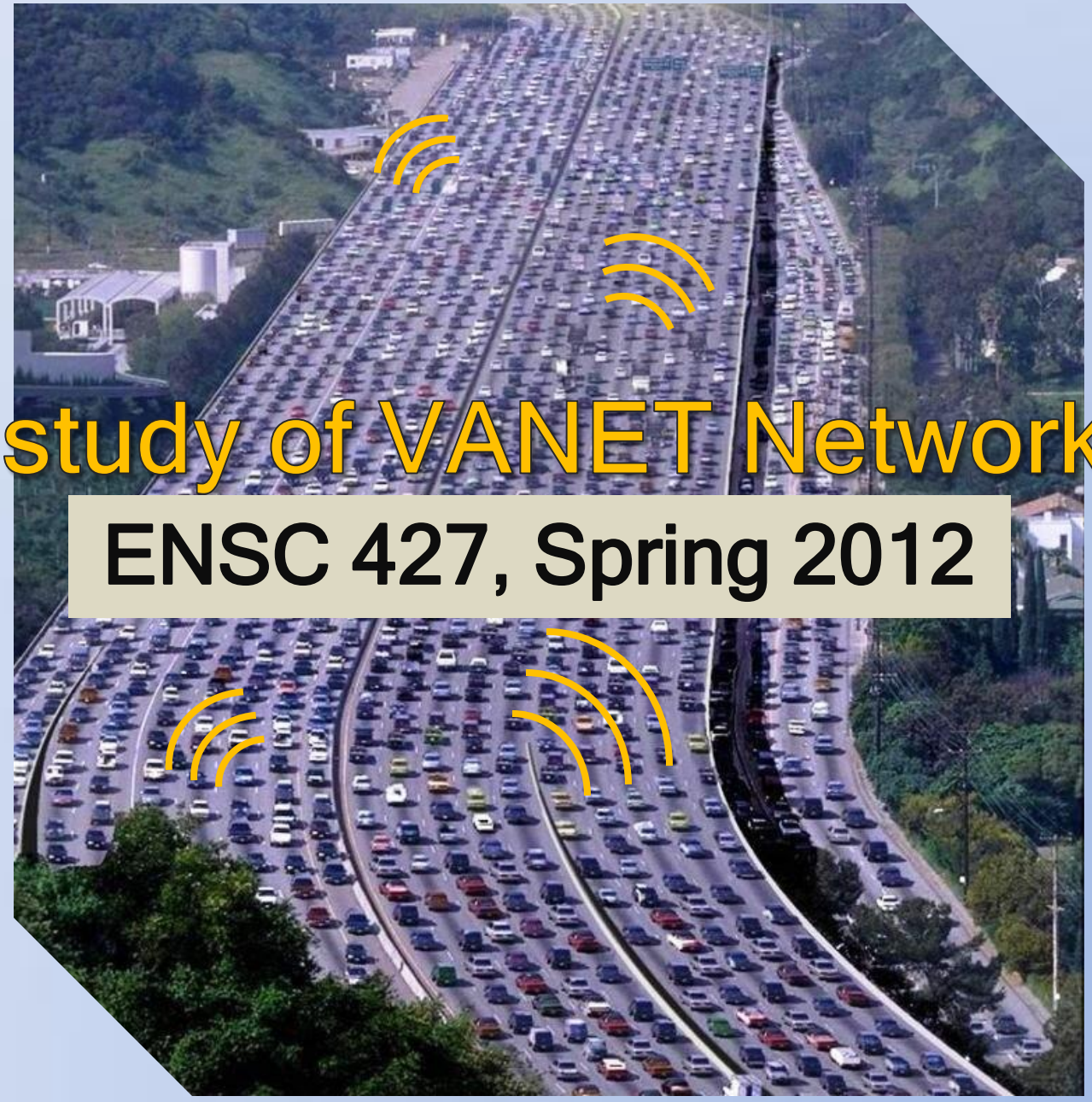


A study of VANET Networks

ENSC 427, Spring 2012

Outline

- Introduction
- DSRC channel allocation
- Standards : IEEE 802.11p + IEEE 1604
- PHY LAYER
- MAC LAYER
- Communication Walkthrough
- Ns-3, Node Mobility, SUMO Traffic Generator
- References

Introduction

The purpose of this project is to conduct a general but informative study of the current trends of *Vehicular Ad Hoc Networks (VANETS)* as they relate to *Intelligent Transport Systems* (ITS).

Along the way a tutorial will be completed to jump-start those interested in learning more about VANETs and simulating contemporary standards in the open-source network simulator ns-3.

Introduction -- Terminology Repository

Vehicular Ad Hoc Networks (VANETS)

Intelligent Transport Systems (ITS).

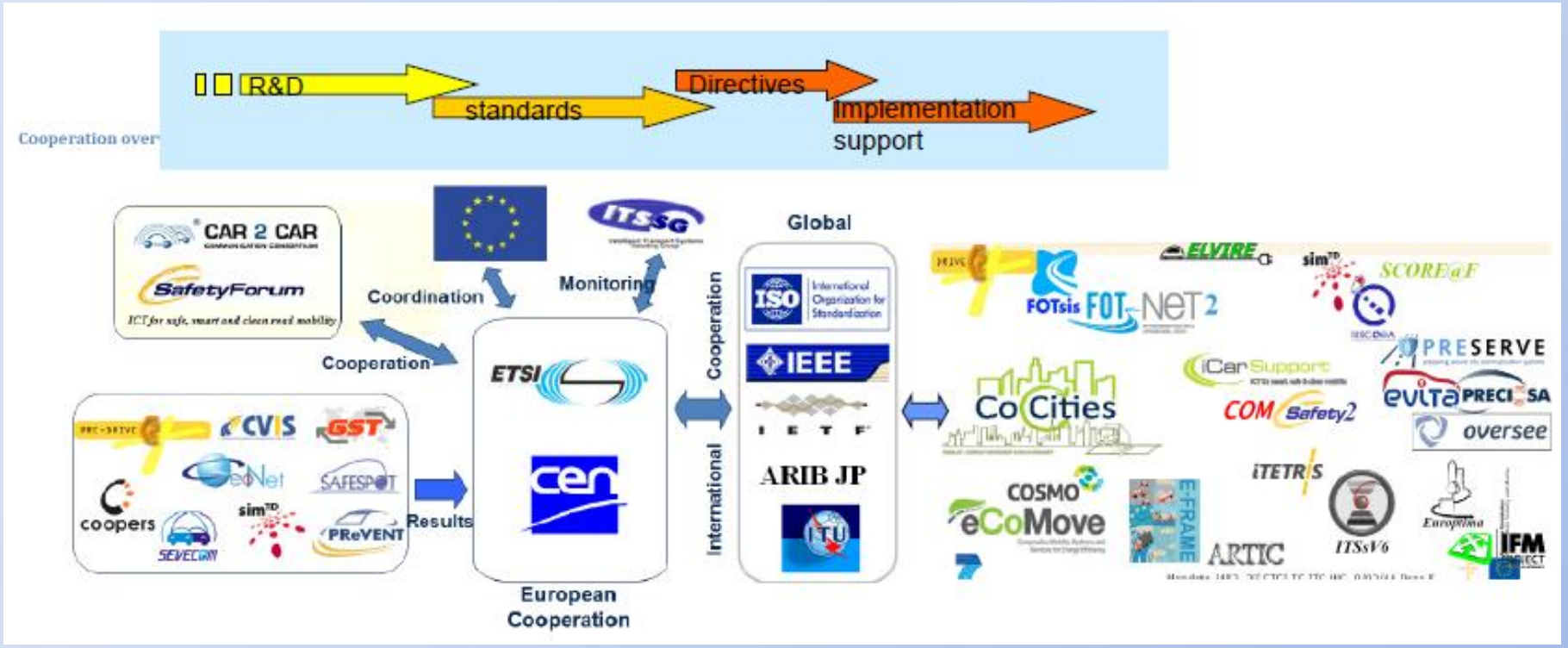
Vehicle-2-Vehicle (V2V) , **Infrastructure-2-Vehicle** (I2V) … also (X2V)

Basic Entities in these networks are: **On-board Units** (OBUs) and **Roadside Units** (RSUs)

Dedicated Short Range Communications (DSRC)

Wireless Access in Vehicular Environments (WAVE)

Introduction -- Current Trends



Reference:

[x] Presentation: “Communications in ITS”

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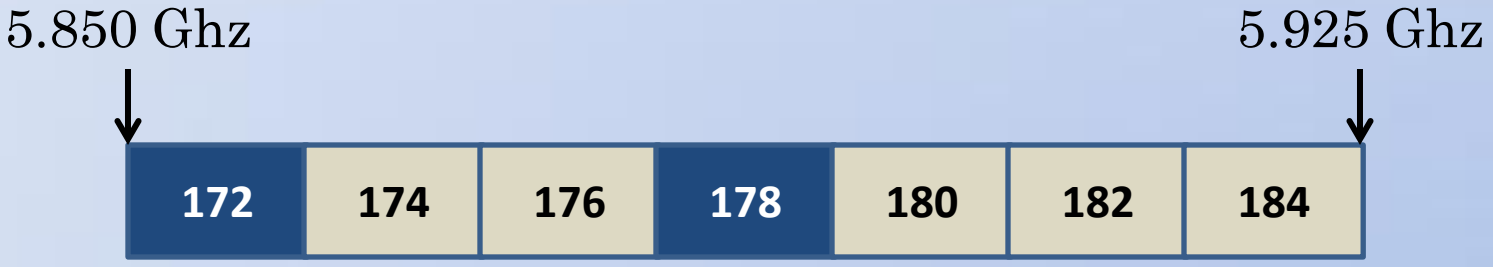
DSRC

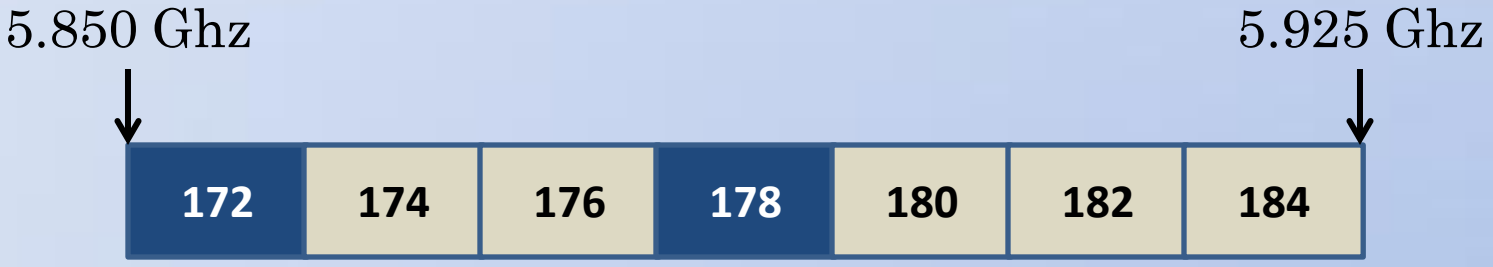


178 : Control CH (CCH)

172 : High Availability and Low Latency (HALL)

Others : Service CH (SCHs)

DSRC



WAVE Short Messages (WSMP) used on CCH

WSMP and IPv6 protocols used on SCHs

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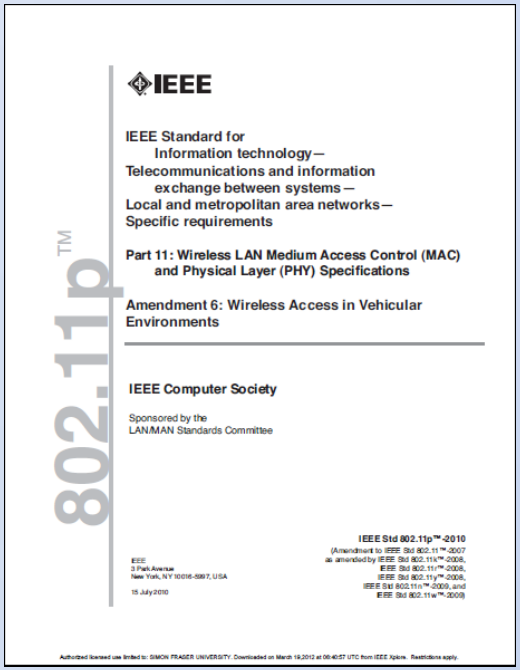
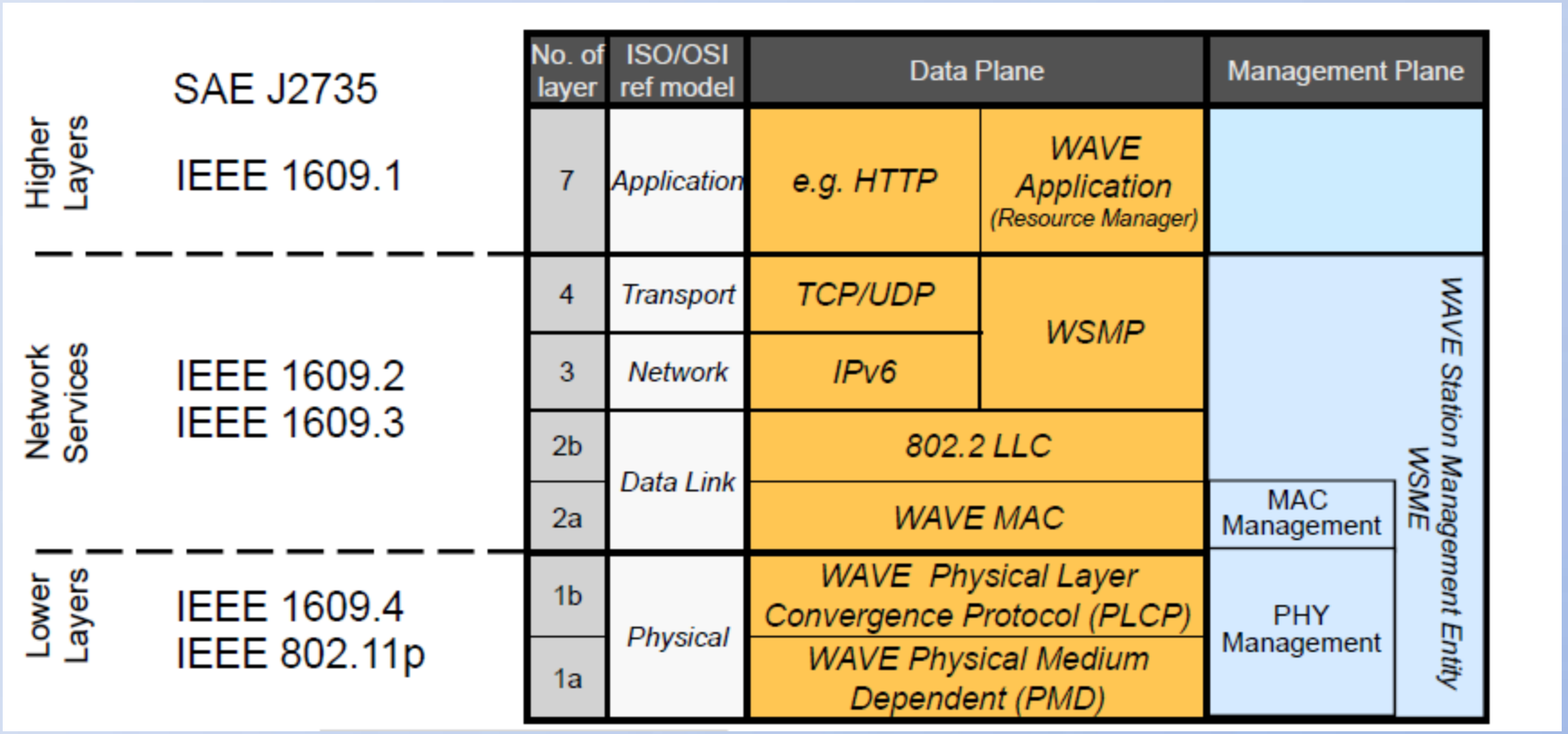
Standards – IEEE 802.11p



802.11p is an amendment to the 802.11 WLAN standard.

It specifies the PHY layer and MAC Layer

Standards – IEEE 802.11p + 1604 (WAVE)



Reference:

[2] *"Vehicle Networks, V2X communication protocols"* Presentation

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Physical Layer

The random nature of the broadcasting medium leads to time-variant channel characteristics.

- Reflections
- Shadowing and Diffraction
- Doppler Shift

Reference:

[4] *"A survey of V2V channel modeling for VANET simulations"*

[x] *Introduction to Analog & Digital Communications*

Physical Layer

"*Multipath propagation and delay dispersion causes frequency selectivity.*"

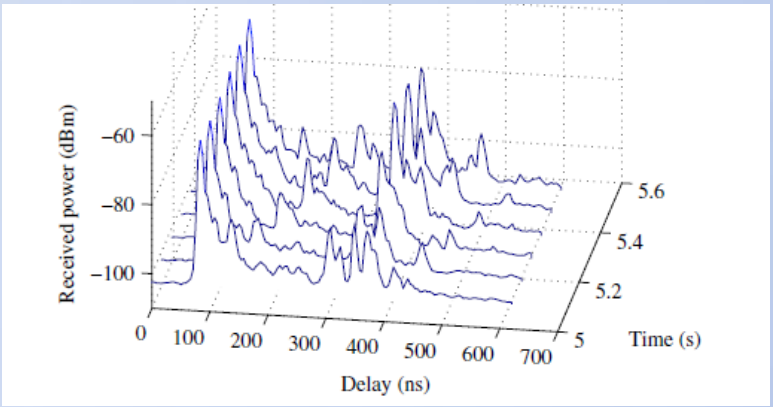
In a static WLAN situation channel fading is less noticeable then in VANETs.

Reference:
[4] *"A survey of V2V channel modeling for VANET simulations"*
[x] *Introduction to Analog & Digital Communications*

Physical Layer -- Doppler Shift

Car speeds of 90 km/h

Measurement Time (delay) resolution = 4.17ns



Observed Doppler Shifts of greater then 1 kHz

Reference:

[7] *"Characterization of Vehicle-to-Vehicle Radio Channels from Measurements at 5.2GHz"*

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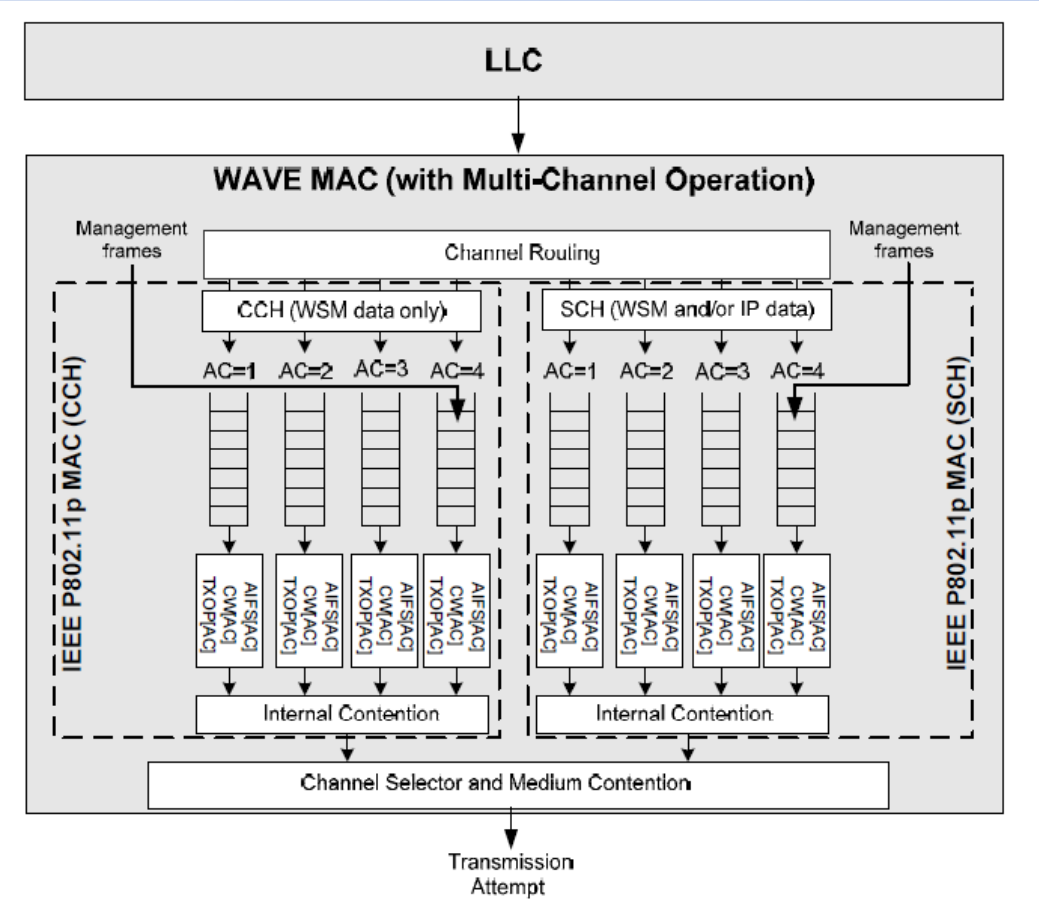
MAC layer

802.11p uses CSMA/CA called Enhanced Distributed Channel Access (EDCA).

Channel use coordination is thus distributed where high priority messages have more like hood to be transmitted no matter which node they originate from.
Issues have be raised about the oscillatory nature of the algorithm.

Reference:
[1] IEEE 802.11p -2010 MAC and PHY Layer Specifications

MAC layer



Reference:

[1] IEEE 802.11p -2010 MAC and PHY Layer Specifications

[x] IEEE 1609.4

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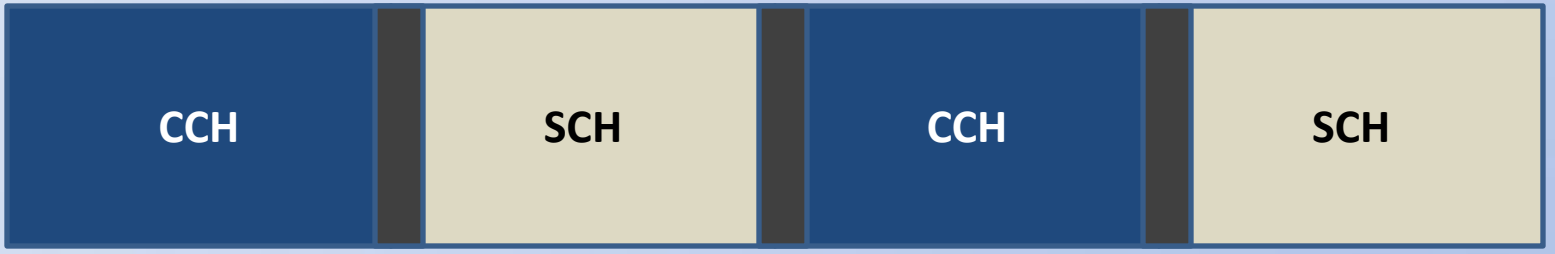
Walkthrough

1. When a car starts-up it randomly generates MAC and IP addresses. The addresses also change during a drive to prevent tracking.
2. The OBU listens to the CCH, beacons safety apps first
3. Initiation of two-way communication on CCH, then switches to SCH

Walkthrough

4. SCH and CCH intervals change at 10 Hz



Possible Improvements

As explained in reference [8], a ITS network is a real-time system and requires a deterministic upper-bound on communication delay.

It recommends using Self-Organizing Time Division Multiple Access (STDMA)

Reference:

[8] *Evaluation of the IEEE 802.11p MAC method for Vehicle-to-Vehicle Communication*

Possible Improvements

By using STDMA nodes are guaranteed a time slot in the CCH interval.

Requires GPS or some other means to provide the timing synchronization.

Reference:

[8] *Evaluation of the IEEE 802.11p MAC method for Vehicle-to-Vehicle Communication*

Possible Improvements

Another reference has a similar approach called Sync-MAC, similar to slotted CSMA.

By synchronizing and also observing which intervals are busy there is a *better packing* of transmissions.

Reference:
[x] Qualcom Presentation

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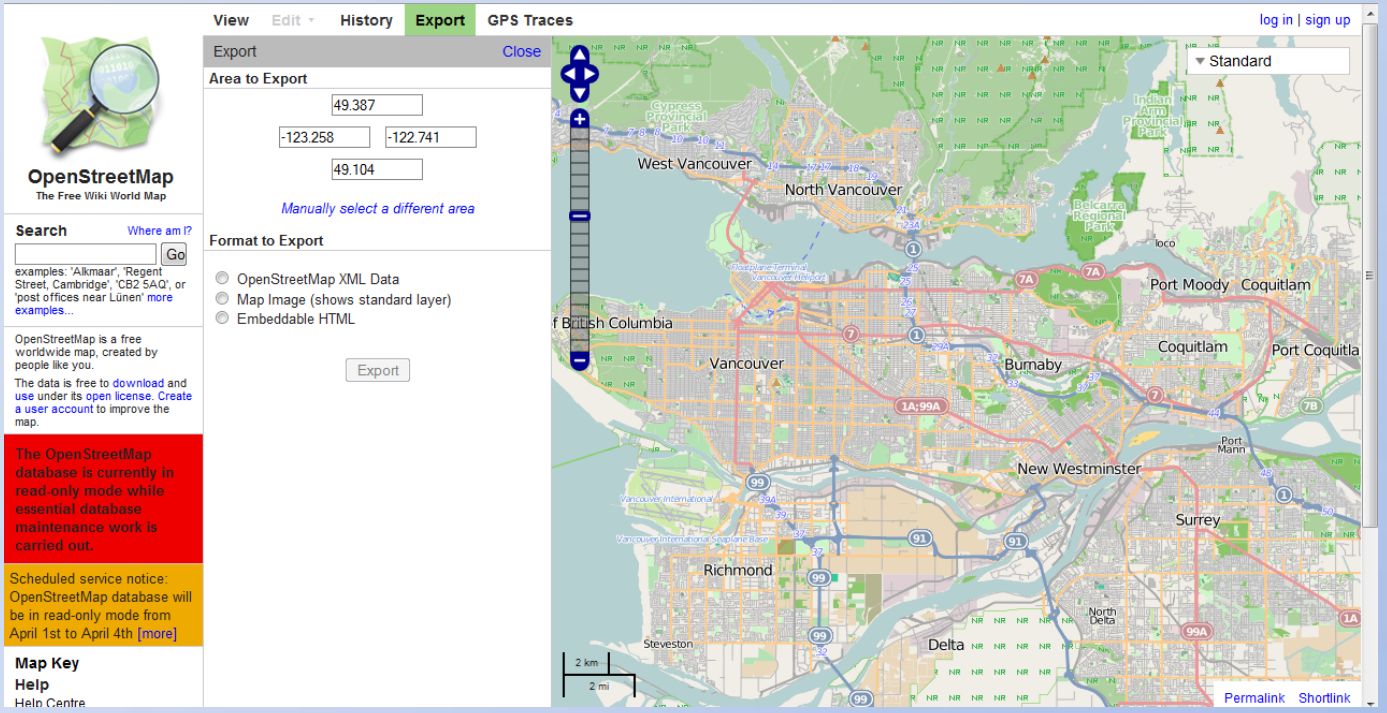
Simulation Project

Objectives :

- Use mobility data from SUMO traffic generator
- Use actual GIS data
- And apply the improvement to MAC protocol and compare performance metrics

Reference:
[1] IEEE 802.11p -2010 MAC and PHY Layer Specifications
[5] *Introduction to Analog & Digital Communications*

Simulation Project -- OpenStreet View



Reference:

[1] Thesis Project *Tracking Vehicular Motion-Position Using V2V Communication*

[x] *Evaluation of Vehicular Ad Hoc Network protocol and applications through simulations*

Simulation Project -- Channel Model

A realistic 802.11p channel model has been created that is more realistic then the default wireless model in the ns-3 package.

PhySim-WiFi

Reference:
[x] PhySim-WiFi ns-3 manual