WISAFECAR
INCREASING TRAFFIC SAFETY
WITH REAL TIME ROAD WEATHER,
INCIDENT AND ACCIDENT DATA
TO VEHICLES
Objectives

• WiSafeCar develops an effective service framework/platform, an intelligent wireless traffic safety network between vehicles and infrastructure (V2V, V2I) with a possibility to use sensor & observation data to offer secure & reliable real-time services for vehicles.

• WiSafeCar analyzes applicability of these solutions to a high-speed vehicular environment with changing network topologies and where nodes may not have prior knowledge of each other until they meet.

• Content-centric networking is studied to increase efficiency of sharing disseminated information & assure secure content exchange.

• WiSafeCar will use technologies in an innovative way in vehicular networking.
Results and Impacts

- To be used by the vehicle industry, authorities, road users, internet/radio service providers and ad-hoc networks
- New advances in terms of optimized mobile services, open software for future research, numerical results from testing of the network and output of road the weather forecast model, etc.
- Framework for vehicle-to-vehicle network with real-time weather information, etc. data enables a variety of new applications and services currently
- Development and collection of temporally sensitive data from several sources with different levels of accuracy helps to deploy a mobile sensor network
- According to the Finnish impact assessments for instance the amount of traffic injuries could be decreased with 11% with the help of real time weather warnings to vehicles (Finnish Ministry of Transport and Communications)
Finnish Background

- WiSafeCar is closely related to main Finnish national strategic R&D initiatives.
- WiSafeCar project is strategically important to the Finnish Meteorological Institute in efforts to provide more accurate road weather information and forecasts in space and time.
- “Finland’s Strategy for Intelligent Transport” by the Ministry of Transport and Communications in 2010 has increased the importance of WiSafeCar.
- WiSafeCar has also raised interest in countries sharing similar road weather challenges as Finland (northern USA, Canada, Japan, etc.)
- The Finnish Transport Agency likewise the Finnish Ministry of Transport and Communications, are members of the WiSafeCar Advisory Board.
FMI Tests in Finland

**RSU-to-vehicle**

<table>
<thead>
<tr>
<th>Bypass speed (km/h)</th>
<th>Avg. Good put time (sec)</th>
<th>Min. Good put time (sec)</th>
<th>Avg. Throughput when connection (MBit/sec)</th>
</tr>
</thead>
<tbody>
<tr>
<td>70</td>
<td>42.437</td>
<td>32.149</td>
<td>1.519250</td>
</tr>
<tr>
<td>80</td>
<td>38.442</td>
<td>32.180</td>
<td>1.526850</td>
</tr>
<tr>
<td>90</td>
<td>33.280</td>
<td>26.186</td>
<td>1.531450</td>
</tr>
<tr>
<td>100</td>
<td>30.320</td>
<td>22.863</td>
<td>1.530300</td>
</tr>
</tbody>
</table>

**Vehicle-to-vehicle**

<table>
<thead>
<tr>
<th>Bypass speed (km/h)</th>
<th>Avg. Goodput time (sec)</th>
<th>Min. Goodput time (sec)</th>
<th>Avg. Throughput when connection (MBit/sec)</th>
</tr>
</thead>
<tbody>
<tr>
<td>70</td>
<td>28.024</td>
<td>24.891</td>
<td>1.578167</td>
</tr>
<tr>
<td>80</td>
<td>26.308</td>
<td>22.585</td>
<td>1.618833</td>
</tr>
<tr>
<td>90</td>
<td>22.711</td>
<td>21.135</td>
<td>1.565833</td>
</tr>
<tr>
<td>100</td>
<td>20.843</td>
<td>16.218</td>
<td>1.585667</td>
</tr>
</tbody>
</table>
Content Centric Networking

CCN principle is that a communication network should allow a user to focus on the needed data rather than having to reference a specific, physical location where that data is to be retrieved from.

Three test scenarios:

- 1&2. test (transmission range, delays)
  - Maximum Transmission range about 180 m
  - Information acquiring from CCN; delay average 20 mS
  - Information acquiring from Internet; delay about 580 mS
  - CCN about 30 times faster than current IP solution

- 3. test proof of CCN advantages
  - Information acquiring without knowing information source and provider.
  - Operates as expected, no need to fetch information from server several times.
Vehicle Platform

In-vehicle system
- The NEC LinkBird (IEEE 802.11p, 5.9 GHz) unit implemented in the WiSafeCar Finnish demonstration vehicle (VTT’s laboratory vehicle)
- The two-folded purpose
  - V2I, classify the road condition with the on-board road condition camera unit (IcOR)
  - I2V, gather data from the road side infrastructure (road weather services) to support the IcOR
Standardisation

Activities related to standardisation

- WiSafeCar plans & results have been mirrored against on-going activities by the main standardisation bodies (CEN, ISO & ETSI).
- WiSafeCar has introduced the ideas and given suggestions to these bodies (e.g. Car 2 Car Forums and International Workshops on Vehicle Communications for Safety and Sustainability)
- WiSafeCar was also presented to and talked with the Head of Unit of ICT for Transport, DG Information Society and Media, European Commission.
## Day 1 Use Cases

<table>
<thead>
<tr>
<th>Use Case</th>
<th>Domain</th>
<th>Other Stakeholders required</th>
<th>Comm. Medium</th>
<th>Optional Medium</th>
</tr>
</thead>
<tbody>
<tr>
<td>Emergency Vehicle Warning</td>
<td>Safety</td>
<td>Essential</td>
<td>ITS G5</td>
<td></td>
</tr>
<tr>
<td>Emergency Brake Light</td>
<td>Safety</td>
<td>-</td>
<td>ITS G5</td>
<td></td>
</tr>
<tr>
<td>Stationary Vehicle Warning, V2X Rescue Signal</td>
<td>Safety</td>
<td>-</td>
<td>ITS G5</td>
<td>Cellular</td>
</tr>
<tr>
<td>Traffic Jam Ahead Warning</td>
<td>Safety</td>
<td>-</td>
<td>ITS G5</td>
<td>Cellular</td>
</tr>
<tr>
<td>Pre-Crash Support (Transmit Vehicle Mass)</td>
<td>Safety</td>
<td>-</td>
<td>ITS G5</td>
<td></td>
</tr>
<tr>
<td>Traffic information &amp; recommended itinerary; enhanced route guidance &amp; navigation</td>
<td>Efficiency</td>
<td>Support</td>
<td>ITS G5</td>
<td>Cellular</td>
</tr>
<tr>
<td>Hazardous Location Warning</td>
<td>Safety</td>
<td>Support</td>
<td>ITS G5</td>
<td>Cellular</td>
</tr>
<tr>
<td>Road Work Warning (stationary and moving)</td>
<td>Safety</td>
<td>Essential</td>
<td>ITS G5</td>
<td>Cellular</td>
</tr>
<tr>
<td>Signal Violation Warning</td>
<td>Safety</td>
<td>Essential</td>
<td>ITS G5</td>
<td>Cellular</td>
</tr>
<tr>
<td>Green Light Optimal Speed Advisory</td>
<td>Efficiency</td>
<td>Essential</td>
<td>ITS G5</td>
<td>Cellular</td>
</tr>
</tbody>
</table>
## Day 1 Use Cases & Finnish Services

<table>
<thead>
<tr>
<th>Use Case</th>
<th>Service</th>
<th>Overview</th>
<th>Internal Data Sources</th>
<th>External Data Sources</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Accident warning</td>
<td>Accident in road interpreted, warning spread to the accident vicinity area</td>
<td>Airbag burst, abnormal GPS location, emergency lights on</td>
<td>-</td>
</tr>
<tr>
<td>Emergency Vehicle Warning</td>
<td>Incident warning, bad conditions</td>
<td>Exceptionally bad weather conditions interpreted or observed</td>
<td>Temperature, GPS</td>
<td>Road surface condition sensors, temperature, rain intensity, humidity, wind</td>
</tr>
<tr>
<td>Emergency Brake Light</td>
<td>Incident warning, slippery road</td>
<td>Slippy road conditions observed in specific spot</td>
<td>Road surface condition sensors, gyroscope, GPS</td>
<td>Road surface condition sensors, temperature, rain intensity, humidity, wind</td>
</tr>
<tr>
<td>Stationary Vehicle Warning, Vehicle</td>
<td>Incident warning, vehicle abnormal behaviour</td>
<td>Abnormal behaviour of vehicle observed, reason not clear but may cause hazard</td>
<td>Gyroscope, GPS</td>
<td>-</td>
</tr>
<tr>
<td>Rescue Signal</td>
<td>Incident warning, approaching emergency vehicle</td>
<td>Indication of approaching emergency vehicle</td>
<td>Vehicle-to-vehicle information through VANET</td>
<td>-</td>
</tr>
<tr>
<td>Traffic Jam Ahead Warning</td>
<td>Incident warning</td>
<td>Indication of roadwork ahead</td>
<td>-</td>
<td>Infrastructure-to-vehicle information through VANET</td>
</tr>
<tr>
<td>Pre-Crash Support (Transmit Vehicle Mass)</td>
<td>Roadwork</td>
<td>-</td>
<td>Local weather observations and forecasts, The Traffic Information Centre</td>
<td></td>
</tr>
<tr>
<td>Traffic information &amp; recommendation itinerary, enhanced route guidance &amp; navigation</td>
<td>Local road weather</td>
<td>Local weather information and forecast to the location of vehicle and vicinity</td>
<td>Temperature, road surface condition sensors, GPS</td>
<td>Road surface condition sensors, temperature, rain intensity, humidity, wind</td>
</tr>
<tr>
<td>Hazardous Location Warning</td>
<td>Route weather</td>
<td>Weather information and forecast to the vehicle route options</td>
<td>Temperature, road surface condition, GPS</td>
<td>Road surface condition sensors, temperature, rain intensity, humidity, wind</td>
</tr>
<tr>
<td>Road Work Warning (stationary moving)</td>
<td></td>
<td></td>
<td>Local weather observations and forecasts</td>
<td>Local weather observations and forecasts</td>
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<tr>
<td>Signal Violation Warning</td>
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*Wired traffic Safety network between Cars*
ITS Stations & WiSafeCar Architecture

CEN: “ITS Stations are prerequisite for Co-operative Systems”
ITS Stations & WiSafeCar Architecture

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WiSaFeCar Architecture
ITS Stations & WiSafeCar Architecture

CEN: “ITS Stations are prerequisite for Co-operative Systems”

WiSaFeCar Architecture
Road Weather Related Data Sources

- Temperature
- Camera
- ABS/ESP
- Gyroscope
- Critical temp. change
- Windshield wiper
- Hazardous location
- Fog Lights On
- Airbag
- Emergency lights
- Slippery
- Car Swerving
- Ice/Slippery
- Rain
- Danger
- Low Visibility
- Accident

Location time speed
Temperature (pre-defined interval, sorted data)
Special Event (instantly)
Components of the Road Weather Pilot (in laboratory car)

- **OBU**
  - NEC Linkbird-MX v3
  - Pulse/Larsen NMO4E5350B Antennas

- **GPS**
  - uBlox EVK-5T

- **GPRS**
- **HMI**
- **Comm PC**
  - Comet D

- **SWITCH**
  - a-link

- **Road friction camera**
  - iQOR

- **Sensors**

- **AU**
  - iPCMax S635F Fanless MiniPC

- **HMI**
  - CAR TFT 7"

**Network Connections**

- RS232
- LAN
- USB
- FireWire
Road Weather Pilot in Laboratory Car

- IcOR camera installation with new PC has been implemented and validated
- Road surface classification
- HLF WiSafeCar component
Temperature Measurements in the Road Weather Pilot

- Ambient / Road surface temperature
  - Ambient temperature = cheap, commercial sensor
  - Road surface temperature = IR-sensor
  - Both installed in a single tube under the vehicle
Voltage Measurements in the Road Weather Pilot

- Light bulbs, warning lights etc. → on/off digital status information
- ABS-pump/windshield wiper pump motor → analog voltage measurement → ESP/ABS activation and the speed of wipers are correlated to current consumption → requires vehicle specific fine-tuning
SUNIT – NEC LinkBird communication

Vehicle 1

- Sunit
- WSCUI (Mobisoft)
- (Interest)
- Payload
- CCNxName
- TCP
- IP (localhost)
- 802.3 (Ethernet)

LinkBird

- CCNxGateway (VTT)
- ccnd
- Payload
- CCNx
- UDP
- IP
- C2X IP Transport
- 802.11p
- 802.3 (Ethernet)

Vehicle 2 or RoadSide Unit

- Sunit
- CCNxGateway (VTT)
- ccnd
- (Data)
- Payload
- CCNxName
- TCP
- IP (localhost)
- 802.3 (Ethernet)

- LinkBird
- Car-2-X
- Payload
- CCNx
- UDP
- IP
- C2X IP Transport
- 802.11p
- 802.3 (Ethernet)

- WSCUI (Mobisoft)
- Vehicle 1 Vehicle 2 or RoadSide Unit

Payload

- CCNxName
- TCP
- IP (localhost)
- 802.3 (Ethernet)
Devices 1/5

NEC LinkBird MX

E-WAVE
Devices 2/5

Sensior Driving Management unit
Devices 3/5

Sunit-d

Sunit-c
Devices 4/5

Deneb PND
Devices 5/5

Google Nexus One

Apple Iphone

Samsung Galaxy Tab

Windows based CarPC
Thank You
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Mobisoft Oy
WiSafeCar Co-ordinator
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