IVHW: an Inter-Vehicle Hazard Warning system

Benoît MAÏSSEU
Project characteristics

• IVHW : a two years DEUFRAKO project - France/Germany co-operation (2001-2002)
• Partners:
  – RENAULT, COFIROUTE, ESTAR, INRETS, ISIS, PSA Peugeot-Citroën
  – BOSCH, DAIMLERCHRYSLER, BASt
• Effort : 154 men x months and € 2.7 million
• Sponsored by:
Today’s new opportunities:

- Broad dissemination of GPS
- Accuracy of GPS (no more scrambling for civil applications)
- Market penetration of telematics platforms for:
  - navigation, electronic tolling, emergency call
- Recent authorization of the use of a band in the 869 MHz allowing to reach the needed range of 1 Km
The concept

• Vehicle-vehicle communication for hazard warning
  – radio « warning flashers »
  – accident
• Also vehicle-infrastructure communication
Without IVHW

- Reasons: **bad visibility** or temporary loss of visibility due to obstacles or weather conditions
- Characteristics: pile-up accidents aren’t statistically very numerous, but *often very serious* …
- That **can be avoided** in some situations if a warning message is delivered in time
Inter-Vehicle Hazard Warning

Sent message n 1234:
- accident
- current position
- past positions
- speed
- direction
- …

Received message n 1234:
- accident
- current position
- past positions
- speed
- direction
- …

Vehicle 2 data:
- current position
- past positions
- speed
- direction
- …

IVHW process

yes

no

Relevant

With IVHW

VSC – Vehicle Safety Communications – Tokyo 030903
Result message with an example of visual HMI

DANGER!
Accident à 900m
Typical conditions of use

Pictures taken during the e-Safety congress of September 2002 in Lyon
Risk of queue end collision
Risk of queue end collision
Vehicle breakdown

VSC – Vehicle Safety Communications – Tokyo 030903

Inter-Vehicle Hazard Warning
Vehicle breakdown

VÉHICULE EN PANNE
à 150 MÈTRES

PRUDENCE

Vehicle breakdown

Inter-Vehicle Hazard Warning
Airbag triggering
Airbag triggering
Warning from infrastructure

Inter-Vehicle Hazard Warning
Warning from infrastructure
Core proposal synthesis

• A reduced set of messages:
  • from vehicles or infrastructure beacons
  • from infrastructure beacons only
Extended proposal

• A proposed extended set of messages (all sent from infrastructure equipment only):

  Traffic congestion

  Very slippery road

  Heavily reduced visibility

  Vehicle on the wrong carriageway
Technology
### Message Content

<table>
<thead>
<tr>
<th>Variable</th>
<th>Size (bit)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Header</td>
<td>8</td>
</tr>
<tr>
<td>Random-Message ID</td>
<td>9</td>
</tr>
<tr>
<td>Road type</td>
<td>3</td>
</tr>
<tr>
<td>Road ID</td>
<td>24</td>
</tr>
<tr>
<td>Hazard type</td>
<td>5</td>
</tr>
<tr>
<td>Current speed</td>
<td>5</td>
</tr>
<tr>
<td>Position and trace data</td>
<td>155</td>
</tr>
<tr>
<td><strong>Total message size</strong></td>
<td><strong>209</strong></td>
</tr>
</tbody>
</table>

No personal data!
System characteristics

- Manual or automatic activation
  - generic warning, stopped vehicle, accident
- IVHW is coupled with the warning flashers
- Manual or automatic deactivation
  - In case of emission of the same message by several vehicles, automatic cancellation of useless messages is foreseen
- Use of several GPS positions
• choice of the 869.4 - 869.65 MHz frequency band
• for 1 Km nominal communication distance
• omni directional broadcast
• relevancy discrimination by the receiver

Ranges of 869MHz at 500mW

- Urban area or woods
- Motorway
- Line of sight

[Graph showing ranges of 869 MHz at 500mW]
Minimum:
- GPS module
- UHF modem
- HMI interface

Optional:
- Navigation system

Useful Information:
- Warning flashers
- Parking brake
- Crash

On-board equipment
Optimisation of the chain of GPS positions

1 2 3 4

IVHW Trace Point Casting Algorithm
Contributed by DaimlerChrysler (Passegger, Dr. Mezger, Linkohr)
Example of discrimination algorithm
**Frequency bands**

**bilan de liaison**

- 433 MHz
- 869 MHz
- 2,4 GHz
- seuil -110 dBm
• Channel width to be respected : 25 KHz
=> Use of GMSK modulation to obtain a minimum data rate of 10 Kbps
Safety stakes
### Accident analysis

#### France (1999) fatalities

<table>
<thead>
<tr>
<th>Fatalities 8028</th>
<th>Urban area 2393</th>
<th>Rural area 5635</th>
</tr>
</thead>
<tbody>
<tr>
<td>Motorways 497</td>
<td>rear-end 77</td>
<td>rear-end 196</td>
</tr>
<tr>
<td></td>
<td>pile-up 45</td>
<td>pile-up 58</td>
</tr>
<tr>
<td></td>
<td>muliple/other&gt;2</td>
<td>muliple/other&gt;2</td>
</tr>
</tbody>
</table>

**IVHW relevant accidents**

<table>
<thead>
<tr>
<th>rear-end</th>
<th>pile-up</th>
<th>muliple/other&gt;2</th>
</tr>
</thead>
<tbody>
<tr>
<td>77</td>
<td>45</td>
<td>71</td>
</tr>
</tbody>
</table>

**All vehicles equiped (100%)**

<table>
<thead>
<tr>
<th></th>
<th>17%</th>
<th>62%</th>
<th>26%</th>
<th>% users saved by IVHW</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>8%</td>
<td>43%</td>
<td>14%</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>saved lives</th>
<th>13</th>
<th>28</th>
<th>19</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>16</td>
<td>25</td>
<td>66</td>
<td></td>
</tr>
</tbody>
</table>

**6 days basis**

| 167 |

**30 days basis**

| 177 |
Current activities
1. Standardisation: the prerequisite
   - work within EUCAR, the European manufacturers’ research framework in order to achieve consensus among car makers
   - Item to be proposed to TC278

2. Equipment of rescue and security vehicles
   - Use of mobile infrastructure beacons
   - Equipment of buses and commercial vehicles

3. Equipment of passenger cars
New developments

• To lower the costs and improve the market penetration, the SAAV project will try to develop a radio communication system allowing several applications to coexist on the same frequency band.

1. IVHW
2. traffic and travel info
3. secure black spots
4. gate control
5. door opening?
6. tire pressure control?

Motorways emergency call boxes
Mobile beacons
Black spot beacons