WiSafeCar

CELTIC Telecommunication Solutions

EUREKA

FINNISH METEOROLOGICAL INSTITUTE

Connected vehicle safety network and road weather forecasting – The WiSafeCar project

Timo Sukuvaara and Pertti Nurmi

Finnish Meteorological Institute

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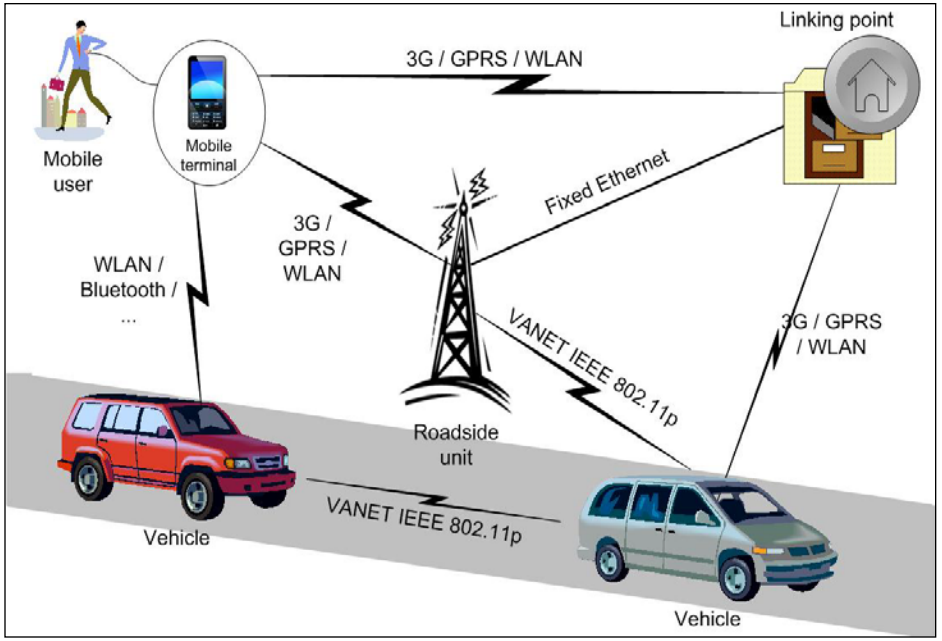
WiSafeCar

Project objectives

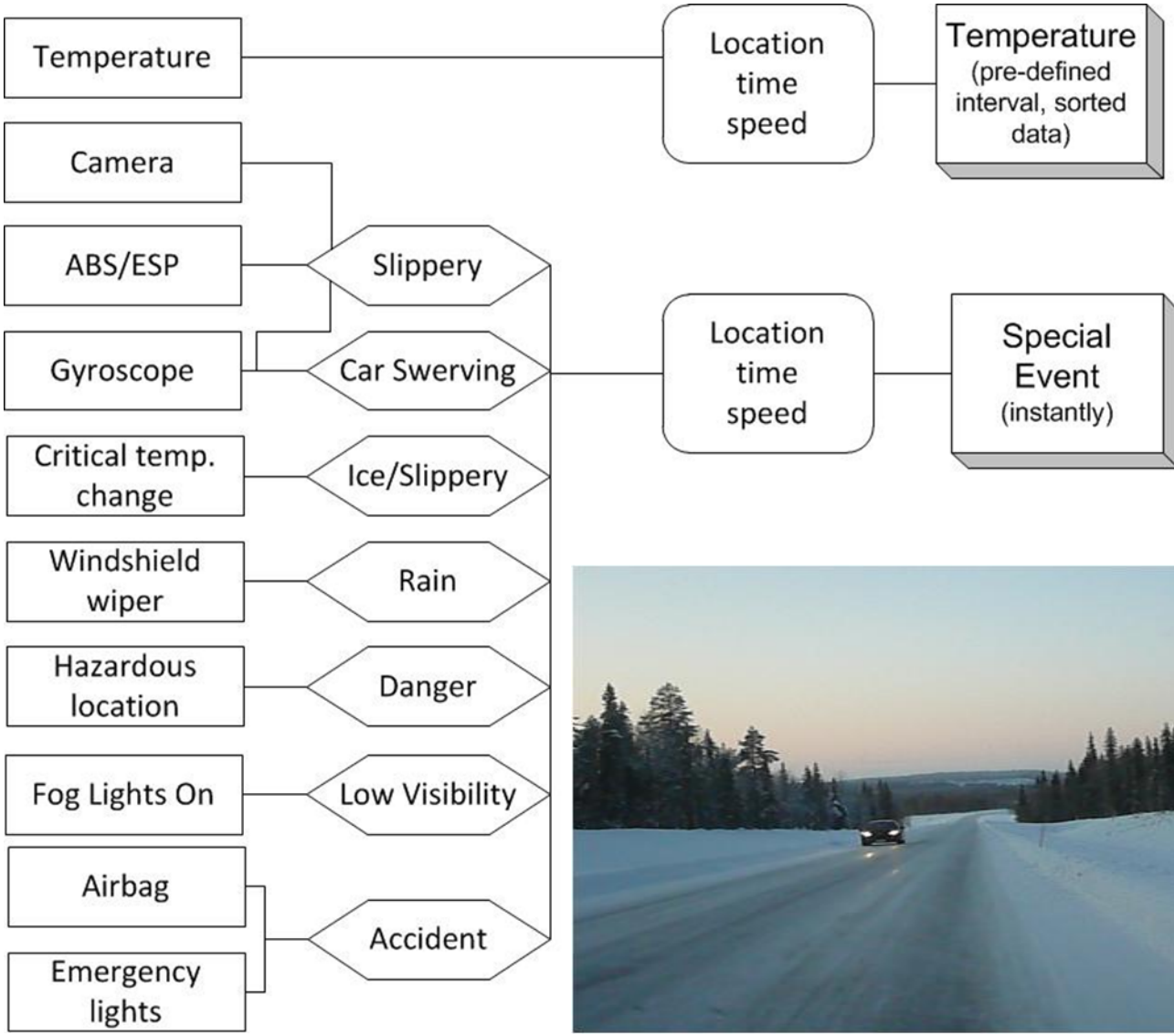
- ✓ EU Eureka-program Celtic-cluster Call 6 project in 2009-2012 (Finland, Luxembourg and Korea)
- ✓ Comprehensive, secure and reliable solution for V2I (Vehicle to Infrastructure) and V2V (Vehicle to Vehicle) communications
- ✓ True V2I and V2V communications based on the car-to-car communication standards developed by the European Committee for Standardization (CEN) and the European Telecommunications Standards Institute (ETSI)
  - Vehicles equipped with on-board vehicle computers & vehicular networking capabilities (IEEE 802.11p and 3G)
  - Access point-like roadside units
  - The linking point within the fixed network, acting as the interface between vehicles and the independent services



Pilot services

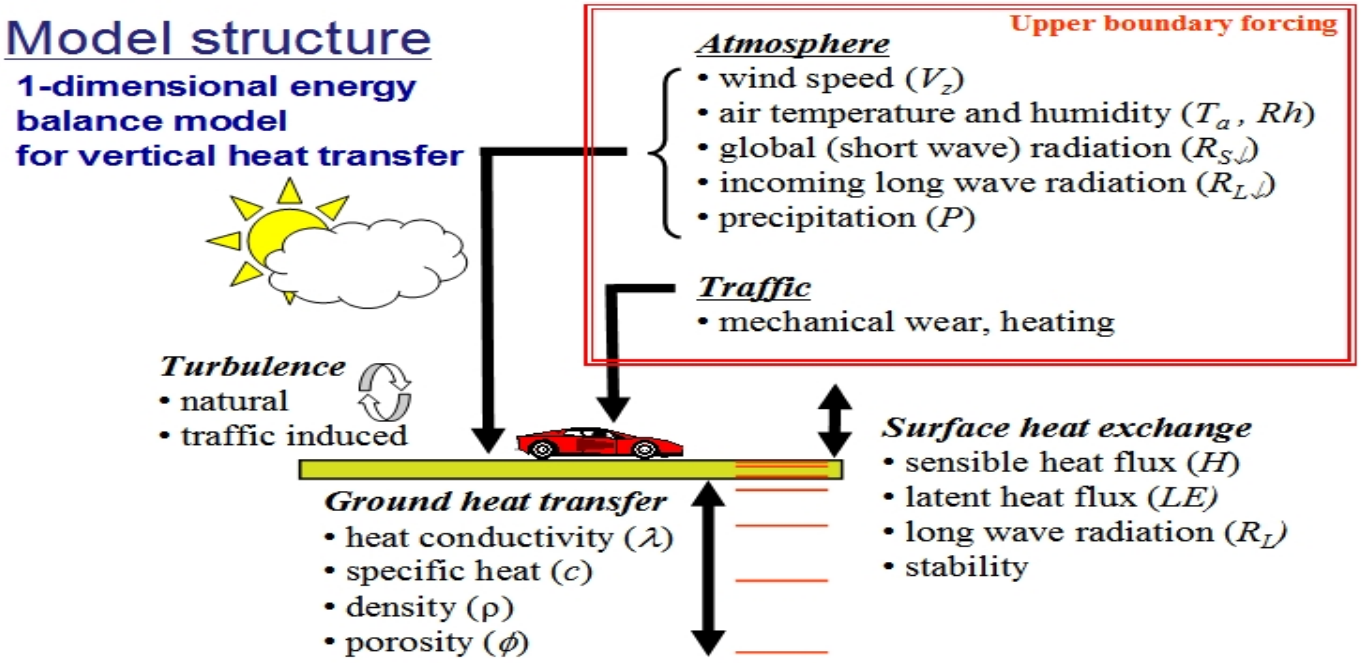
Service	*Overview*	*Internal Data Sources*		*External Data Sources*
		Vehicle	*Roadside Unit*	
Accident warning	Accident in road interpreted, warning spreaded to the accident vicinity area	Airbag burst, abnormal GPS location, emergency lights on	-	Accident info from The Traffic Information Centre or authorities
Incident warning, bad conditions	Exceptionally bad weather conditions interpreted or observed	Temperature, GPS, ESP activation, ABS activation, friction, surface sensors	Road surface condition sensors, temperature, rain intensity, humidity, wind	Weather radars, weather stations etc., The Traffic Information Centre
Incident warning, slippery road	Slippery road conditions observed in specific spot	Surface sensors, angular speed /acceleration, GPS, ESP, ABS, friction	Road surface condition sensors, temperature, rain intensity, humidity, wind	Weather radars, weather stations etc., The Traffic Information Centre
Incident warning, vehicle abnormal behaviour	Abnormal behaviour (sliding, sudden breaking) of vehicle observed, reason not clear but may cause hazard	Gyroscope, GPS	-	The Traffic Information Centre
Incident warning, approaching emergency vehicle	Indication of approaching emergency vehicle	Vehicle-to-vehicle information through VANET	-	-
Incident warning, Roadwork/Intersection	Indication of roadwork ahead	-	Infrastructure-to-vehicle information through VANET	The Traffic Information Centre
Road weather	Local weather information and forecast to the location of vehicle and vicinity ahead, using speed and bearing of vehicle	Temperature, road surface condition sensors, GPS, friction	Road surface condition sensors, temperature, rain intensity, humidity, wind	Weather radars, weather stations etc.
Traffic jam info	Information about traffic jams and congestion, re-routing	-	Traffic amount estimation	The Traffic Information Centre
Route planner	Planning route to expected destination	-	Traffic amount estimation	The Traffic Information Centre
Parking places	Real-time parking place availability info	-	-	The Traffic Information Centre

Vehicle data generation



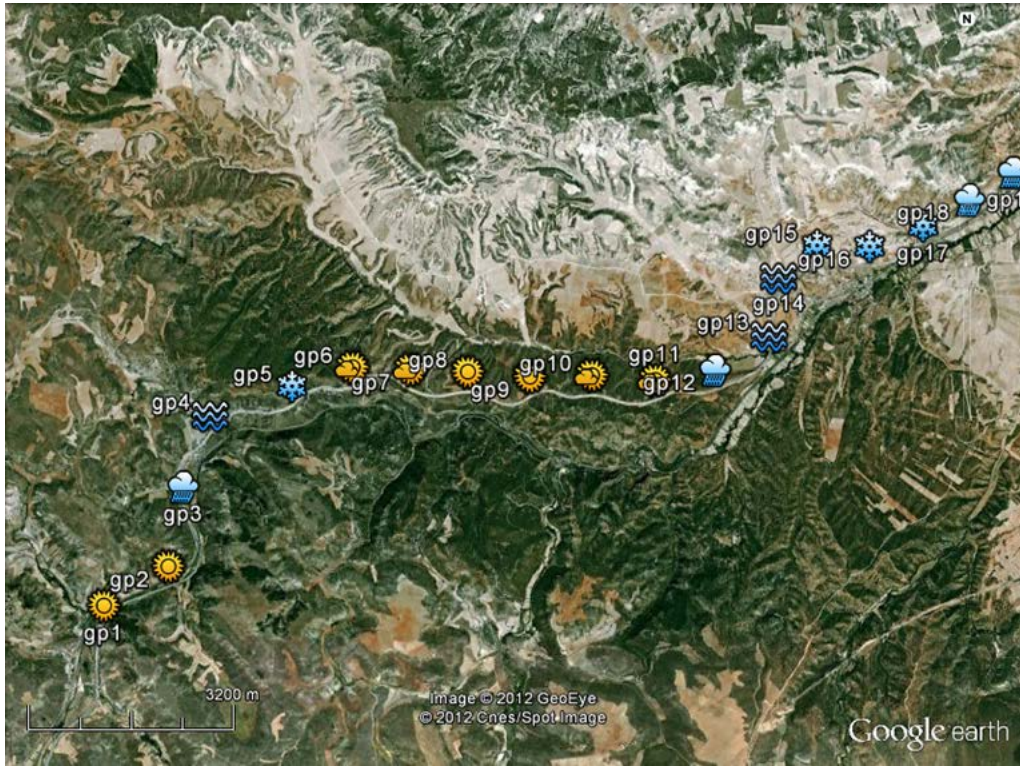
Road weather model

- ✓ One dimensional energy balance model which takes into account the special conditions at the road surface and inside underlying ground, as well as traffic density effects
- ✓ Output from a Numerical Weather Prediction (NWP) model is used as upper boundary
- ✓ 5 km horizontal resolution of the NWP model cannot resolve meteorological features beyond this spatial scale
  - Model spatial scale can be enhanced with novelty sub-grid analysis techniques and additional weather data collected from platform vehicles, roadside units and other potential sources.



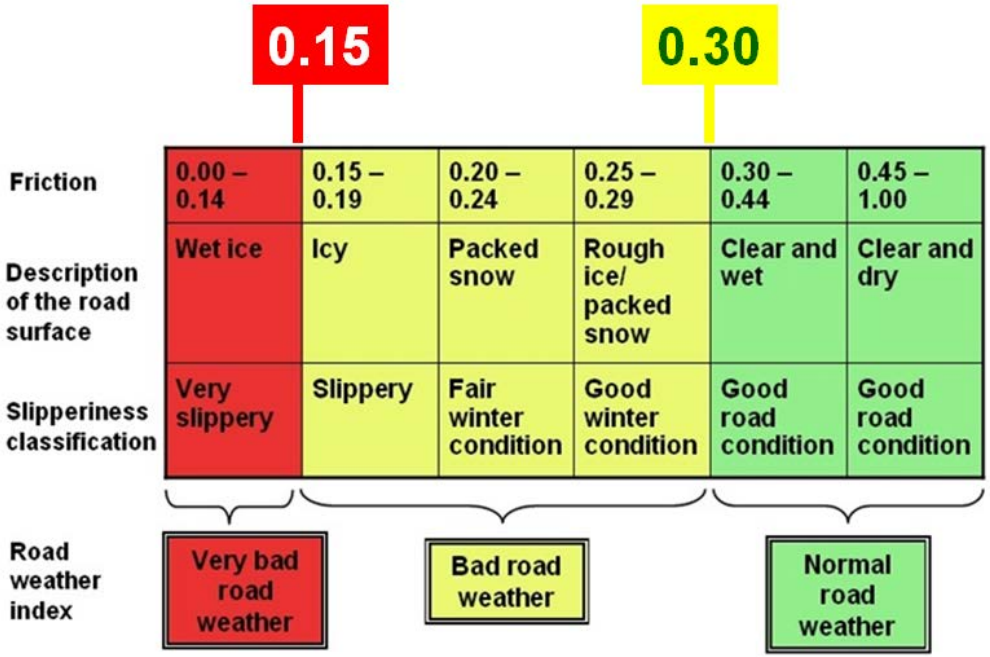
Road weather model operation

- ✓ To produce road weather forecasts with higher spatial resolution we divide road stretches into a number of segments (scale from a few kilometres down to metre-scale, depending on the available computer resources)
- ✓ Model results are further interpolated from regular grid to the centre of each road segment, and a Road Weather Model (RWM) simulations is further done for each of the road segments
- ✓ By default, the input to the RWM are forecasts of a 3D NWP model; however RWM accuracy can be improved by using local weather and traffic observations
- ✓ Final results of the system are the forecasts of road weather and road surface conditions at selected points/segments



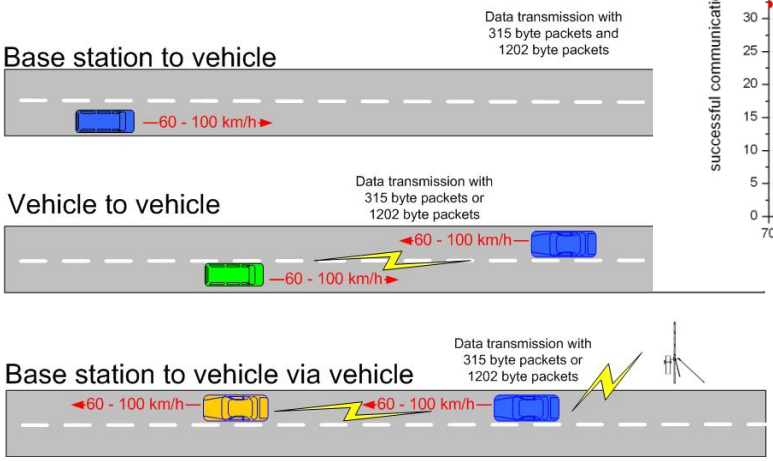
Friction forecasting

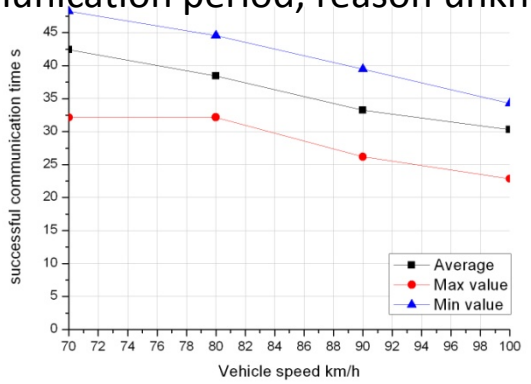
- ✓ An innovative state-of-the-art statistical-numerical road surface friction forecasting technique has been recently developed at FMI
  - Detailed pre-information of potential slipperiness on the roads
  - A decrease in road surface friction is a highly significant negative factor affecting driving conditions
  - The application produces short-range (up to 6 hours) forecasts of friction as absolute values (between 0 and 1), addressed as critical threshold values
- ✓ Friction forecasting was tested during WiSafeCar pilots

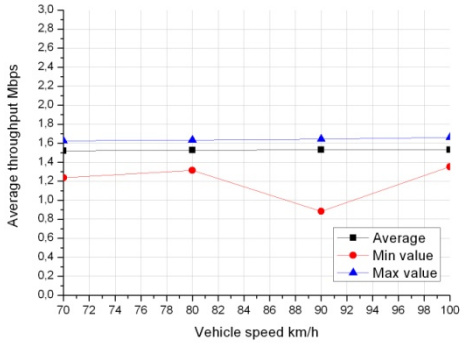


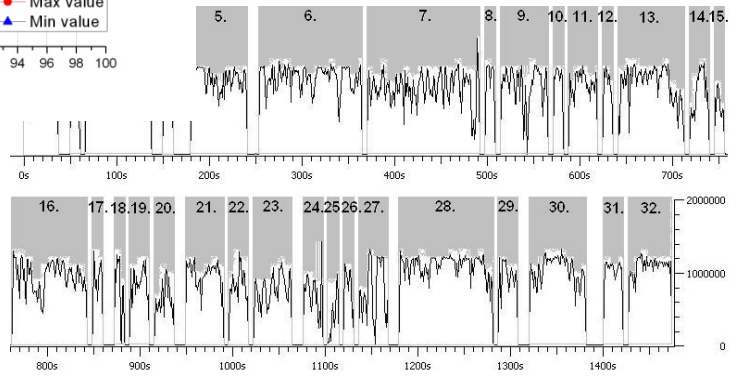
Supporting field measurements

- ✓ Sunit vehicle-pc:s integrated or installed to vehicles, with NEC LinkBird-MX radio tranceivers (IEEE 802.11p capable) installed to 1-4 test vehicles
- ✓ Data transmission capacity and general connectivity analysed in different scenari
- ✓ The vehicle-to-infratructure:
  - Average throughput during connection 1.5 Mbps with 100 km/h
  - Link is accessable on average 35 seconds with 100 km/h
- ✓ The vehicle-to-vehicle:
  - With 100 km/h, the average connection time is more than 20 s
  - The data speed remains approximately same, regardless of the vehicle speed
- ✓ The vehicle-to-vehicle via relaying vehicle
  - Average throughput dropped to around 1.0 Mbps
  - Semi-regular length of communication period, reason unknown



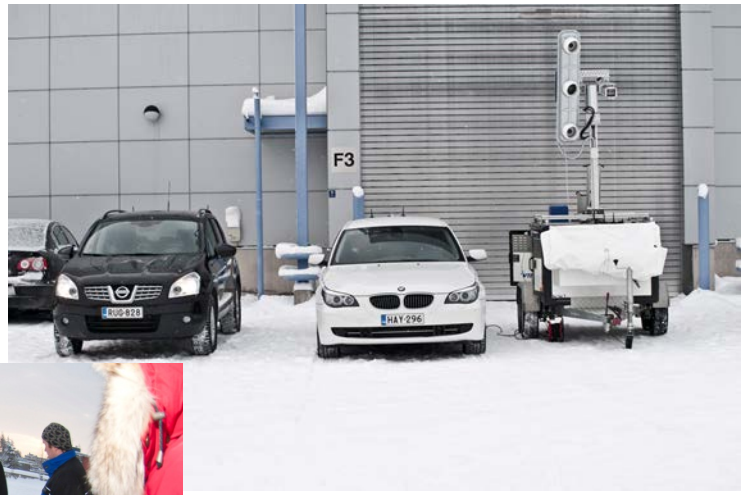






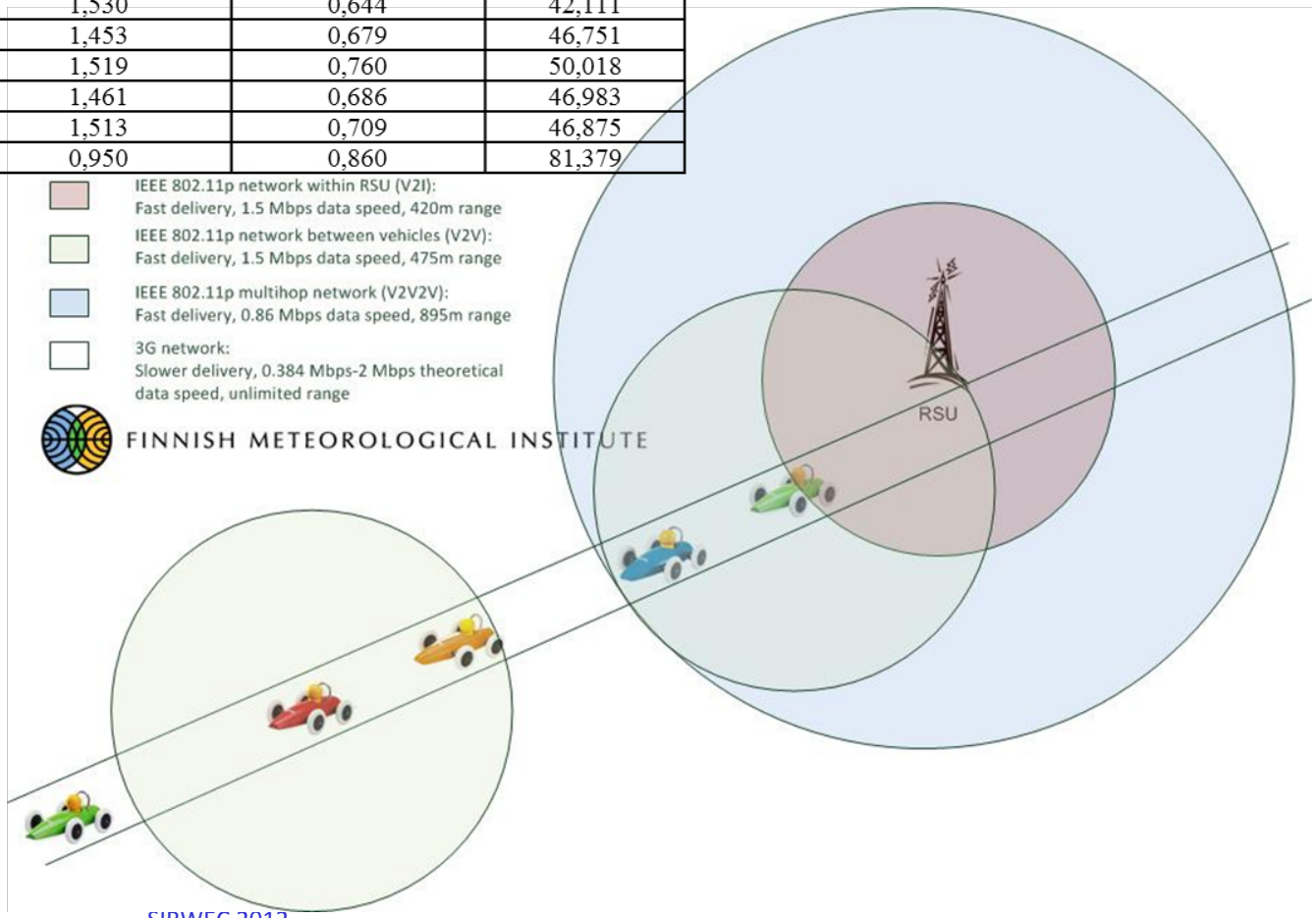
Pilot system

- ✓ Project pilot conducted in Finland in January 2012
  - 4 special equipped vehicles to accurate service tests, with one road side unit and large fleet of vehicles collecting platform data
  - Pilot services (including weather services) operated through pilot platform installation
  - Pilot services and overall system performance estimation



The summary of results and preliminary deployment estimation

Scenario	Bypass speed (km/h)	Goodput time (sec)	Avg. Throughput when connection (Mbps)	Avg. Throughput during session (Mbps)	Connection availability %
V2I	70	42,437	1,519	0,627	41,257
V2I	80	38,442	1,527	0,652	42,713
V2I	90	33,280	1,531	0,637	41,600
V2I	100	30,320	1,530	0,644	42,111
V2V	70	24,044	1,453	0,679	46,751
V2V	80	22,508	1,519	0,760	50,018
V2V	90	18,793	1,461	0,686	46,983
V2V	100	16,875	1,513	0,709	46,875
V2V2V	60-80	36,121	0,950	0,860	81,379



Summary

- ✓ An intelligent wireless traffic service platform between cars supported with wireless roadside base stations
- ✓ Combined communication structure ensures operation also in early deployment phase or in rural areas, where base station density is low
- ✓ Set of example serviced created to exploit platform capabilities and provide enhancements for traffic safety
- ✓ Basic operability verified via simulations, field measurements and system deployment
- ✓ Considerable amount of traffic fatalities can be avoided with operative system with real time weather and accident info