# THE FULLY NETWORKED CAR

## Integration of Vehicular Communication Gateway and Car-to-Car Communication for Future Vehicular Applications

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**Geneva, 7-9 March 2007**

o Overview on wireless vehicular communications

o Inter-vehicle communication for safety services

o The vehicular communication gateway for MYCAREVENT project

o Integrated vehicular communication gateway with C2C communications

o Conclusion and outlook

o Vehicular Communication of Intelligent Transportation System (ITS)
   - Safety applications
   - Non-safety and comfort oriented applications
o Regulations worldwide
   - ETSI 5.8GHz for CEN DSRC, ETSI ERM TG37 5.9GHz for European ITS
   - U.S. FCC 75MHz @5.9GHz for ITS
   - Japan 5.8GHz ITS
o Standardization
   - CEN DSRC, ISO/ETSI CALM
   - IEEE 1609/ 802.11p (WAVE)
   - Car2Car Communication Consortium
o Projects
   - Crash Avoidance Metrics Partnership (CAMP)
   - Vehicle Infrastructure Integration (VII)
   - CarTalk2000, PReVENT, e-Safety
   - Fleetnet, Network-on-Wheels (NoW)
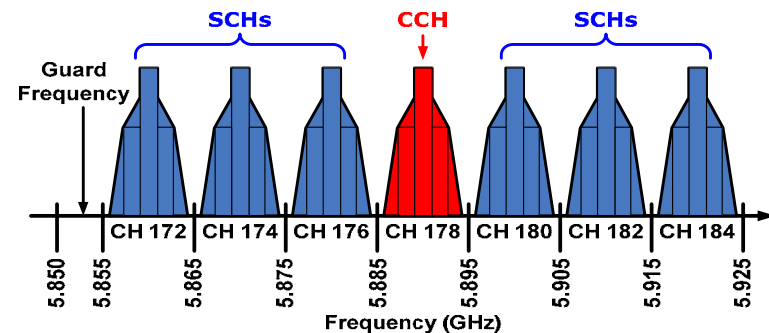
# Car-2-Car (C2C) Communications

C2C is meant to be a complement to cellular communications by providing very high data transfer rates in circumstances where minimizing latency in the communication link and isolating relatively small communication zones are important.*

o ## Applications

- Safety: public safety, danger warning, cooperative driving
- Non-safety: telematic, infotainment, on-board internet
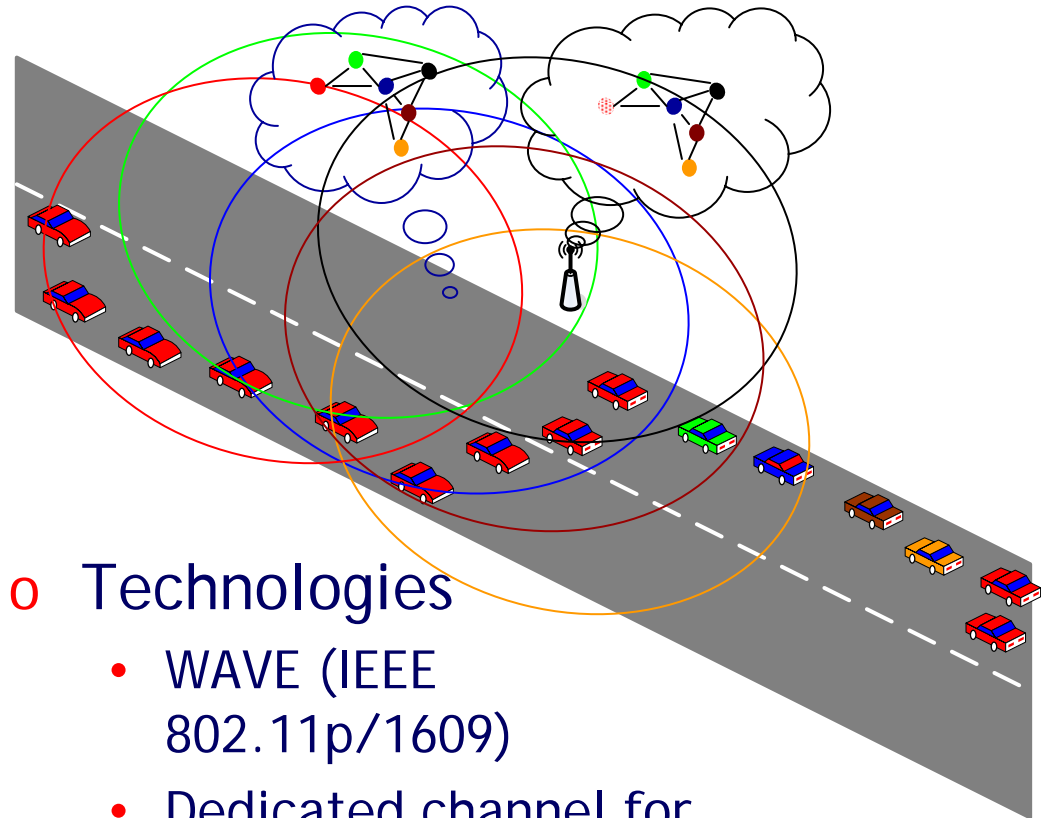
o ## Technologies

- WAVE (IEEE 802.11p/1609)
- Dedicated channel for vehicle safety and commercial applications



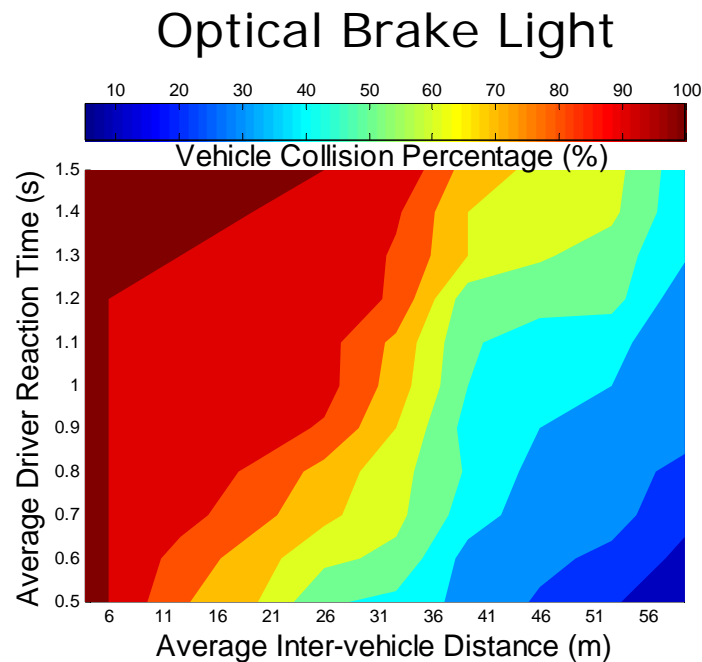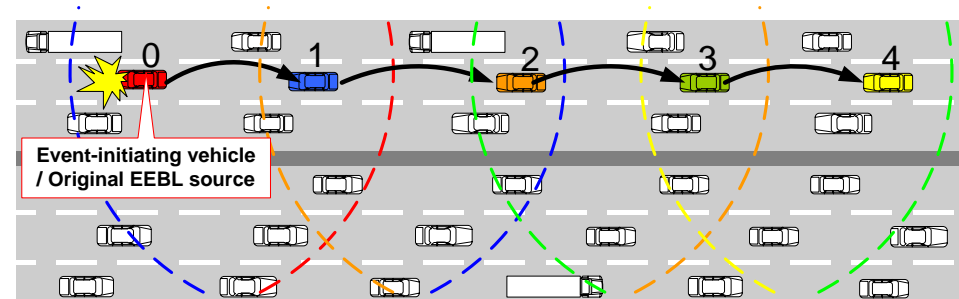| IEEE P1609.1<br>WAVE Resource Manager | | |
|---|---|---|
| WME | IEEE P1609.3<br>Networking Services | IEEE P1609.2<br>Security Services for Applications and Management Messages |
| | IEEE P1609.4<br>Multi-channel Operations<br>(MAC Extension) | WME:<br>WAVE Management Entity |
| MLME | IEEE 802.11p<br>WAVE MAC | MLME:<br>MAC Layer Management Entity |
| PLME | IEEE 802.11p<br>WAVE PHY | PLME:<br>Physical Layer Management Entity |

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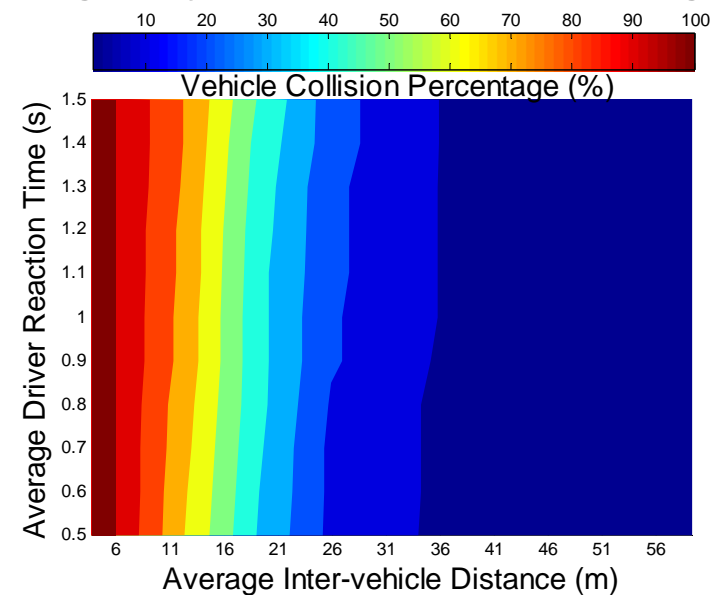
*IEEE Magazine on Wireless Comm.

o **Emergency Electronic Brake Light (EEBL) using WAVE system**

o **Effective in reducing vehicle collision probability**



Event-initiating vehicle / Original EEBL source

## Optical Brake Light

Vehicle Collision Percentage (%)

Average Driver Reaction Time (s)

Average Inter-vehicle Distance (m)

## Emergency Electronic Brake Light

Vehicle Collision Percentage (%)

Average Driver Reaction Time (s)

Average Inter-vehicle Distance (m)

*Data source: European PreVENT/WILLWARN Project Report

Vehicle Collision Percentage (%) vs Penetration Rate — Directional Flooding, Cluster Broadcast
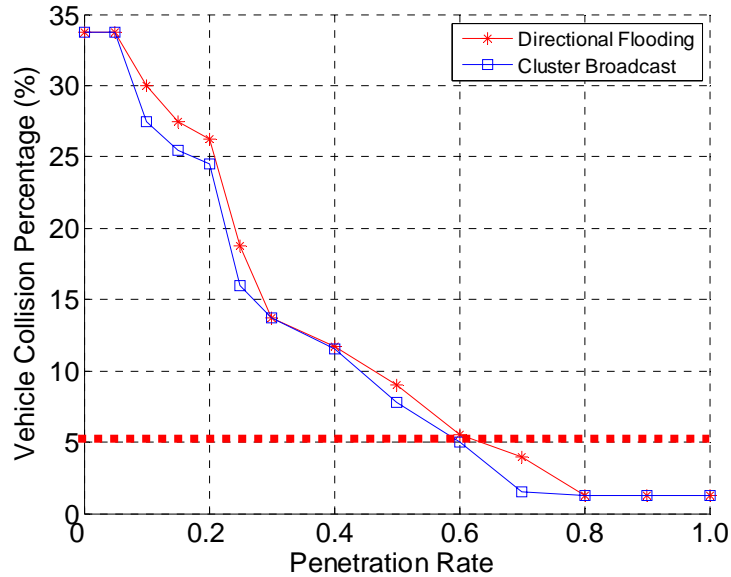
o **EEBL performance (51m, 1s)**
- min. penetration rate 20%
- Collision free: 70%

o **Solutions**
- Devices for legacy vehicles
- "Light" WAVE device


Emergency Electronic Brake Light Block Diagram

*Data source: European PreVENT/WILLWARN Project Report
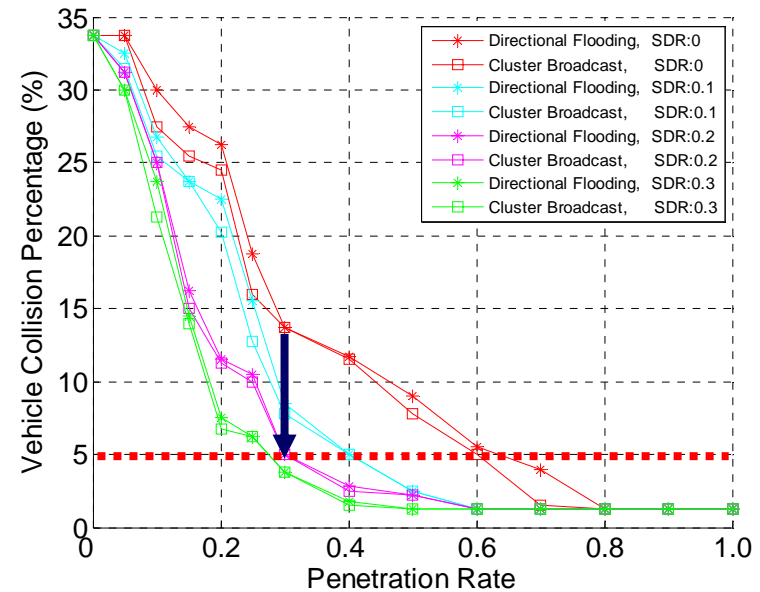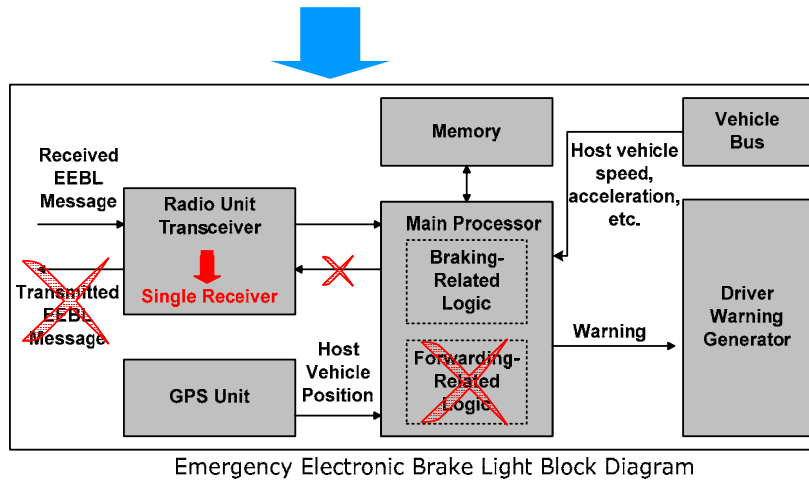
o Effective on enhancing the safety of transportation system

o The performance depends on the market penetration rate

o There are ways to speed up the market penetration rate

o For non-safety applications:

- Broadband, low latency

- Limited communication range, RSU deployment

- Restricted access to Internet and general services

# MobilitY and CollAboRative work in European Vehicle Emergency NeTworks (MYCAREVENT)

**Mobile Service Providers**
- Location based Services
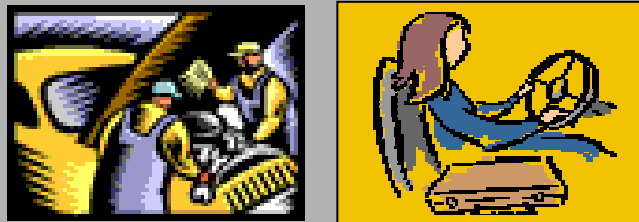- Diagnostic Tools & Apps
- Long-/ Short Range Comm
- ...

**Vehicle**
- On-board diagnostics
- Long-/ Short Range Comm
- Sensors
- Location based info
- ...

**Services**

**Products**

**Mobile Worker & User**

**Service Portals & Service Applications**
- 1st & 2nd Level Diagnose
- Data Communication over IP
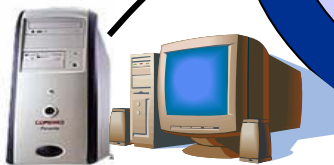- Long Range Communication (LRC)
- 

**Workshops**
- Stationary Services
- Long-/ Short Range Comm
- (Spare Parts Warehouse)
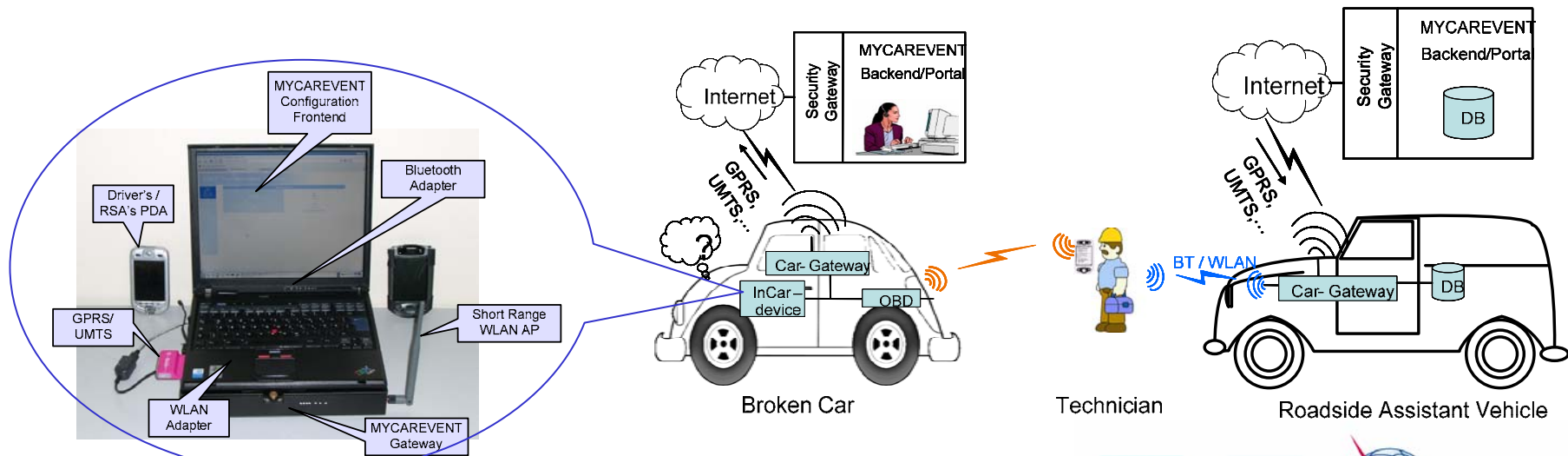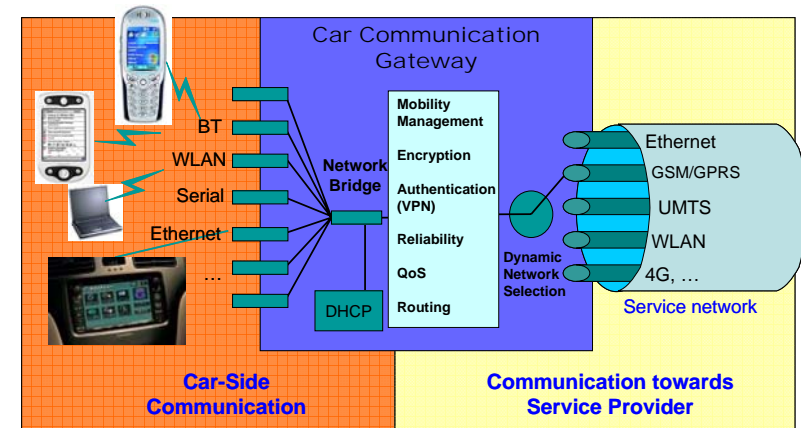- Enhanced Diagnose Tools
- Enhanced Repair Tools & Devices
- ...

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o **Always Best Connected**
  - UMTS/GPRS, WLAN, Bluetooth, etc.

o **Secure transmission**

o **Reliable transmission**



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o Limitations of Vehicular Communication Gateway (VCG)

- Cost

- Dependence on cellular system

o Integration of the VCG and C2C communications

- VANET based on C2C comm.

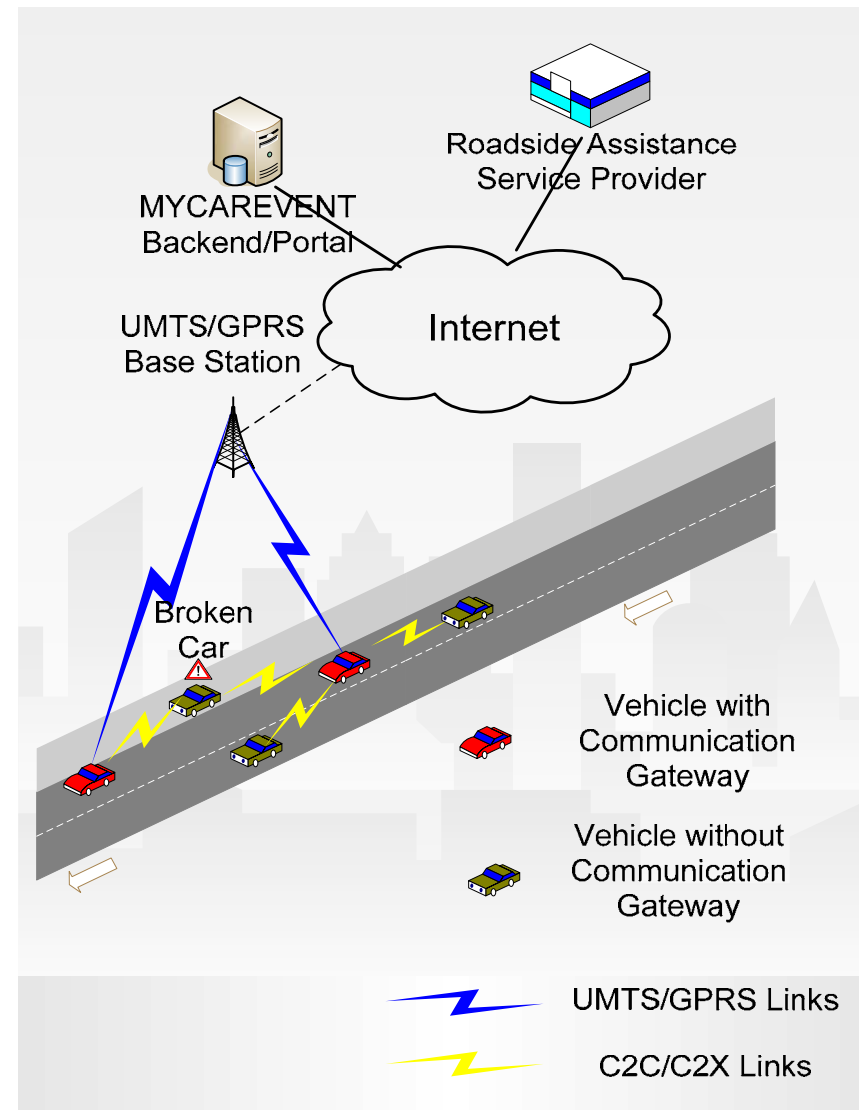- VCG as the VANET gateway

o Service range extension of VCG via C2C

- The broken car located out the range of UMTS/GPRS
- Help request / emergency message picked by passing by vehicles via C2C link
- Store and forward when the VCG is back in the UMTS/GPRS range
- Message dissemination / forwarding via multi-hop C2C or mobility prediction
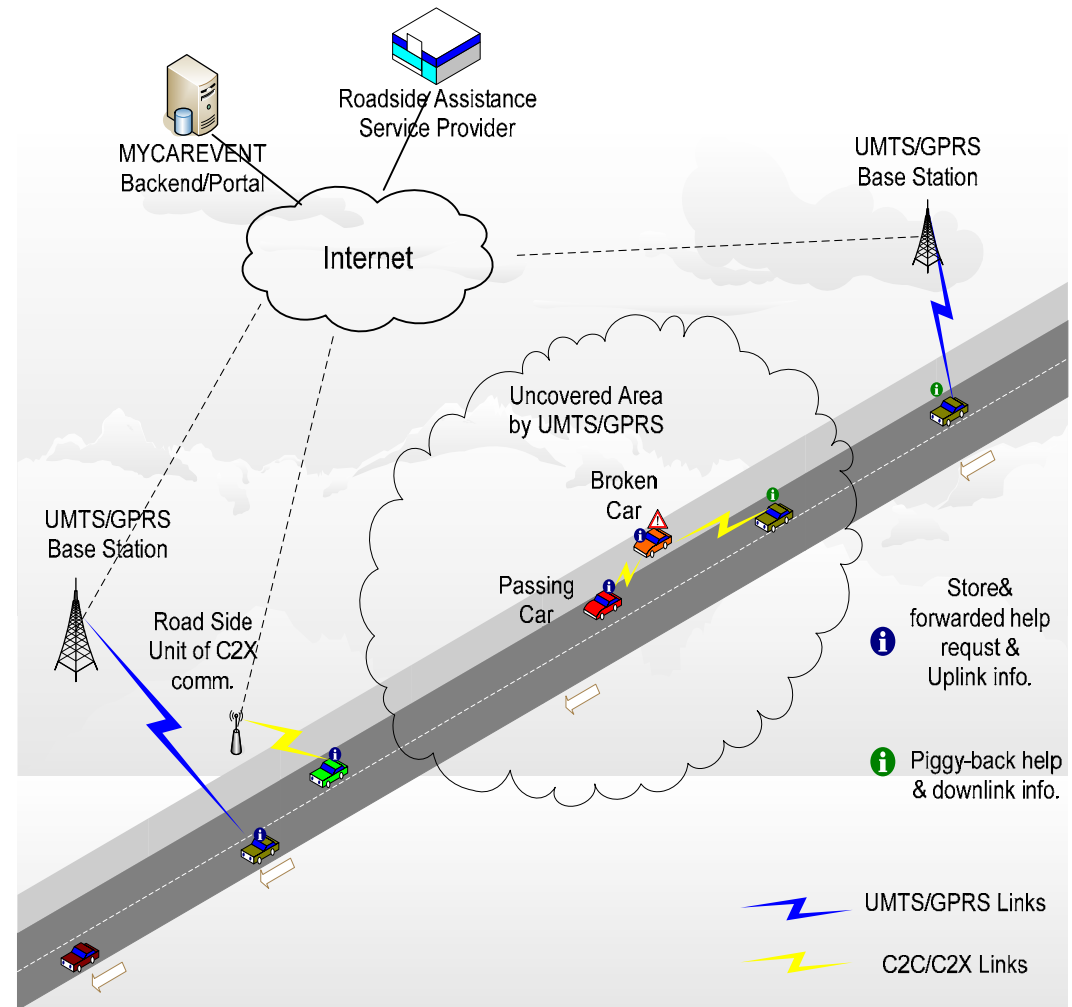
o  Internet access to C2C user via VCG

- Cars with VCG act as Internet gateways
- Through the VCG other C2C users can
    - Use MYCAREVENT service
    - Access internet
- Additional services than danger warning may stimulate the C2C market



Roadside Assistance Service Provider

MYCAREVENT Backend/Portal

Internet

UMTS/GPRS Base Station

Broken Car

Vehicle with Communication Gateway

Vehicle without Communication Gateway

UMTS/GPRS Links

C2C/C2X Links

o C2C communication is an promising technology

o Vehicular Communication Gateway is the solution for secure, reliable and always best vehicular connection

o The integrated solution extends the service range of VCG and provides the C2C user Internet access and general services

o Challenges foreseen:
  - Self-organized VANET
  - Service discovery and routing
  - Resource management in cellular system
  - Business case and billing issue

# Thanks for your attention!

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