- The Car (Vehicles in general)
- Conclusions
Not yet quite so bad in Europe – but we are getting there
Traffic jams cost Millions

More lanes is not the long term answer

Cooperative driving can help solve jams occurring / building up

Vehicles and road side infrastructure designed for cooperative driving must reach a market penetration level of 30% to have large effects
Are Zebra Crossings Safe?

Vulnerable Road Users with wearable Wi-Fi warning beacons

Accident and Collision Avoidance with C2X 802.11p for fast communication in critical situations
Accident and collision avoidance

Cooperative concepts between vehicles and vulnerable road users will save lives

Vehicles will be capable of reacting faster than humans and avoiding accidents safely

Knowing who else is sharing the road with you will prevent rash actions at crossings and while overtaking
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Communications:
GSM, LTE, GPS, DAB, WLAN 802.11p

Sensors:
Motion, Weather, Road Status
Tire pressure, Weight, Center of Gravity

Interconnect:
BlueTooth, WiFi, ZigBee

Antenna:
Multi-purpose, Compact, Protected

Heads-up Display:
Context oriented assistance
Forward looking mirror
Blind angle view

Autonomous:
Braking, Speed, Steering

Drive train:
Full Electric Vehicle
Conclusions

- The introduction of cooperative driving will take time but once started must progress fast to have a large market penetration quickly.
- Some ADAS applications will start earlier, business ones leading the way.
- Safety will follow fast with C2C & C2I communication.
- Electronic traffic management is required to solve the problems on the roads economically.
- The car of the future is a necessity and not a luxury.