

# The “Telematics Horizon” V2V and V2I Networking

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*Telematics horizon*: the reach of sensor awareness of a “connected car”

compared to

*line of sight* for an unconnected one.

*Origin*: Daimler, per Dr. Christian Weiß



[mentor.com/embedded](http://mentor.com/embedded)

# Goal: increase safety and reduce accidents

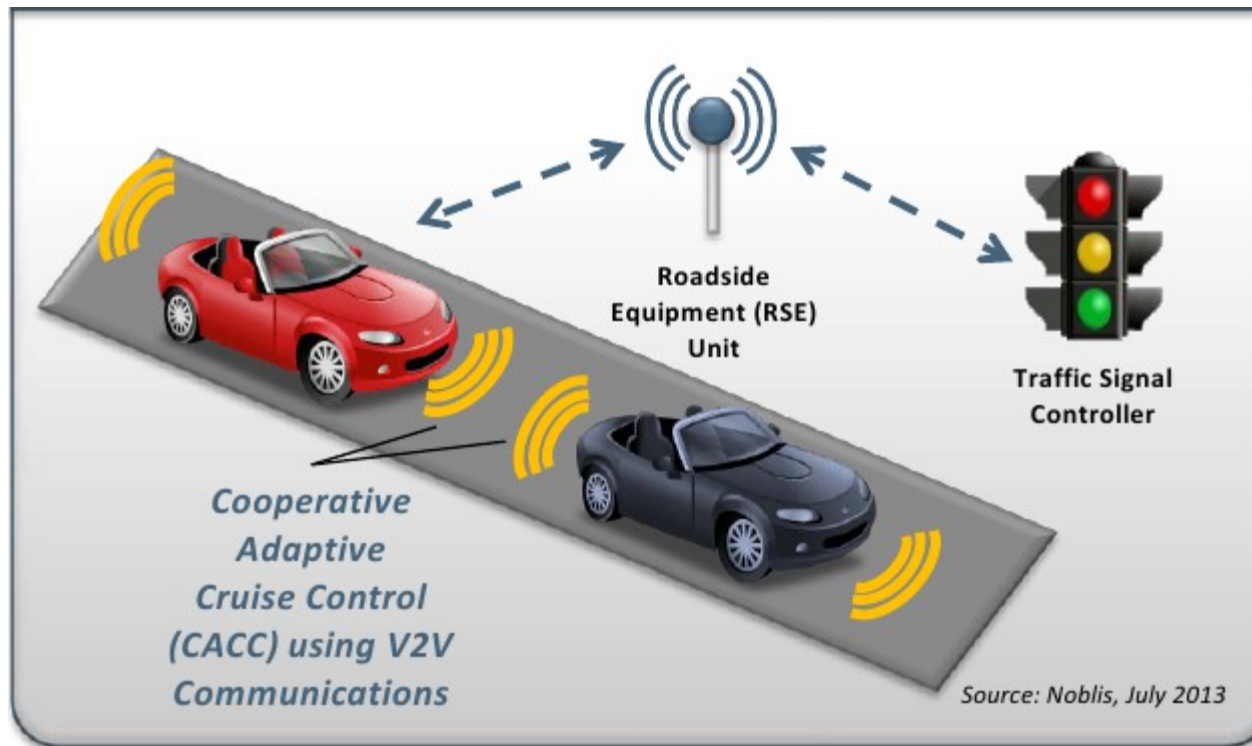


First semi-autonomous vehicles (H/T Greg Dibb, Nissan)


# Agenda

- Introducing vehicle-to-infrastructure (V2I) and vehicle-to-vehicle (V2V)
- V2X hardware and protocol stacks
- Safety Pilot and simTD pilots
- ~~Security and GeoNetworking~~ (Q&A)
- Future prospects

# “Killer App”: Green-light optimal speed advisory





GLOSA will allow drivers to set optimal green-signal speed.



What hardware will  
automotive internets use?

*IEEE-802.11p*  
(= *ITS-G5*)



# Why V2V needs low latency

## Target Scenarios for Forward Crash Warning (FCW) & Lane Change Warning (LCW)

### FCW

Lead Vehicle Stopped



Lead Vehicle Slower

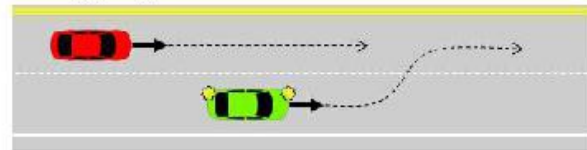


Lead Vehicle Decelerating

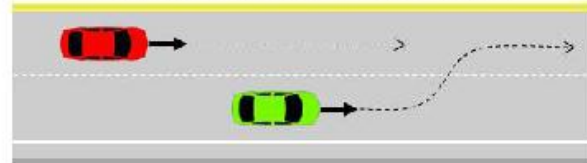


### LCW

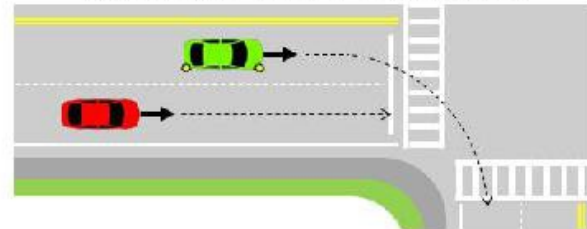
Changing Lanes/Same Direction



Drifting/Same Direction



Turning/Same Direction



# 802.11p vs. LTE vs. Satellite and FM

- 802.11p is the only *low-latency* safety channel.
- LTE has the largest install base and is industry-funded.
- Terrestrial and satellite radio will carry vehicular data:



+



- 3G (UMTS) already employed in simTD.
- Telcos are investing heavily in automotive.



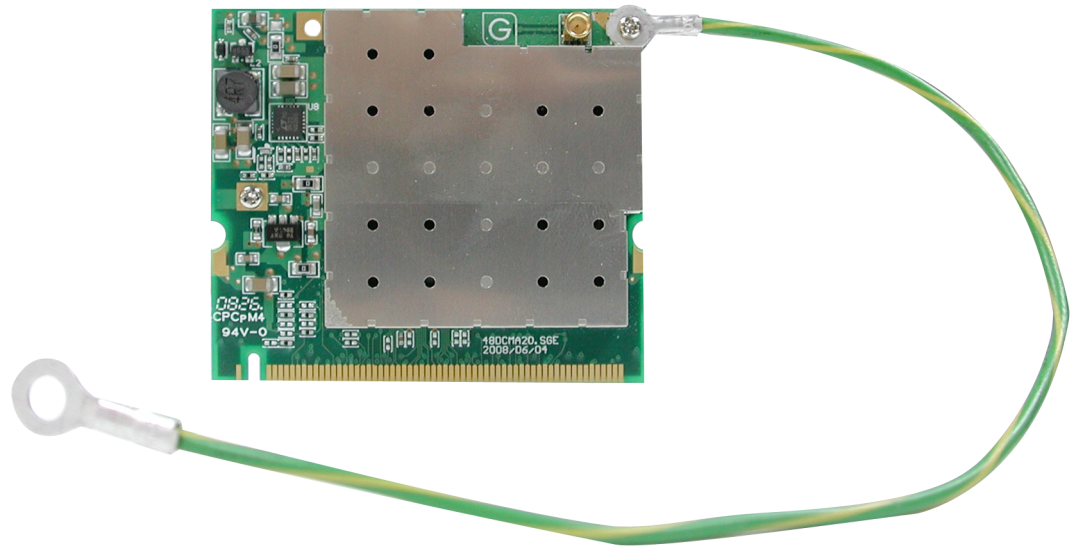
# 802.11p (WAVE) vs. other Comms Modes

- Lower-overhead protocol for safety messages.
- No access point (AP) and no basic service set (BSS)
  - Too much delay for moving vehicles.
  - Lower latency than 802.11a/b/g/n, LTE or satellite.
- Message priorities 0-7.
- Half-width channels; always *ad hoc*.
- Up to 33 dBm (~1 km) in E.U. and 44 dBm in U.S.
- No upstream Linux driver.

# Manufacturers of 802.11p radios

- NEC
- Cisco/Cohda Wireless
- Commsignia (BSD-based)
- Denso
- Delphi
- Savari      SafetyPilot
- Kapsch
- Siemens
- UNEX
- AutoTalks
- Arada
- DGE
- Componentality

UNEX DCMA-86P2 miniPCI



collected by Alexandru Petrescu, cea.fr

# Products are all OpenWRT-based routers?

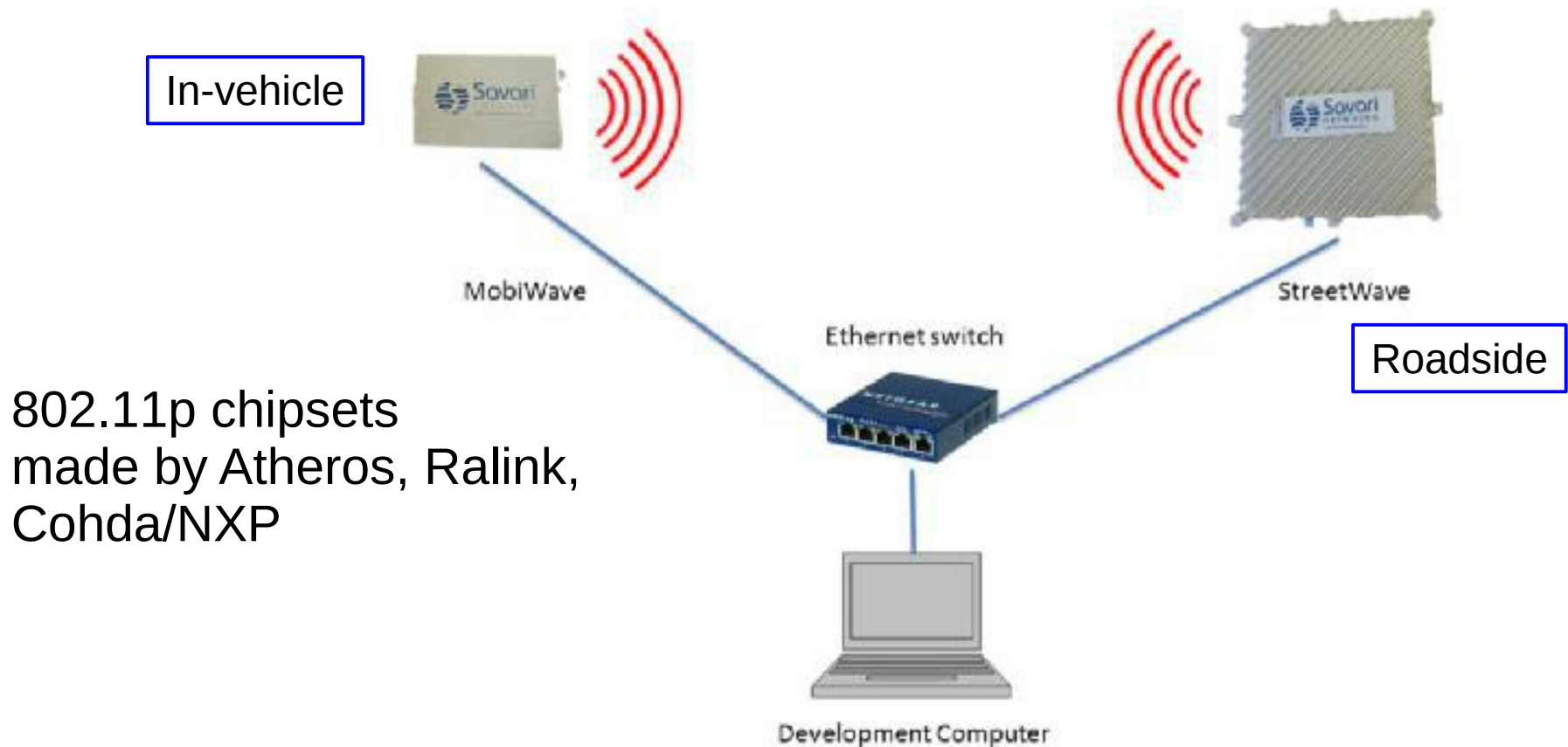


Image: "IntelliDrive Technology based Yellow Onset ® Decision Assistance System for Trucks", Sharma et al.

# Componentality: open-source 802.11p stack: the **bluez** of DSRC?

## Typical Set Of Technologies



**OpenWrt**

ATHxK drivers

WAVE library

ITS applications

...and nothing else!



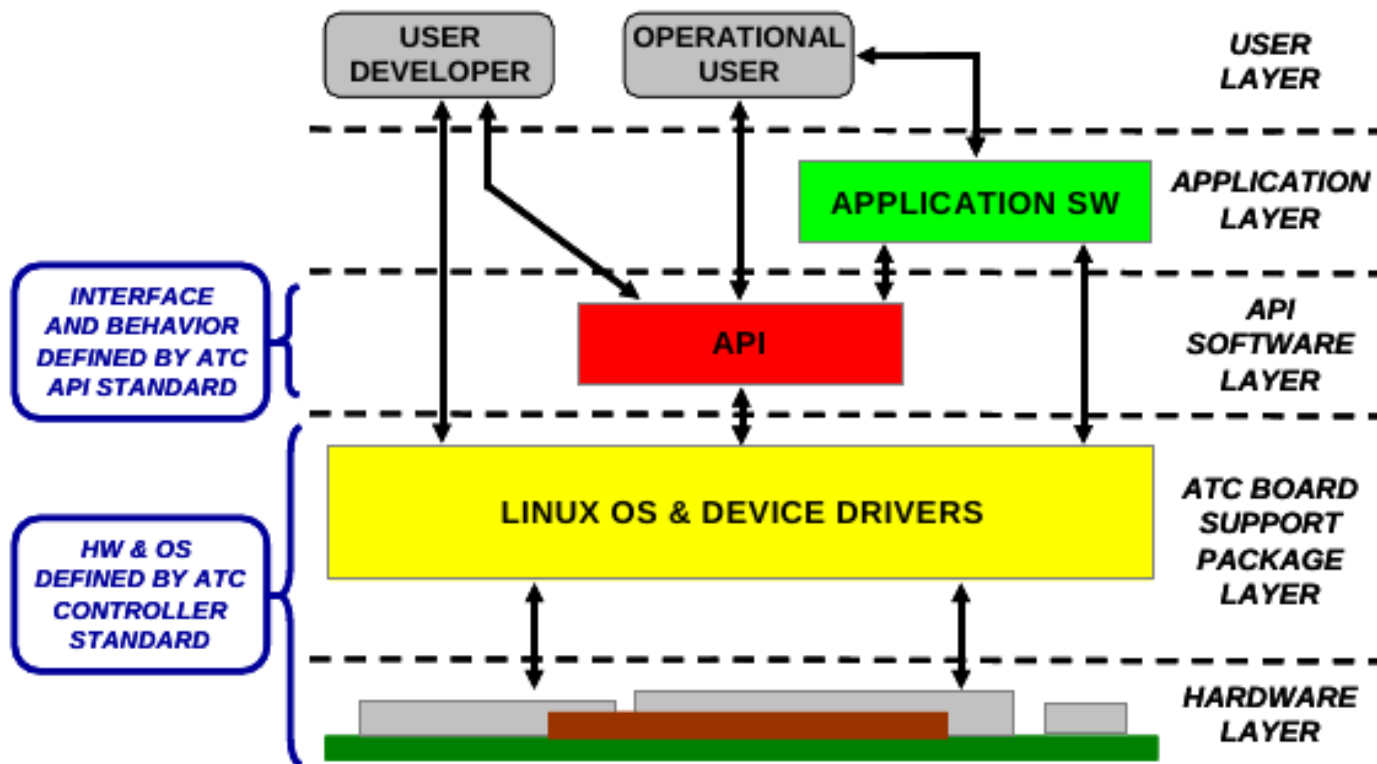
Source: "Using Open Source Solutions for V2V and V2I Communications,"  
Automotive Grade Linux webinar

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# Linux in V2I:

## Advanced Transportation Controller (ATC)

*Applications:* GLOSA; Traffic Surveillance; Ramp Meter; Dynamic Message Signs; Weather monitor; Weigh stations; Rail intersections; Lane usage controls; Roadworks warning . . .



Source: [Institute for Traffic Engineers](#)



## Recently completed field trials: Safety Pilot and simTD

# CEN DSRC in Europe = electronic tolling

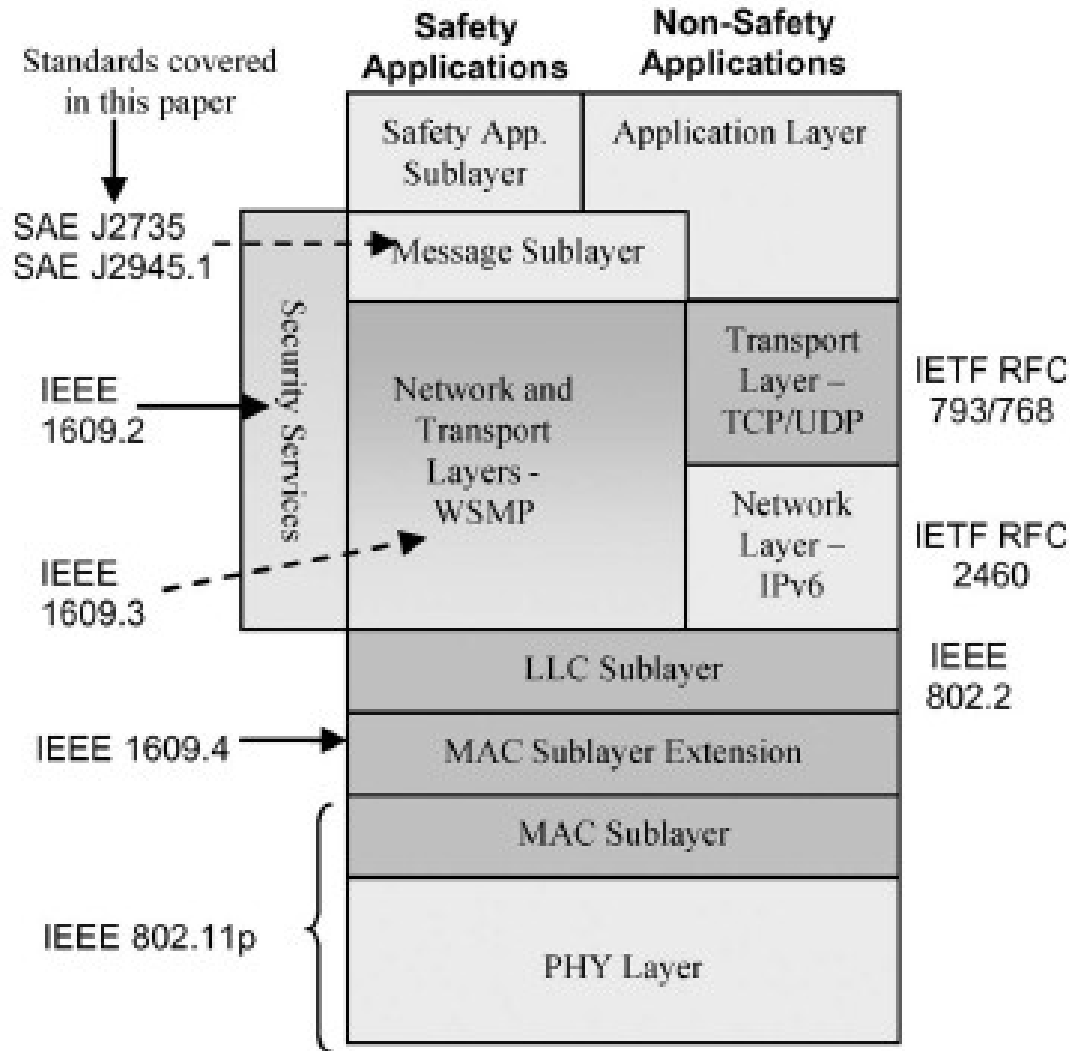
(Comité Européen de Normalisation)

## TRX-1320 Single-Lane Transceiver.



The single-lane transceiver TRX-1320 is part of the TS3200-06 road-side system. The transceiver is intended for use in applications based on 5.8 GHz Dedicated Short Range Communication (DSRC) according to the European Committee for Standardization (CEN) TC278 DSRC and electronic fee collection (EFC) standards.

# U.S. DSRC: safety protocol



Two stacks:  
safety stack  
does **not** use  
TCP/UDP or IP

**Fig. 2.** Layered architecture for DSRC communication in the US.



# Safety Pilot trial in Ann Arbor MI

- Originally 8/2012-8/2013, but extended.
- 2800 cars, trucks and buses from 7 automakers.
- 64 embedded systems, 300 aftermarket, rest transmit-only.
- NHTSA decision late 2013.
  - “Notice of Proposed Rule Making” likely late 2014
- V2V only so far.

AUGUST 28, 2013 AT 7:07 PM

## U.S. extends connected vehicle pilot program in Ann Arbor

DAVID SHEPARDSON AND MELISSA BURDEN COMMENTS 

The National Highway Traffic Safety Administration is extending a pilot project in Ann Arbor on connected vehicles by another six months, but said it won't change its timetable for deciding whether to move forward with the new technology.

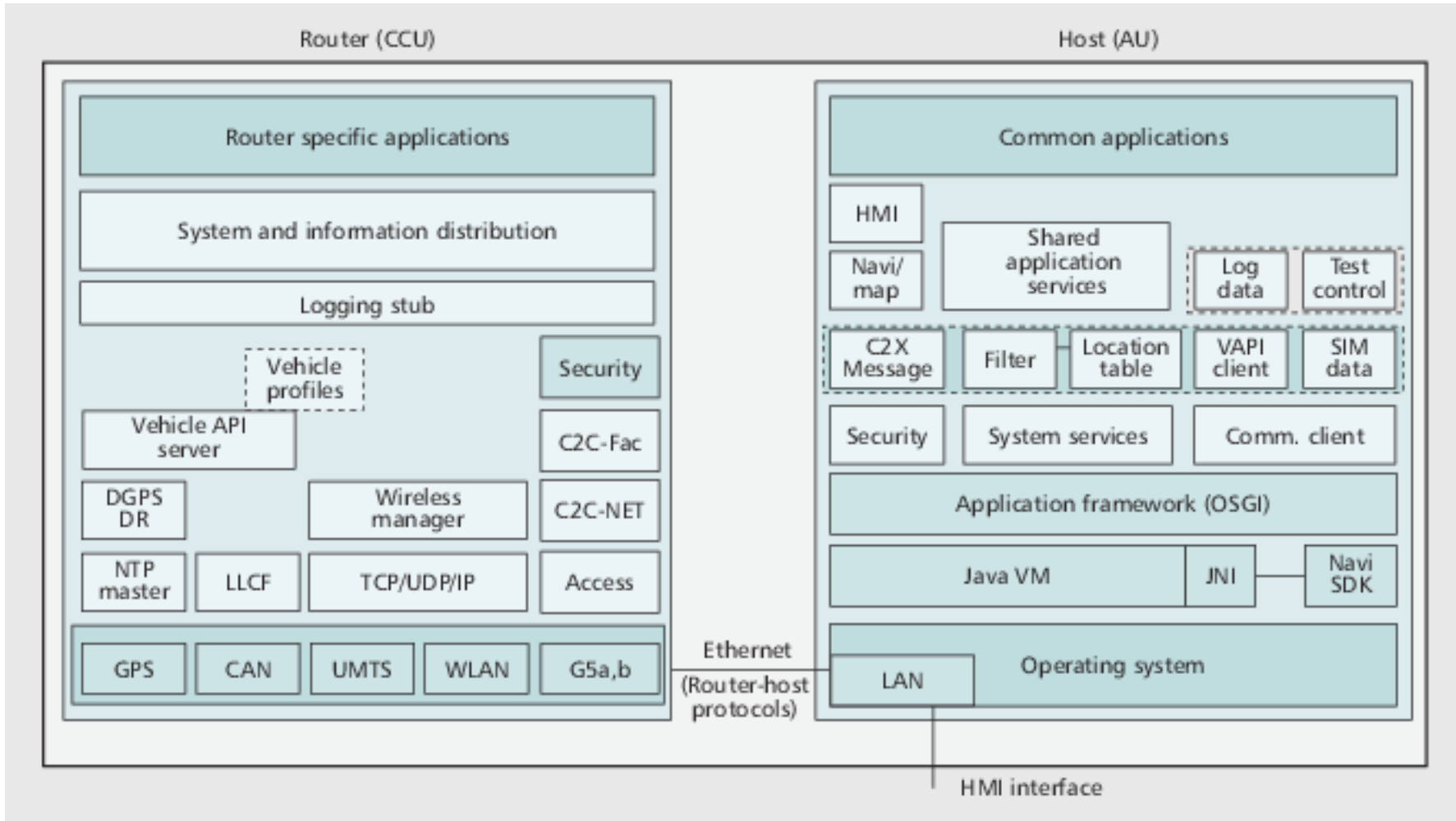
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# E.U.'s Safe Intelligent Mobility—Test Area Germany (simTD) Pilot

- Opel; Audi; BMW; Daimler; Ford; VW; Bosch; Conti; Deutsche Telekom, plus govs and unis.
- 120 vehicles and 3 motorcycles plus RSUs.
- Data collection 2012-6/2013, 41K hrs and 1.65M km.
- 2015: 'Cooperative ITS Corridor Rotterdam - Frankfurt am Main - Vienna'
  - Features “Roadworks Warning” and “Detection of Traffic Conditions”.

# simTD's “vehicle stations”

Linux router + Windows XP Host



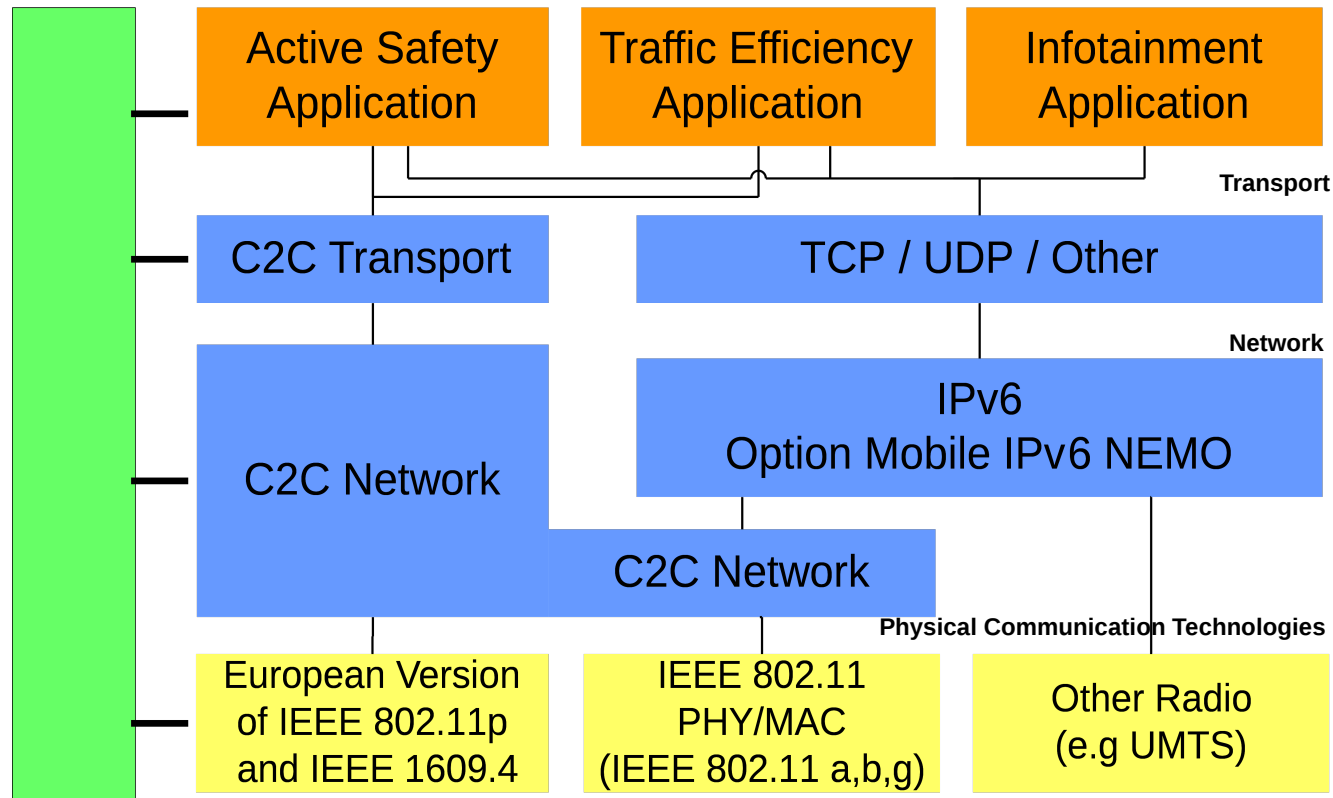
Ref.: H. Stübing *et al.*, IEEE Comm. 148 (2010).

# Dual protocol stacks of simTD

- Based on **ETSI ITS G5** plus GeoNetworking.

Management

Applications



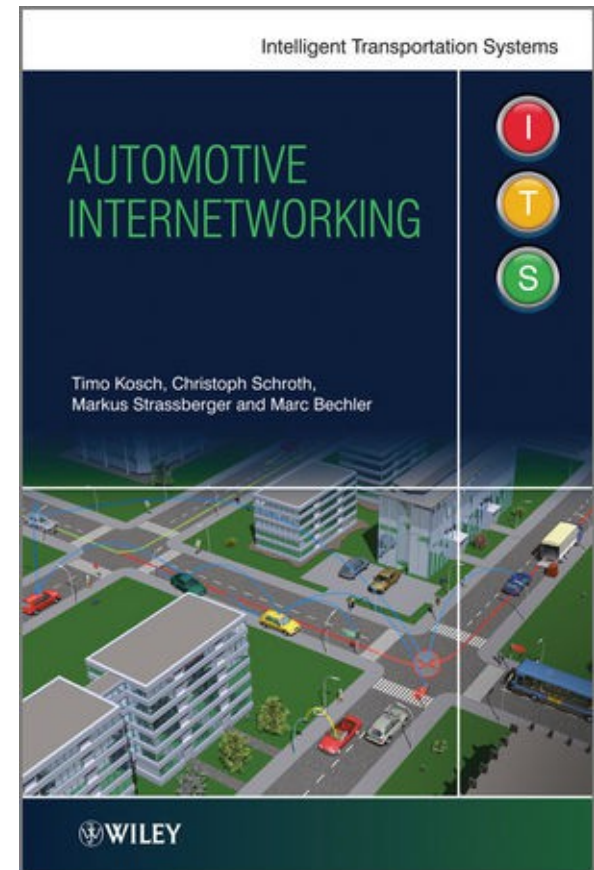
From **Automotive Internetworking**, courtesy M. Bechler, BMW.

# Internet Engineering Task Force (IETF) work on Geonetworking and ITS

- 3 draft standards in preparation
  - Geonetworking ([submitted](#))
  - 'Scenarios and Requirements for IP in Intelligent Transportation Systems' ([submitted](#))
  - IPv6 over 802.11p (particular GENIVI interest)
  - V2X (with MANET working group of IETF?)
- Info: <https://www.ietf.org/mailman/listinfo/its>
- chief organizer: Alex Petrescu of CEA
- in contact with GENIVI Networking Expert Group

# Resources

- simTD and Safety Pilot
- ITSSv6, CALM, ETSI, ISO C-ITS
- SAE, IEEE, ISO, IETF, FCC, NHTSA standards
- IETF-ITS mailing list
- Componentality's FlexRoad
- Automotive Grade Linux
- Telematics News, Wired Autopia
- [slideshare.net/chaiken](http://slideshare.net/chaiken)



# Acknowledgements

(for corrections, not endorsements)

- Alex Petrescu, CEA
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- Konstantin Khait, Componentality
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- Andreas Festag, TU Dresden
- Special thanks to Sarah Newman and Kevin Dankwardt

# Conclusions

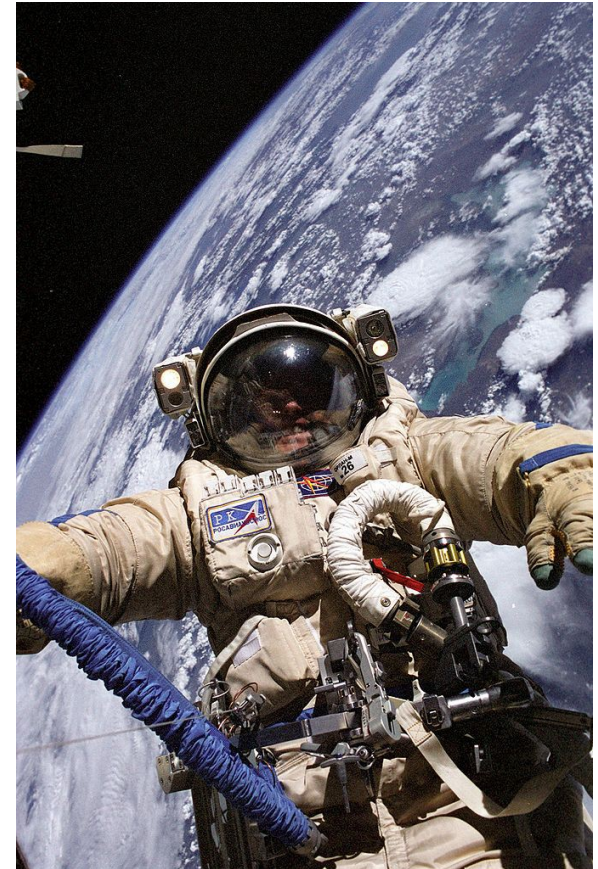
- **Safety Pilot** and **simTD** trials indicate gov't and OEM commitment.
- 1st EU trial centers on V2I; US one V2V.
- EU vs. U.S.: compatible spectrum, but slightly different protocols.
- **IETF-ITS** and **Componentality** seek participants.
- HW is expensive and lacks Linux support.
- Anticipated US decision will raise awareness.



Extra slides follow

# Special cases

- Transit-service vehicles
  - Emergency responders
  - Over-the-air software updates
  - Agricultural equipment
  - Fleet vehicles
  - Rental cars
- ... and many more.



# Warning: not about streaming media or web browsers

## Perlman's View of ISO Layers

- 1: Physical
- 2: Data link: (neighbor to neighbor)
- 3: Network: create path, forward data (e.g., IP)
- 4: Transport: end-to end (e.g., TCP, UDP)
- 5 and above: .... boring



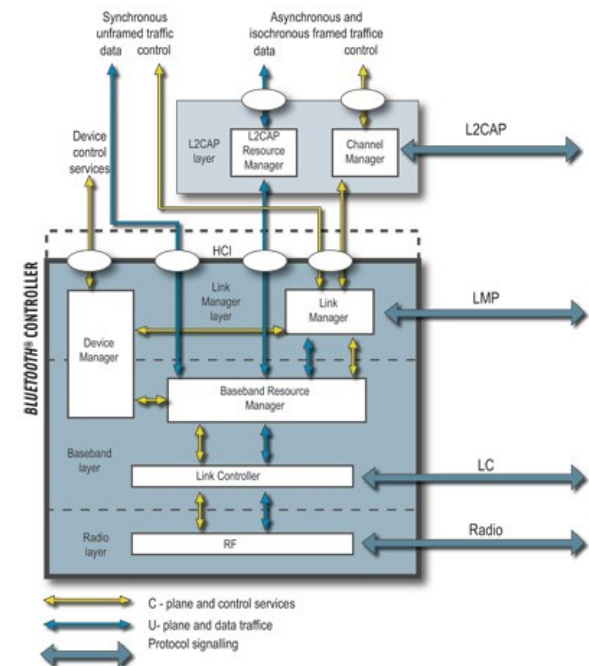
# Or proprietary IEEE-1609 stacks akin to Bluetooth?



**BlueZ**

Official Linux Bluetooth protocol stack

**VS.**



# V2V Model Deployment Safety Applications

OEM/Applications	Ford	GM	Honda	Mercedes	Toyota	Hyundai-Kia	Nissan	VW-Audi
EEBL	X	X	X	X	X			X
FCW	X	X	X	X		X	X	X
BSW / LCW	X	X	X	X	X	X	X (BSW)	
DNPW	X	X	X					
IMA	X	X	X	X	X			X
LTA							X	

EEBL: Emergency Electronic Brake Lights

FCW: Forward Collision Warning

BSW/LCW: Blind Spot Warning/Lane Change Warning

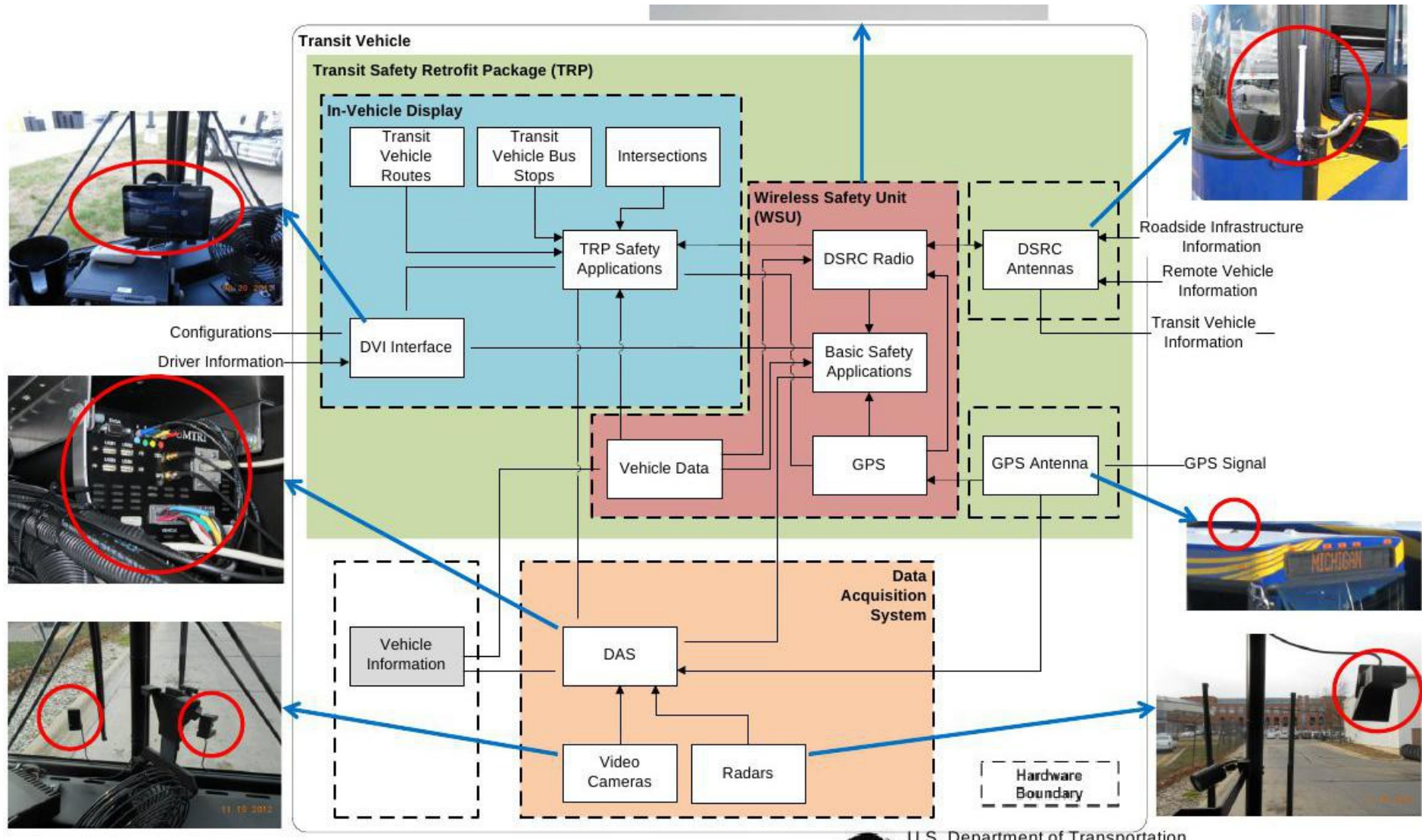
DNPW: Do Not Pass Warning

IMA: Intersection Movement Assist

LTA: Left Turn Assist



# Safety Pilot's transit vehicle system



Source: S. Mortensen, [Connected Vehicle Public Meeting](#)



# Glossary

- Common to EU and US:
  - Vehicle-to-vehicle (V2V)
  - Vehicle-to-infrastructure (V2I)
  - Wireless Access Vehicular Environment = IEEE-802.11p = ITS-G5
  - WAVE Short Message Protocol (WSMP)
- Different:
  - On Board Unit (US) = ITS Vehicle Station (EU) = OBE
  - Road Side Unit (US) = ITS Roadside Station (EU) = RSE
  - Basic Safety Message (US) = Cooperative Awareness Message (EU)
  - **Dedicated Short Range Communication (DSRC)**

# Participating standards bodies

- Intl: ISO, SAE, IEEE, IETF, ITU, ITE, TPEG
- EU: ETSI, CEN, C2C Consortium, Ofcom
- US: FHWA, NHTSA, FCC, ASTM, V2C3
- Japan: ARIB
- Indian and Chinese activity
- ~5.9 GHz dedicated spectrum in both U.S and EU
- Analog TV “whitespace” in Britain (via BT) and dedicated spectrum in Japan



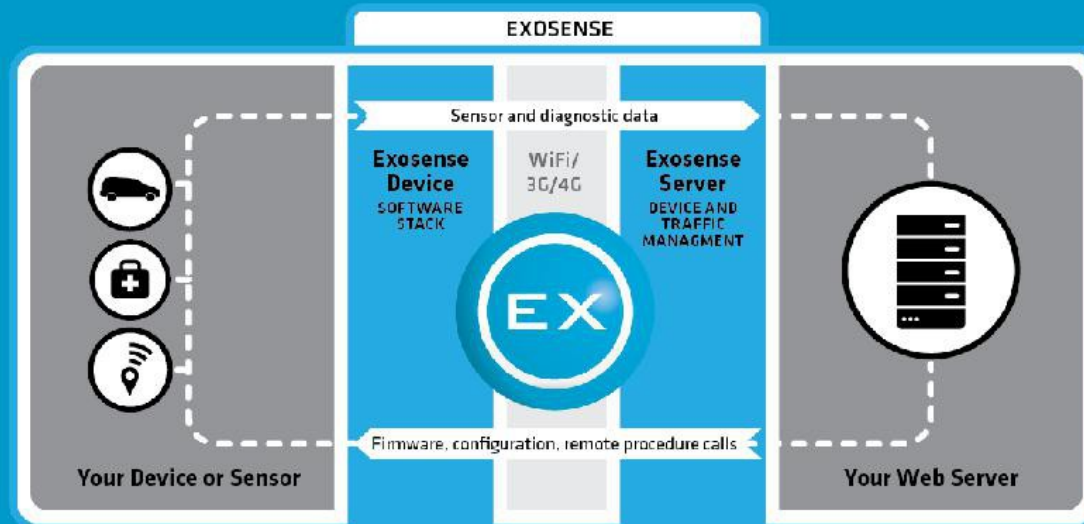
# IETF ITS Standards History (courtesy A. Petrescu)

- Network Mobility (NEMO) Working Group (2003)
- Mobile Ad Hoc Network and NEMO: MANEMO BoF (2007)
- In-Vehicle Routing Requirements in Low Power and Lossy Networks (I-D 2008)
- Automotive Industry Requirements for NEMO Route Optimization (I-D 2009)
- Transport Protocol for Decentralized Probe Applications for Vehicles (I-D 2010)
- Best Current Practice for IP-based In-Vehicle Emergency Calls (I-D 2010)
- Traffic safety applications requirements (I-D 2010)
- ITSsv6, geocasting, DLEP protocol – informal meeting (2012)
- Potential topics of work: IPv6-straight-over-80211p, direct V2V and Geonetworking – bar BoF ITS (2013)

# Feuer Labs' Exosense

FEUERLABS

## What is it?



- Hardware and com libraries for connected devices
- OSS - MPLv2
- Interfaces low-level Linux APIs
- Written in Erlang
- Yocto build system fully supported

Internet Engineering Task Force  
Internet-Draft  
Intended status: Informational  
Expires: March 23, 2014

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NEC Germany  
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September 23, 2013

Internet-wide Geo-networking Problem Statement  
draft-karagiannis-problem-statement-geonetworking-00

Abstract

This document describes the need of specifying Internet-wide location-aware forwarding IETF-based protocol solutions that provide packet routing using geographical positions for packet transport.

# Safety Pilot participants

## Roadside:

Arada, Kapsch, ITRI, Cohda/Cisco, Savari

## In-vehicle:

AutoTalks, Cohda, Denso, DGE, ITRI, Savari, Arada

## Aftermarket Safety Devices:

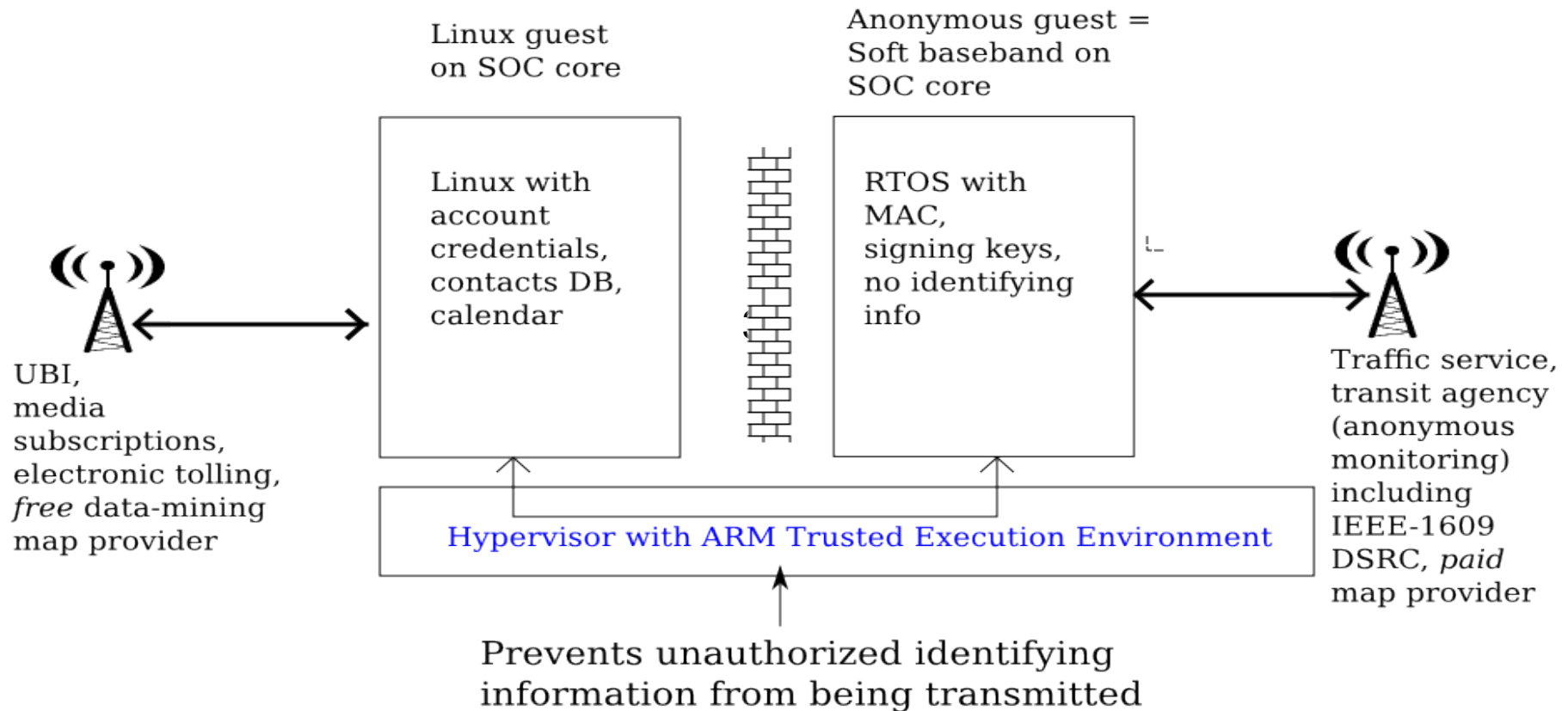
Cohda/Delphi, Cohda/Visteon, Denso, Kapsch

## Automakers:

GM, Ford, Toyota, Honda, VW, Daimler, Hyundai and Nissan

# Assured anonymity in a multicore, shared-radio architecture

With proper security, the radio can potentially be shared between the guests.



Thanks to Mentor's Faheem Sheikh and Felix Baum.



# Ofer Shezaf, “Who can hack a[n EV] plug?”

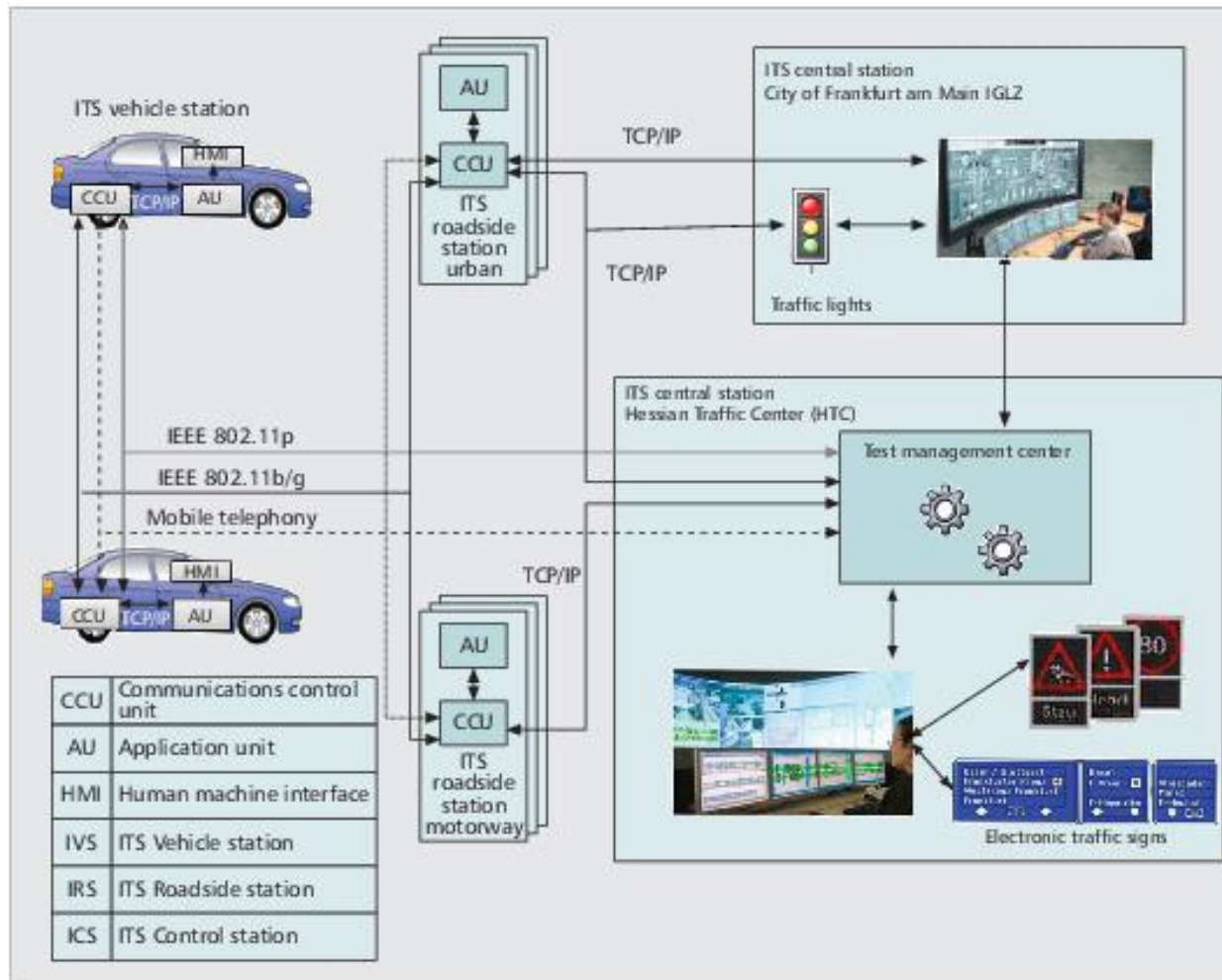
## Potential Vulnerabilities

- Physical access
- Short range communications
- Encryption
- Internet of things
- The human factor

All the information in this section is based on public sources and in most cases from vendors' web sites.

Looking into the suggested possibilities is left as an exercise to the audience.

# Architecture of simTD



Unlike SafetyPilot, includes Central Station and emphasizes V2I.

# Ofer Shezaf, “Who can hack a[n EV] plug?”

## Internet of things: protocols

### Charge station to central management

- Identification, starting and stopping a charge transaction
- Reservations
- Maintenance: Setup, heartbeat, Configuration, Firmware Updates, Errors and diagnostics

### Car to charge station

- Negotiate current
- Identification

### Potential vulnerabilities

- Security by obscurity
- Trust in end points
- SSH and SNMP used extensively for management

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