CeBIT Event 2008

FINNISH METEOROLOGICAL INSTITUTE

CARLINK

Wireless Traffic Service Platform for Linking Cars

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VTT SUNIT

MOBISOFT MOBILE DATA SOFTWARE

infoTripla

moviquity

Centro de Automática Aplicada HENRI TUDOR

SYNERGIUMS

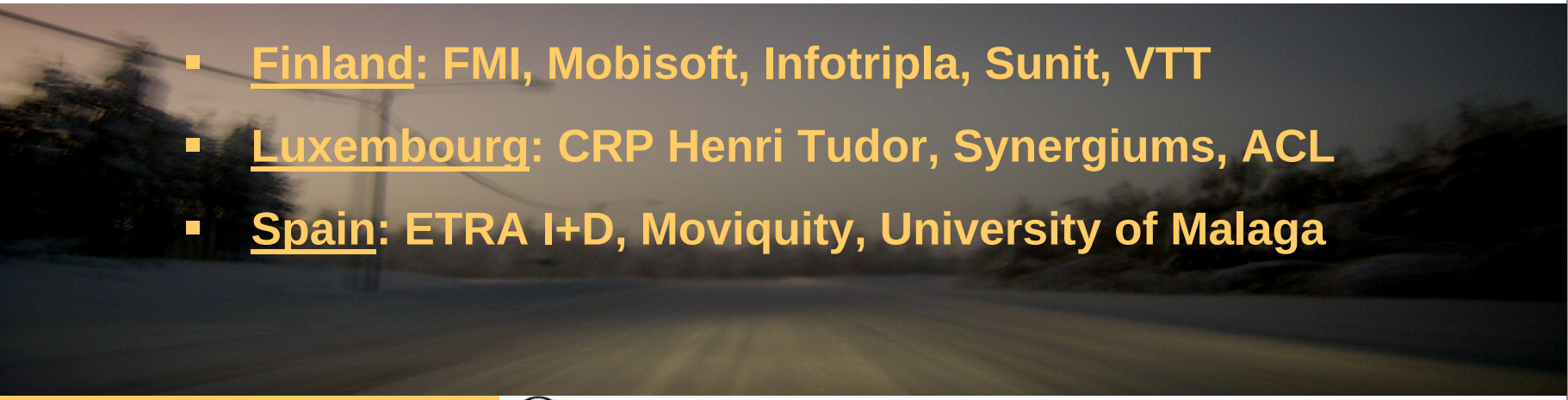
ACL

ETRA I+D

UNIVERSIDAD DE MÁLAGA

Background

- **Aim ⇔ Develop an intelligent wireless traffic service platform between cars supported with wireless transceivers** (WLAN / WiMAX) **along the roads**
- **2-year project: Sep 2006 … Dec 2008**
- **EU_Eureka Program Celtic Cluster** (Call 3) **project**
- **Partners from Finland, Luxembourg, Spain**
- **International project coordinator: ETRA I+D (Spain)**
- **Finnish project team coordinator: FMI**



- **Finland: FMI, Mobisoft, Infotripla, Sunit, VTT**
- **Luxembourg: CRP Henri Tudor, Synergiums, ACL**
- **Spain: ETRA I+D, Moviquity, University of Malaga**

Approach

- **An intelligent wireless traffic service platform between cars supported with wireless** (WLAN / WiMAX) **transceivers along the roads**
- **Central unit beyond wireless transceivers maintains the system**
- **Central unit communicates in real-time with vehicles allowing for updateing of services**
  - e.g. up-to-date local road weather
- **Similarities with ”traditional” hybrid ad-hoc network, main differences being in the speed of nodes**

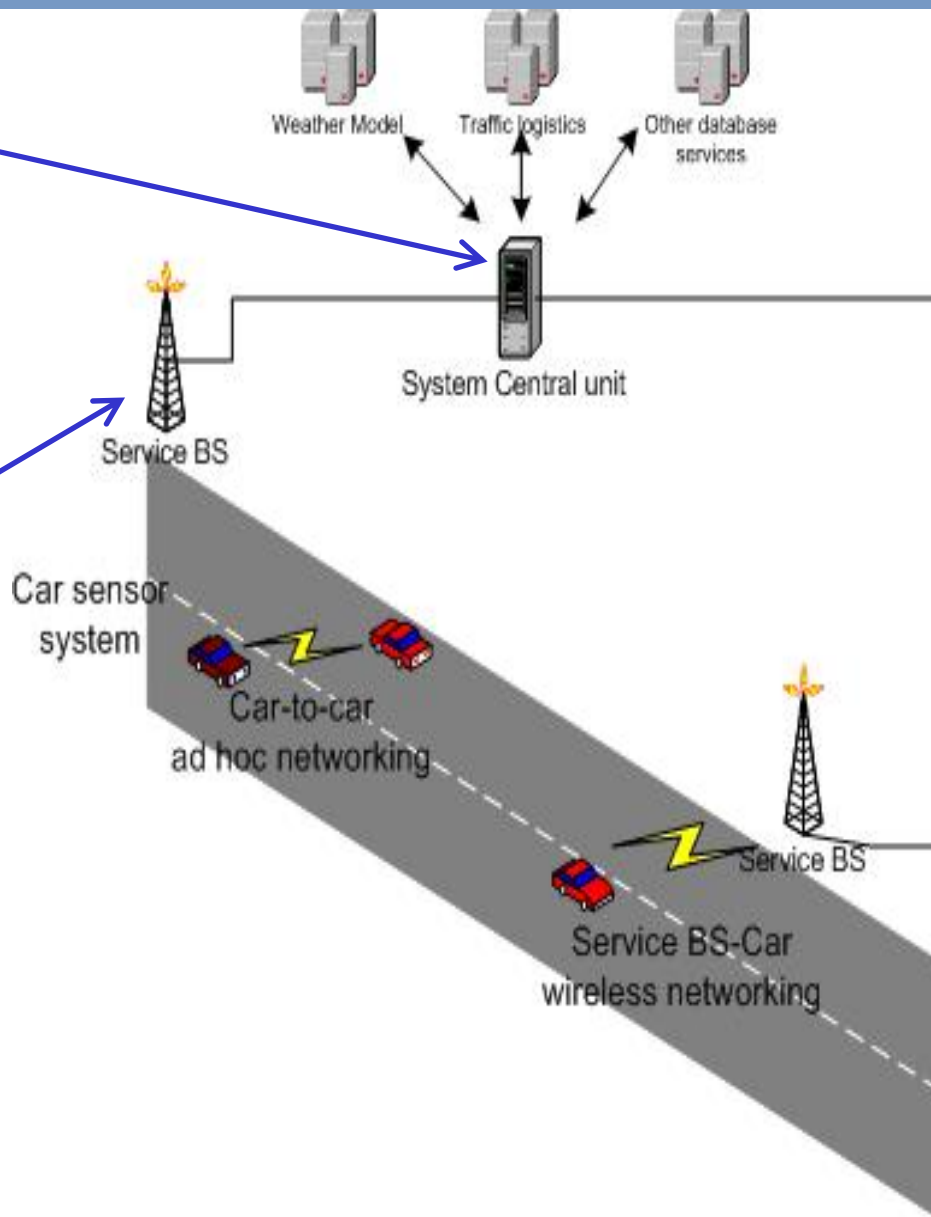
Platform Structure

- **System Central Unit**

  Communication centre collecting vehicle data from Base Station network and GPRS-network, delivering data to service cores, and delivering weather and warning data from services to vehicles

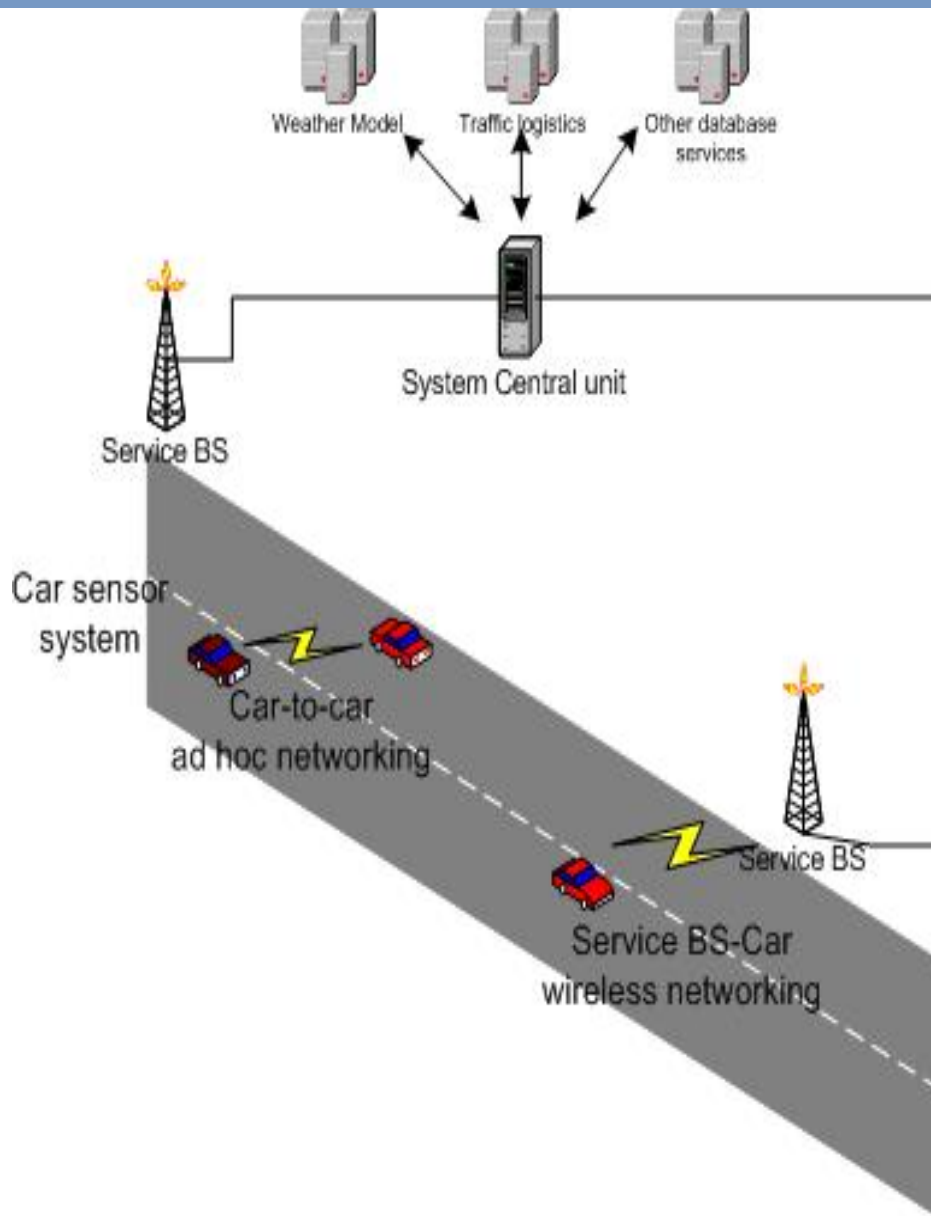
- **Service Base Stations**

  Along the roads storing up-to-date data from Central Unit and delivering it to bypassing vehicles; Vehicle observed data are collected simultaneously and delivered to Central Unit



Platform Structure

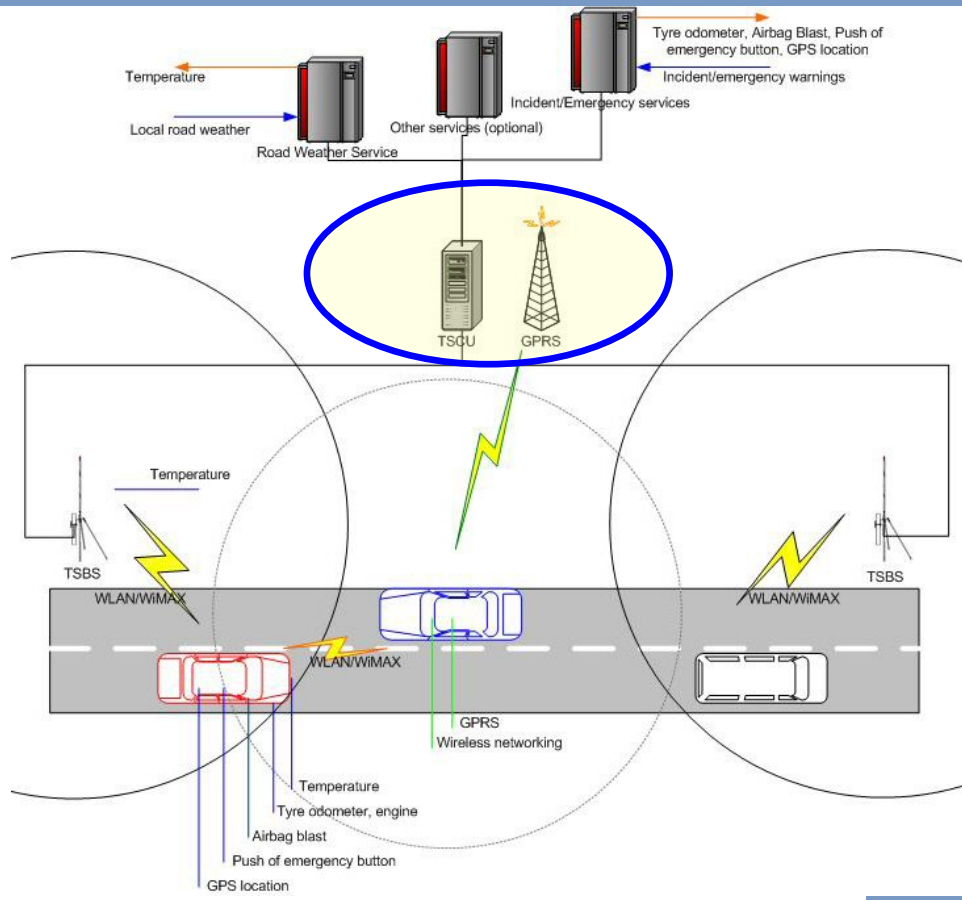
- **Vehicles receive latest service data** *(e.g. local weather and warnings)* **when passing by Service Base Stations. Vehicle observed data is delivered simultaneously to Service Base Stations. Vehicles can forward their newest service data to encountering vehicles → Base Station range is enhanced**
- **Critical data** *(e.g. accident warning)* **are delivered through GPRS network to guarantee instant delivery**



Platform Elements (1)

Traffic Service Central Unit (TSCU)

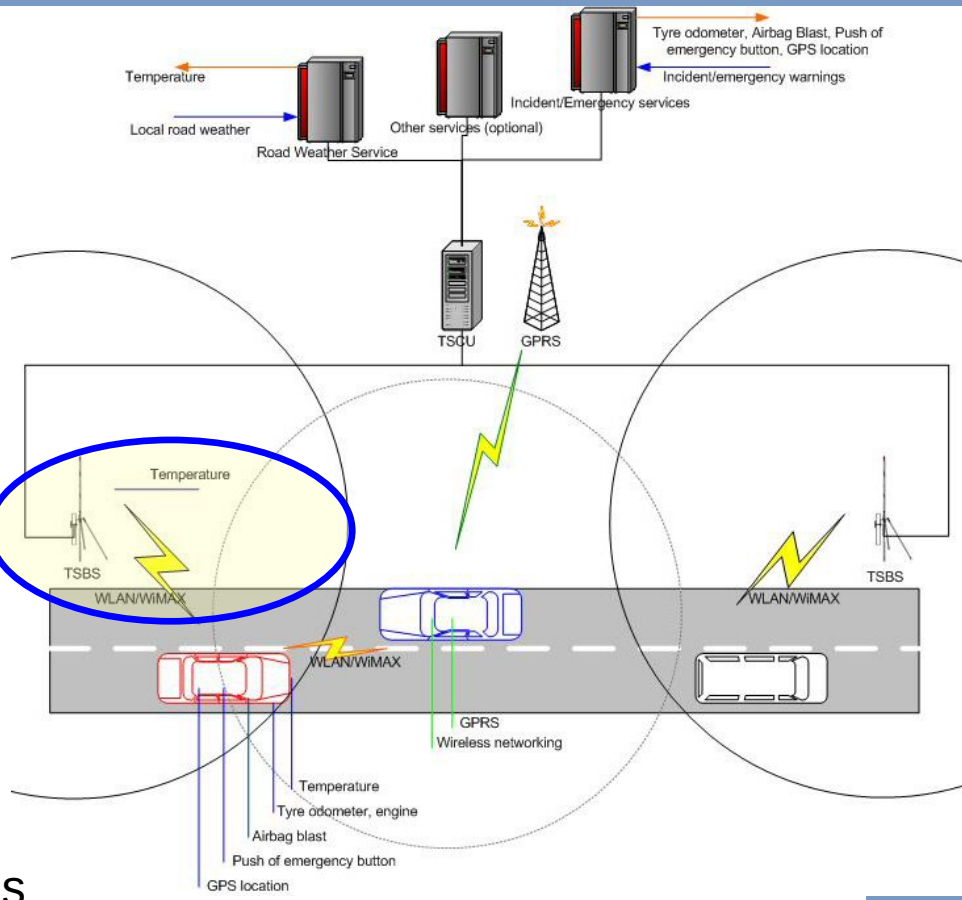
- System central unit
- User management
- Data storage ⇔ Both vehicle observed data and service data
- 2-way connection towards vehicles
  - Indirect connection thru base stations: Main channel
  - GPRS: Emergency data



Platform Elements (2)

Traffic Service Base Station (TSBS)

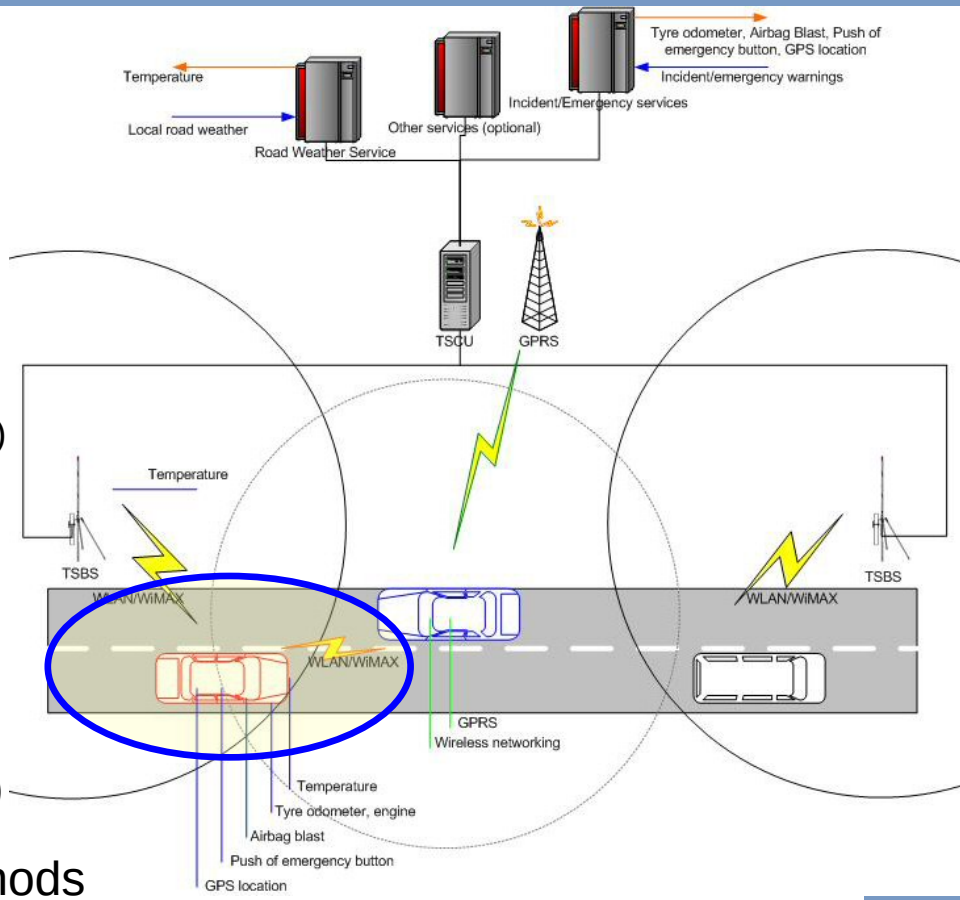
- Base station network along roads
- Delivers TSCU data to vehicles + collects vehicle observed data
  - Up-to-date TSCU data stored into TSBS ⇔ Delivery during vehicle bypassing
  - TSBSs include more accurate weather station facilities than vehicle weather info
    ⇔ Data can be used for vehicle data quality monitoring
- Wireless communication by 2 methods
  - Mobile WiMAX
  - WLAN_IEE 802.11g



Platform Elements (3)

Mobile End User (MEU)

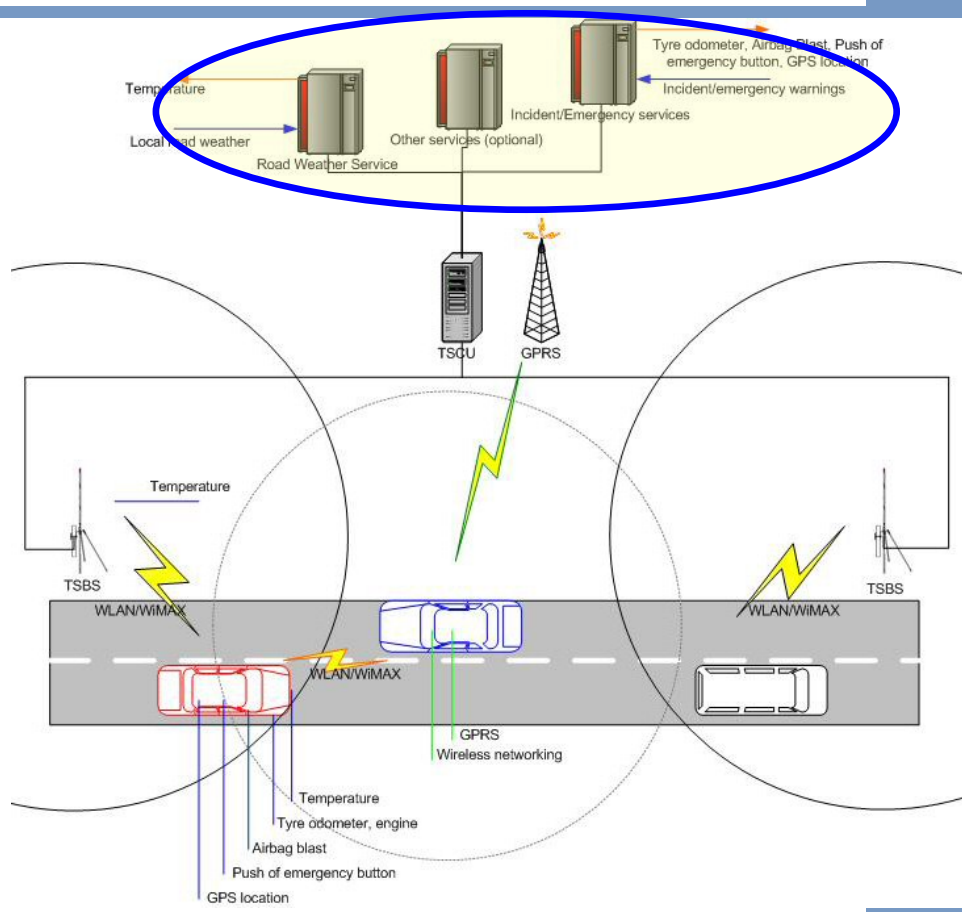
- Vehicle communication system
- 2-way communication with TSCU
  - Indirectly thru base stations
    ⇔ Main channel (hi-capacity)
  - GPRS: Emergency data (lo-capacity)
- Vehicle-to-vehicle communication
  - WLAN or WiMAX
  - Emergency data
  - Most recent platform data
  - True networking with multihop connection to base stations (future)
- Wireless communication by 2 methods
  - WiMAX (mesh)
  - WLAN_IEE 802.11g
- Additional features (new service discovery, update and use) to be developed in Transport Management Service scenario



Platform Elements (4)

Services

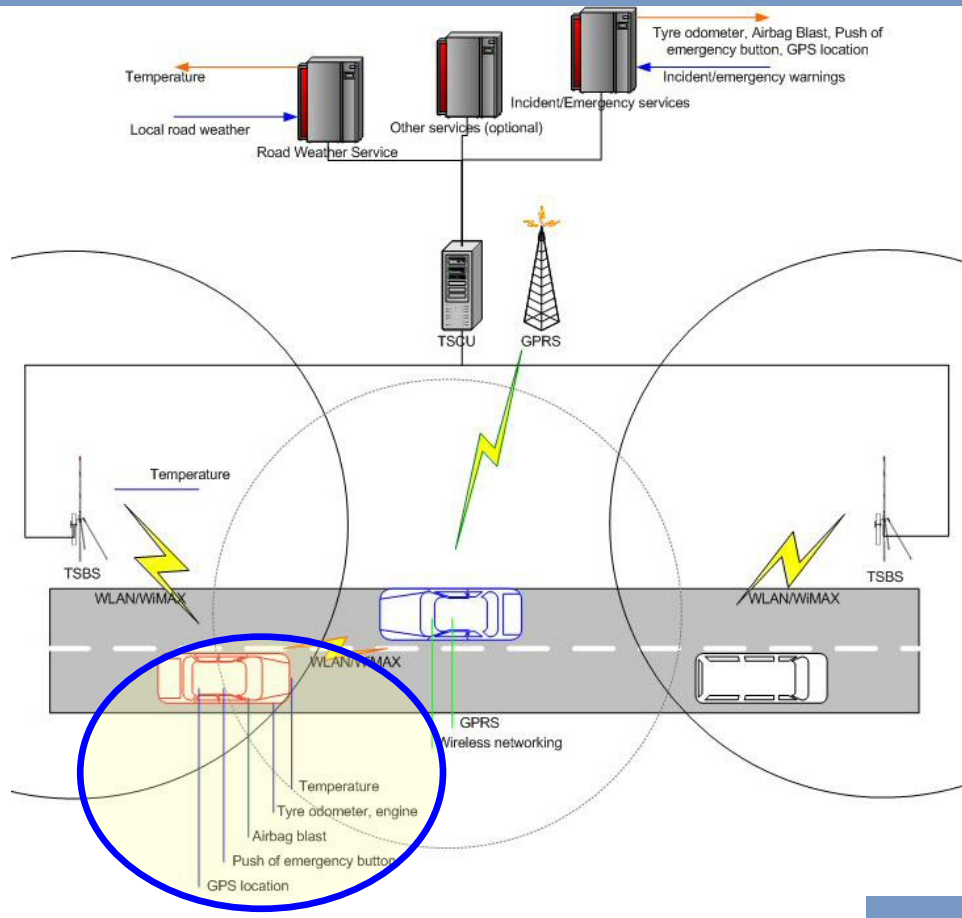
- Located in a fixed network beyond TSCU
- Direct connection to TSCU
- Allows for various services
- **Road Weather Service**
  - Based on FMI road weather model
  - Present 10 km model resolution enhanced with local vehicle data
  - Delivered to different TSBSs
- Emergency services
  - Accidents and other critical data collected as local warnings
- Traffic logistics
  - Exploiting inofrmation of traffic load
- Mobile user
  - Guidance and information services for moving users



Platform Elements (5)

Vehicle systems

- Communication system in the vehicle computer unit - Data from:
  - Car Internal CAN-Bus
    - ✓ Tire rotation speed
    - ✓ Airbag burst
  - CAN-Bus or own measurements
    - ✓ Outside temperature
    - ✓ Road surface temperature
    - ✓ GPS location
  - User interface
    - ✓ Emergency button
- Observation data at pre-defined intervals, with GPS location, delivered thru TSBS to TSCU
- Instant emergency over GPRS to TSCU and thru WLAN / WiMAX to encountering vehicles

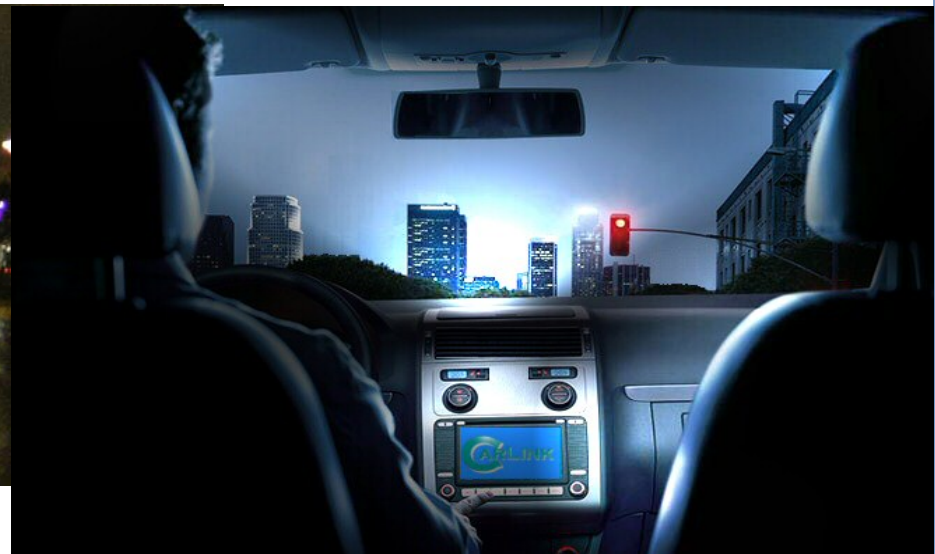


Goals

”Demonstration systems will be constructed to test various usage scenarios and services”

- **Define interfaces between platform elements**
- **Define individual elements and ensure their interface compabilities** (by different Partners)
- **Operability and efficiency analysis and estimation**
  - Simulations, analysis, test the operation of demonstration systems
  - **Simulation model to compare and analyze WiMAX- and WLAN-based platform structures**
  - **Test local Road Weather Service comparing with FMI’s other observations and forecasting systems**

FMI



Simulations (1)

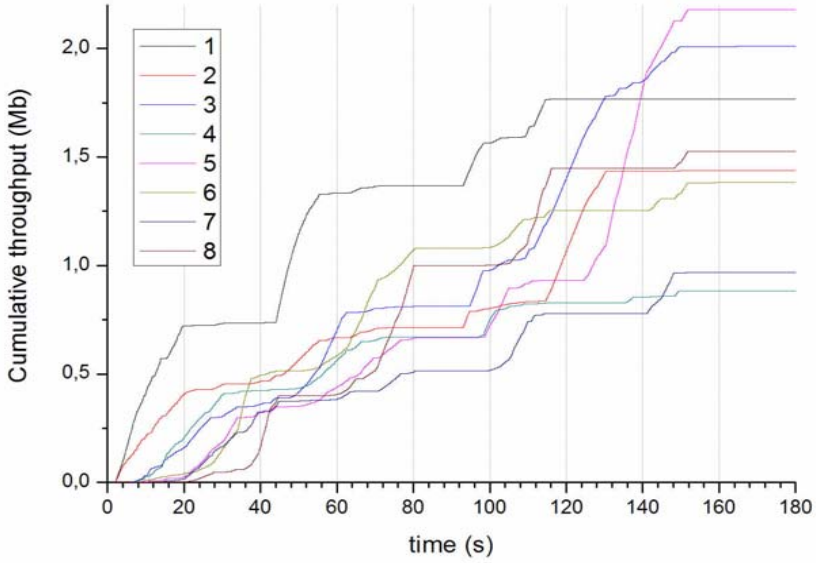
- **Conducted with NS-2 simulator; 802.11 & 802.16 MAC models**
- **Currently only first simulations with 802.11 available**
- **First simulation process of 2 scenarios:**
  1. Scenario: 8 vehicles driving to same direction at equal 100 m distance
  2. Scenario: 8 + 8 vehicles driving to opposite directions, those with same direction having equal 100 m distance
     - Both scenarios: 4 base stations beside the road, 1000 m apart
- Study changes in connection break times and thruputs with increasing traffic amount ⇔ Optimization of base station distances

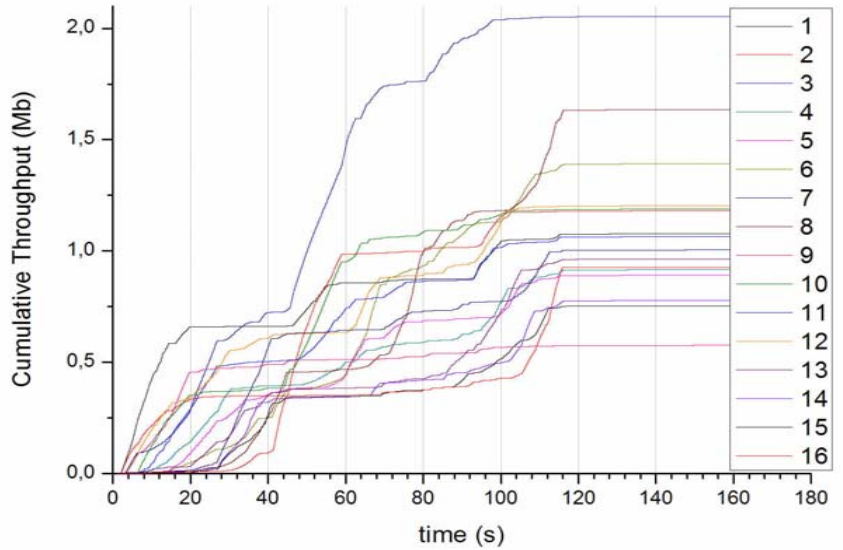
Simulations (2)

- **Scenario 1 vs. Scenario 2:**
  - Longer breaks in communication
  - Higher thruput

	Connection time (%)	Cumulative throughput per vehicle	Average throughput per vehicle
Scenario 1	64	1,5 Mb	15,8 kbps
Scenario 2	81	1,1 Mb	11,7 kbps

- **Average thruput insufficient**
  - Increase base station density
  - Optimization of simulation parameters
- Base station distance < than 1 km for breakless communication





Test measurements (1)

- **Communication between base station and vehicles tested with vehicle passing by base station at different speeds**
- **Extensive test procedures within demonstration system**
  ⇔ Preliminary tests at speeds 60, 70, 80 and 90 km/h
  (with 95 km/h communication could not be conducted)

End January 2008

Equipment

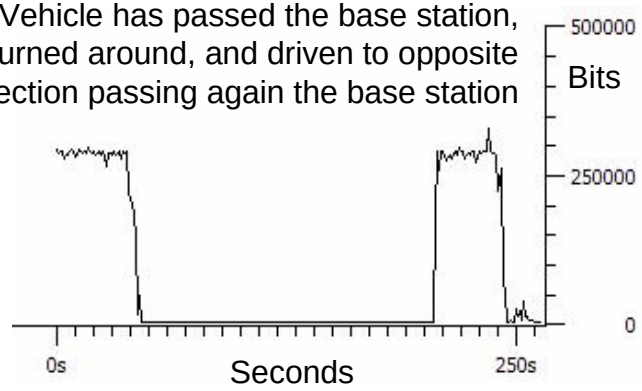
- ✓ Colubris MAP-330 Multiservice Access Points
- ✓ Sunit D7 Vehicle PC System
- ✓ Toyota Hilux 2007

Test measurements (2)

- **Preliminary results only indicative: Thruput expected to decrease with increasing speed**
  - Illogical results due to small sample (?)
  - Variations dependable on vehicle's approaching direction, temperature
- **Main result, however: Thruput appears adequate for platform services, at least**
  - Up to 90 km/h
  - For base station-to-vehcile communication

Example of test measurement:

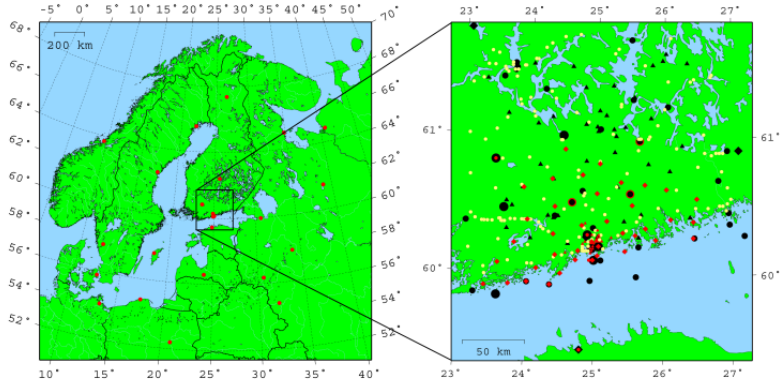
Vehicle has passed the base station, turned around, and driven to opposite direction passing again the base station



Speed	Connection uptime during one pass	Average thruput during one pass	Avg. cumulative thruput during one pass
60 km/h	50 s	0,27 Mbps	13,3 Mb
70 km/h	38 s	0,27 Mbps	10,1 Mb
80 km/h	40 s	0,27 Mbps	10,8 Mb
90 km/h	42 s	0,26 Mbps	10,8 Mb

Demonstration in Finland (1)

- **Scheduled late spring 2008**
- **Helsinki-Turku highway**
- **Dense weather observation network: http://testbed.fmi.fi**
- **Infrastructure:**
  - TSCU: Server in fixed network, not physically in the area; with GPRS capabilities
  - TSBS: IEEE 802.11g access points on laptop PCs; Additional connection to weather stations
  - MEU: Sunit vehicle PC, with IEEE 802.11g tranceiver, GPS locator, GPRS unit, and interfaces to CAN-Bus and external measurements
  - Services: Road Weather and Warning service; located in fixed network

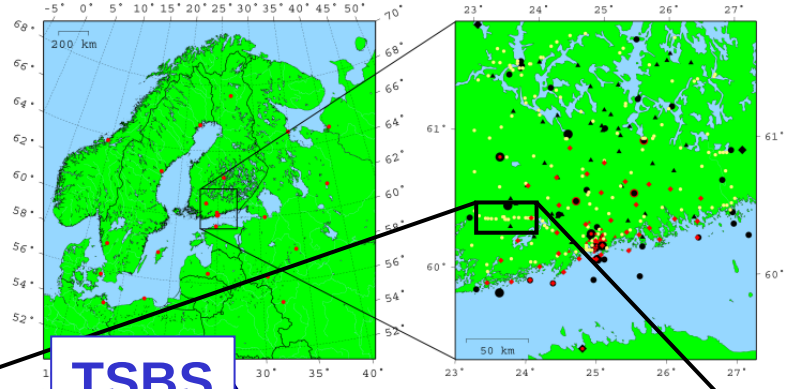


No.	Sites in Helsinki Testbed domain	
46	FMI weather stations	●
34	FMI precipitation stations	▲
13	Off-line temperature loggers in greater Helsinki area	▲
8	Weather transmitters in greater Helsinki area	▲
191	Road weather stations	●
292	**Surface weather stations, total**	
42	Pairs of weather transmitters in masts	◆
5	Optical backscatter profilers (new ceilometers)	●
6	FMI ceilometers	●
4	C-band Doppler radars	◆
1	Dual polarization Doppler radar	◆
4	RAOB sounding stations	●
1	UHF wind profiler	▲
-	Total lightning network	-

Demonstration in Finland (2)

Parameters to test/demonstrate:

- ✓ Base station distance optimization
- ✓ Vehicle observation evaluation
- ✓ User interface evaluation
- ✓ Connection time (%)
- ✓ Thruput
- ✓ Service update time
  - Road weather
  - Accident warning



TSBS

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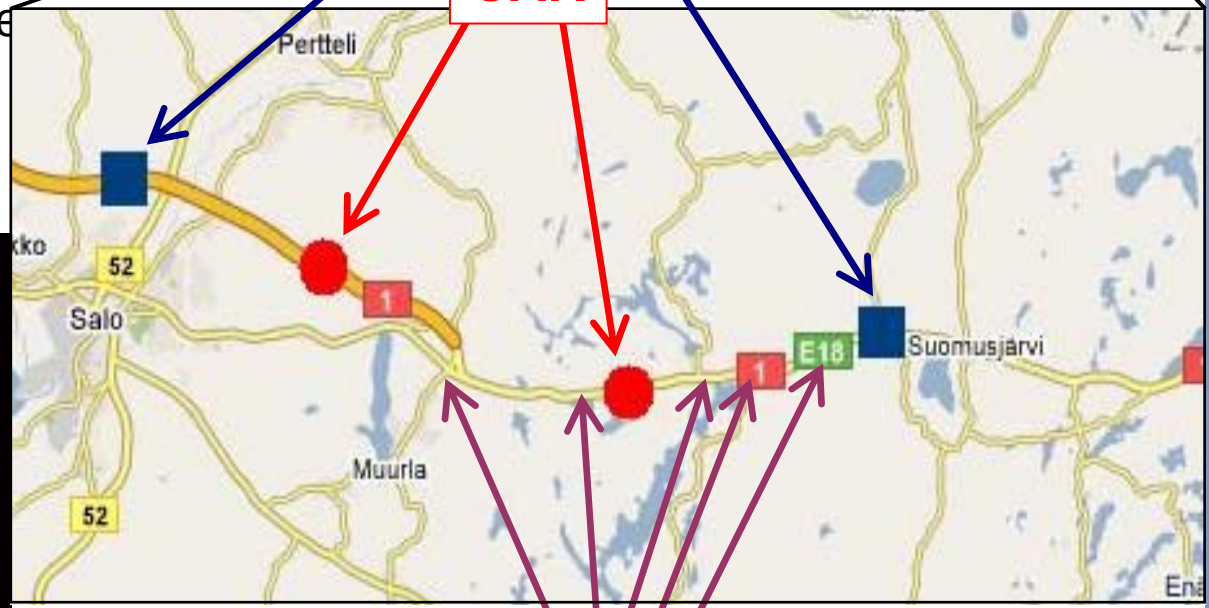

Several "COLDSPOTS" sites along route

CARLINK

Wireless Traffic Service Platform for Linking Cars

Thank You for Your Attention !