CUTRIC National Smart Vehicle Demonstration and Integration Trial

Kristina Mlakar, National Operations Manager & Project Lead

Canadian Urban Transit Research and Innovation Consortium (CUTRIC)

Consortium de recherche et d’innovation en transport urbain au Canada (CRITUC)

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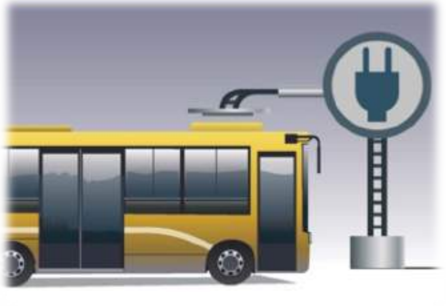
CUTRIC Vision & Pillars of Innovation

To make Canada a **global leader** in **low-carbon smart mobility technology innovation** across light-duty and heavy-duty platforms, including advanced transit, transportation, and integrated mobility applications.

Pillar #1



Zero-emissions & low-carbon propulsion systems with fueling & charging system integration

Pillar #2

"Smart" vehicles and "smart" infrastructure

Pillar #3

Big data advanced mobility

Pillar #4

Cybersecurity in mobility

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Areas of Activity

Project Management

Commercialization Projects - Technology Readiness Level (TRL) 7-9

Funding

Co-funding for projects in Ontario - TRL 2-6

Applied Industrial Research

Predictive Feasibility Energy, Emissions, and Economic Modelling; National and Global Industry Overviews; EVSE Siting

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Marquee Projects

Pan-Canadian Electric Bus Demonstration and Integration Trial: Phase I & II

Pan-Canadian Hydrogen Fuel Cell Demonstration & Integration Trial: Phase I

National Smart Vehicle Demonstration & Integration Trial: Phase I

Rail Innovation Focus Group

Natural Gas Mobility Innovation

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Smart Vehicle Project Overview

The National Smart Vehicle Demonstration and Integration Trial will integrate fully autonomous, connected, low-speed, electrified shuttles (e-LSA) in up to 12 Canadian municipal jurisdictions as first-mile/last-mile applications.

Standardized V2V and V2I communication protocols	Standardized cybersecurity protocol	Interoperability of e-LSA charging equipment	Central operating system across manufacturers

Integration of rail technologies for e-LSAs V2V communication and digital command room control.

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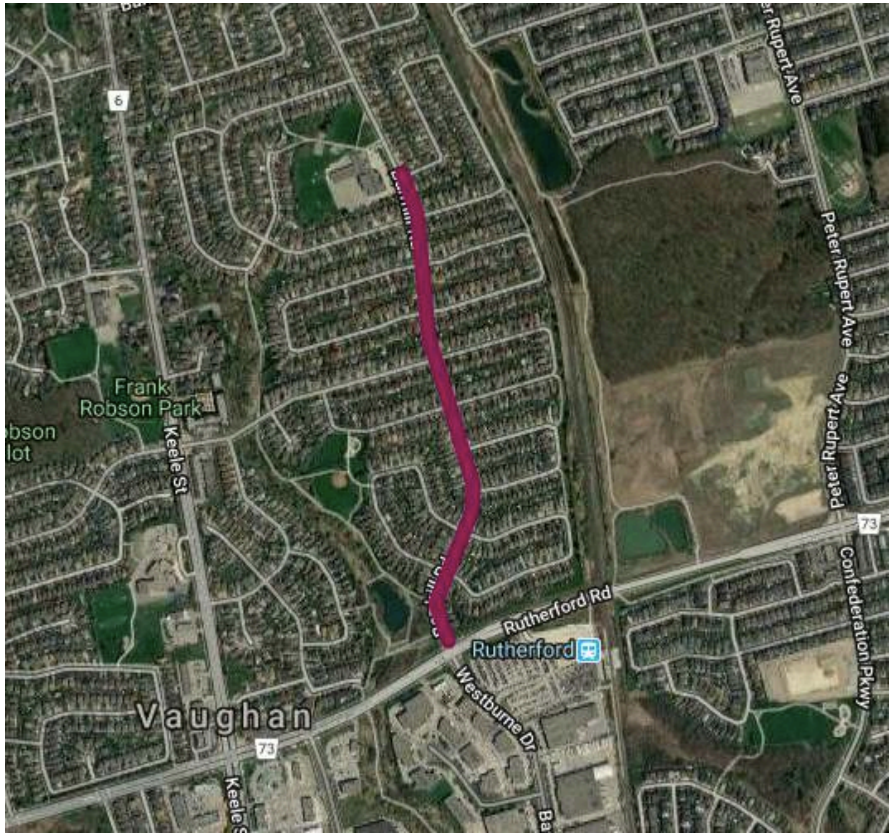
Defining First-Mile/Last-Mile Barriers

First-Mile



Last-Mile

Why a municipally-led CAV trial?

https://tvtropes.org/pmwiki/pmwiki.php/Main/BusesAreForFreaks

VS

WAYMO

Uber

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Project Phases

Phase I

- Electrified low-speed autonomous and connected shuttles as first-mile/last-mile applications, with standardized V2V, V2I, and cybersecurity protocols

Phase II

- On-demand e-LSAs and electrified autonomous and connected heavy-duty buses

Phase III

- Connected vehicle communication systems for Bus Rapid Transit (BRT) applications

Project Scope & Vision

Twelve Cities:

- Vancouver, Surrey, Cochrane, Winnipeg, York Region, Windsor, Brampton, Toronto, Ottawa, Montréal, Québec City, Trois-Rivières

Cost per city: $2 million - $4 million
Number of vehicles per route: 2-3 e-LSAs
Number of OEMs: Minimum 2 OEM products per route
Route length: ~1 km
Transit service option: No current bus services

Total project cost is estimated at **$30-40 Million (2019-2021)**

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e-LSA Manufacturers

NAVYA

2getthere

EasyMile

FPInnovations

e-LSA Manufacturer Profile: 2getthere

Headquarters	Netherlands
Founded	1994
Passenger Capacity	22 (8 seated, 14 standing)
Top Speed	60 km/h
Operating System	TOMS

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e-LSA Manufacturer Profile: NAVYA

Headquarters	France
Founded	2014
Passenger Capacity	15 (4 seated, 11 standing)
Top Speed	25 km/h
Operating System	NAVYA LEAD

e-LSA Manufacturer Profile: EasyMile

Headquarters	France
Founded	2014
Passenger Capacity	15 (6 seated, 9 standing)
Top Speed	12-14 km/h
Operating System	EZ Fleet

Current Industry Stakeholders

e-LSA OEMs:

2getthere

navya

easymile

FPInnovations

Charging System OEMs:

ABB

SIEMENS

ecamion POWER OVER ENERGY

ELIX

Operators:

PWTransit Canada safely home

BOMBARDIER the evolution of mobility

THALES

Other:

NEW FLYER

NOVABUS

SMARTCONE Technologies Inc Safety | Security | Surveillance

Pantero

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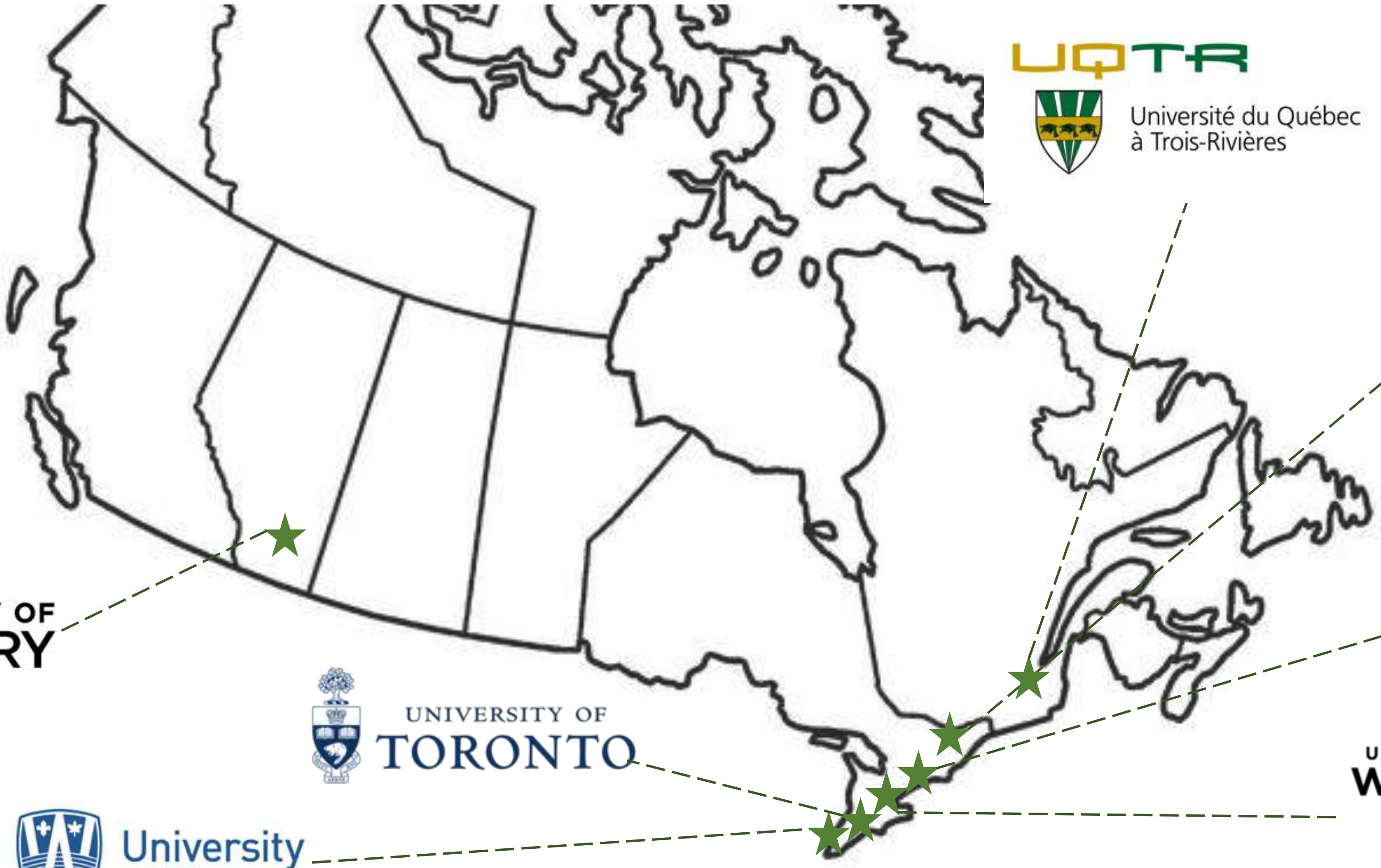
National Academic Advisory Committee



UQTR
Université du Québec à Trois-Rivières

Carleton UNIVERSITY

UNIVERSITY OF CALGARY

Queen's UNIVERSITY

UNIVERSITY OF TORONTO

UNIVERSITY OF WATERLOO

University of Windsor

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Autonomous Vehicles

Are Autonomous Vehicles Here??

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Automotive vs. TNC vs. Shuttle

Auto:

GM
TESLA
Mercedes-Benz
VOLVO
Ford
TOYOTA

TNC:

Uber
WAYMO
lyft
Bai du 百度

Shuttle:

EASY MILE
local motors by LM
navya
2getthere
AURRIGO
may mobility

Where Are we Really?

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Where Are we Really?

CAR TECH

Waymo CEO: Autonomous cars won't ever be able to drive in all conditions

And it will be decades before self-driving cars are all over the roads, John Krafcik says.

BY SHARA TIBKEN | NOVEMBER 13, 2018 9:25 AM PST

Where Are we Really?

Range of object detection

- Low speeds

False positives

- Dangers of disabling (e.g. Uber crash)

Lack of interaction with other road users

- V2V, V2P

Safety gap requirements

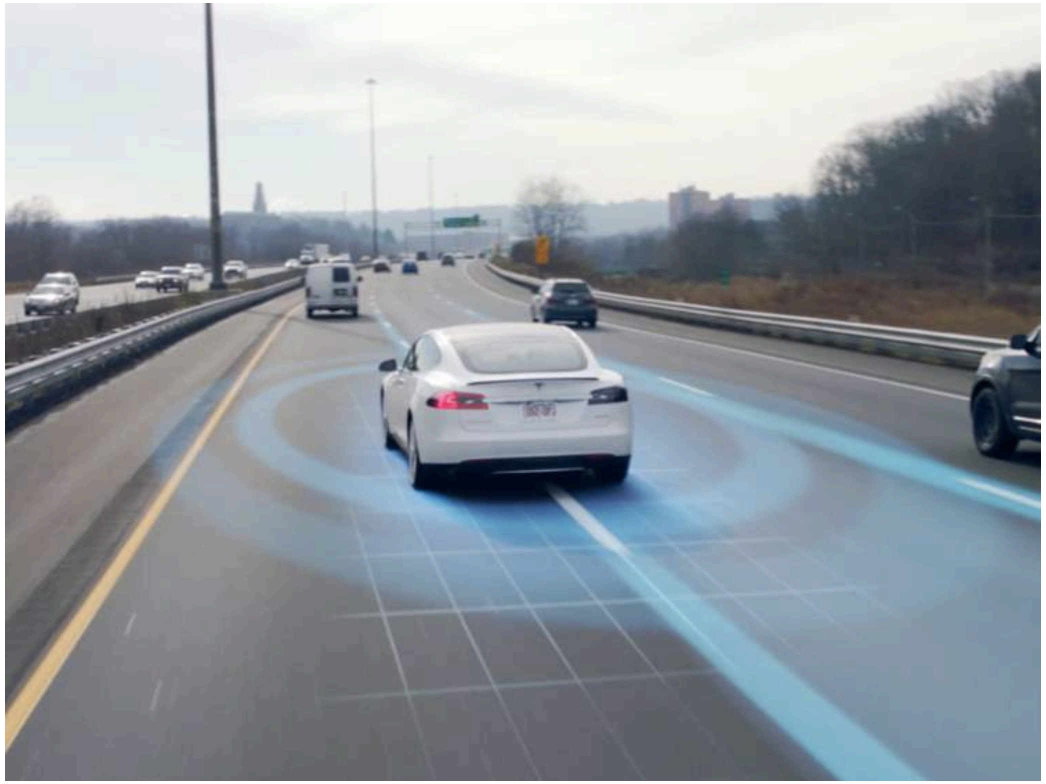
- Hesitant

Localization & Navigation Infrastructure

Auto Manufacturer Profile: Tesla

Sensory System
Front-facing radar, sonars, cameras

Localization & Navigation System
Cameras



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What does this mean for municipal infrastructure?

Magnetic Markers
GNSS RTK
GPS RTK
HD Mapping
Cameras

Regulatory Landscape

Transport Canada:

- Canadian Motor Vehicle Safety Standards (CMVSS)
- Exemptions under Schedule VII allow temporary importation for testing purposes

Ministry of Innovation, Science and Economic Development (ISED):

- Data privacy and security

Provincial Governments:

- Responsible for regulating road operations
- Ontario Reg. 306/15: Pilot Project – Automated Vehicles
- Alberta Transportation – Permitting process

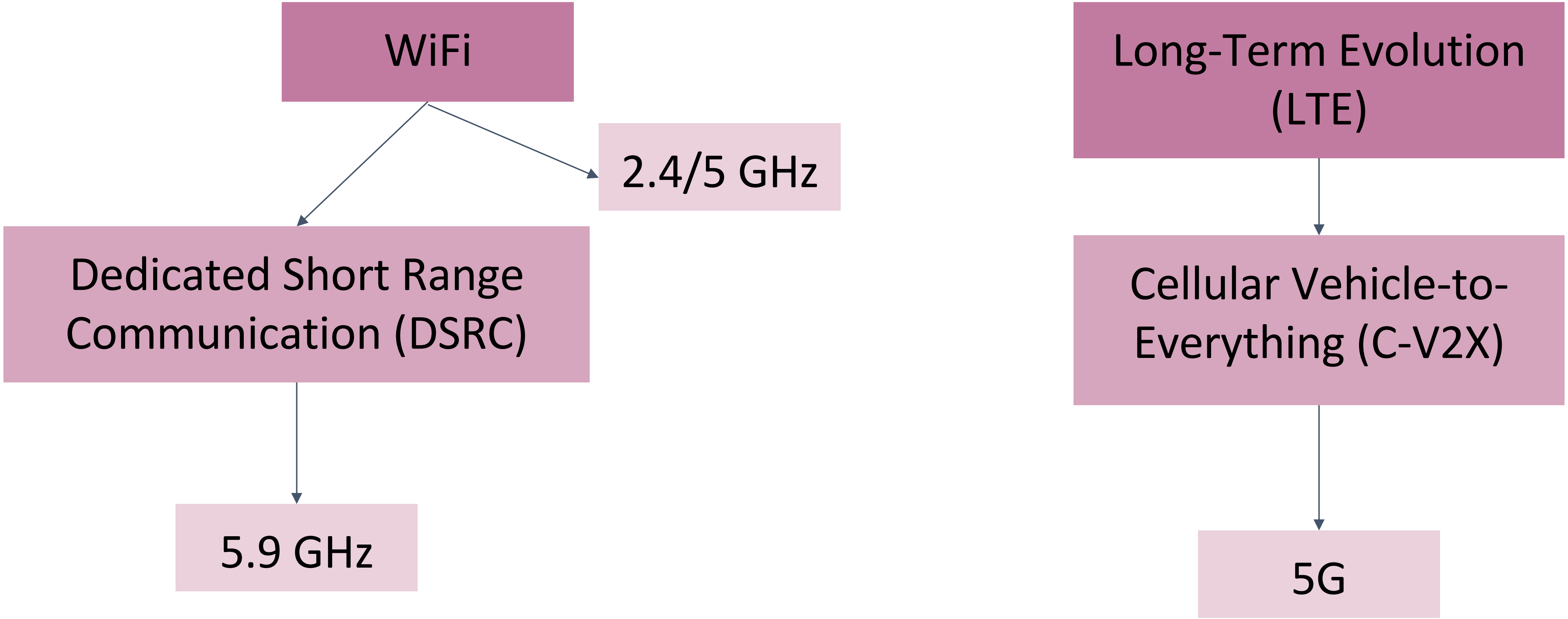
Municipal Governments:

- Responsible for allocating road space and road pricing

Connected Vehicles

CV Technology Overview

CV Technology Overview



CV Technology Overview

DSRC:

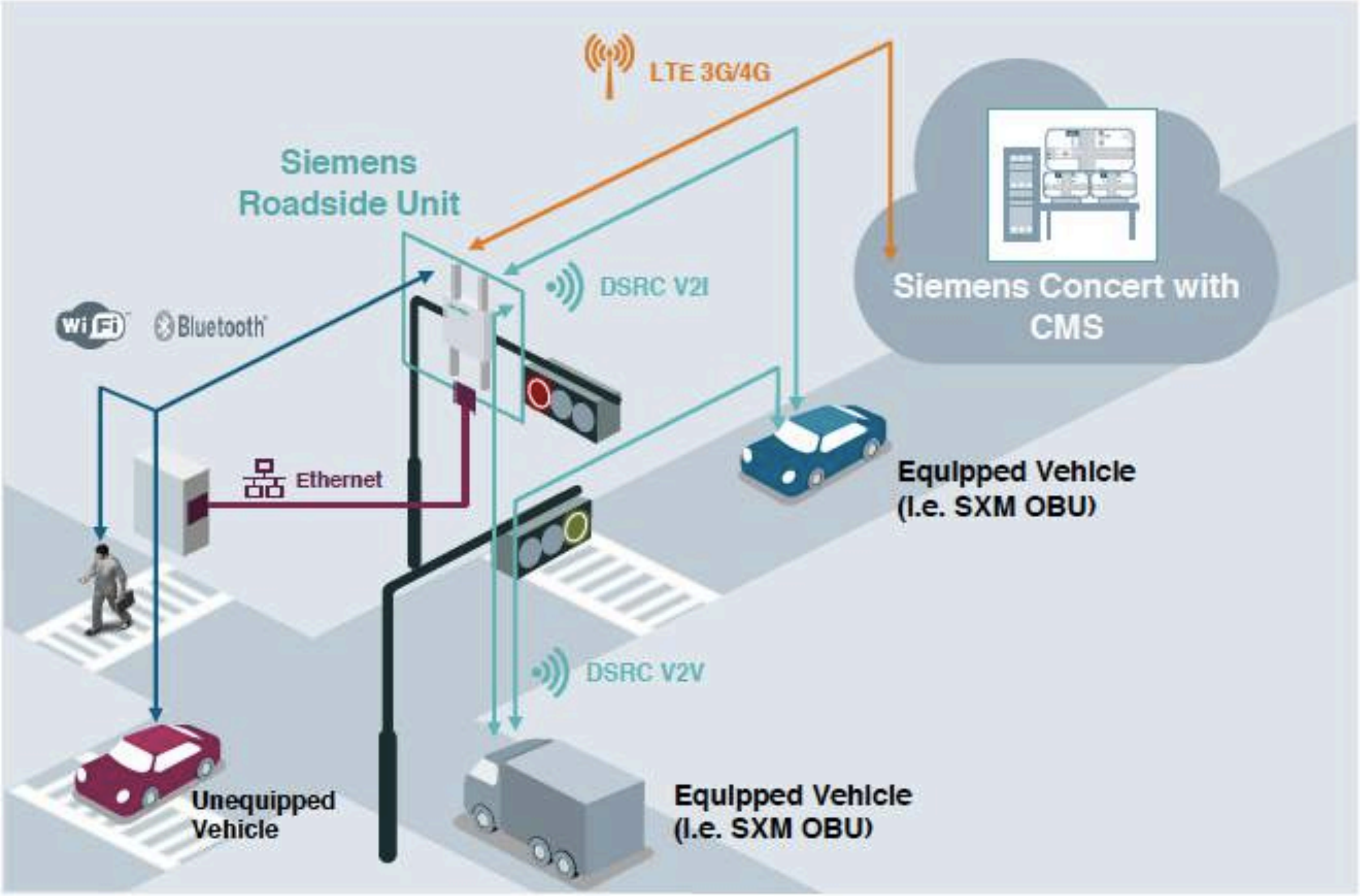
- Commercial modules available today
- Technical standards are available
- GM, Honda, Nissan Toyota, Volkswagen installing DSRC OBU’s on all new vehicles

5G:

- 5GAA Petition for Waiver
- ENCQOR Network: Thales, IBM, Ciena, CGI, Ericsson

How the Siemens connected vehicle solution works

SIEMENS
Ingenuity for life



Vehicles continuously send location, speed, driving direction and vehicle status (BSM)

Vehicle crash prediction

RSU connected to signal controller sends signal states, time to change and intersection topology (SPAT/MAP)

Red Light Violation prediction

Siemens Concert traffic management system for RSU management and V2I data broadcast and retrieval

Data collection & management

Connect to smart devices & unequipped vehicles for ped safety and travel time

Travel time & pedestrian safety

DSRC WAVE Protocol Stack

SAE J2735-2016

Application services based on messages like BSM, MAP, SPAT, TIM, …

IEEE 1609.2-2016: Security Services for Applications and Management Messages

Signing/verification as well as encryption/decryption of messages based on certificates (PKI)

IEEE1609.3-2016: Networking Service

WSMP (WAVE Short Message Protocol) and IPv6

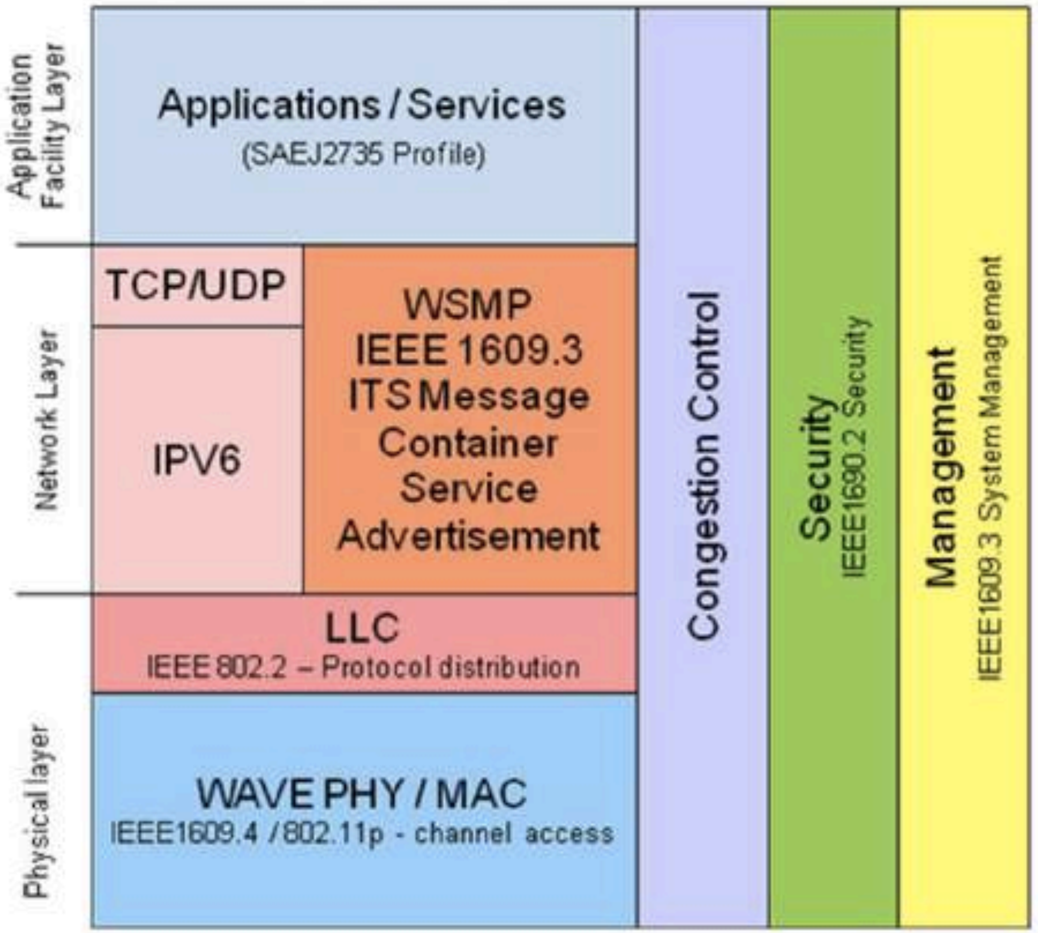
IEEE 1609.4-2016: Multi Channel Operation

Operating modes for usage of one or more channels

IEEE 802.11p-2012: Physical and Medium Access Control

The physical layer for low level radio interface

WAVE Protocol stack:



Frequency Allocation WiFi / DSRC

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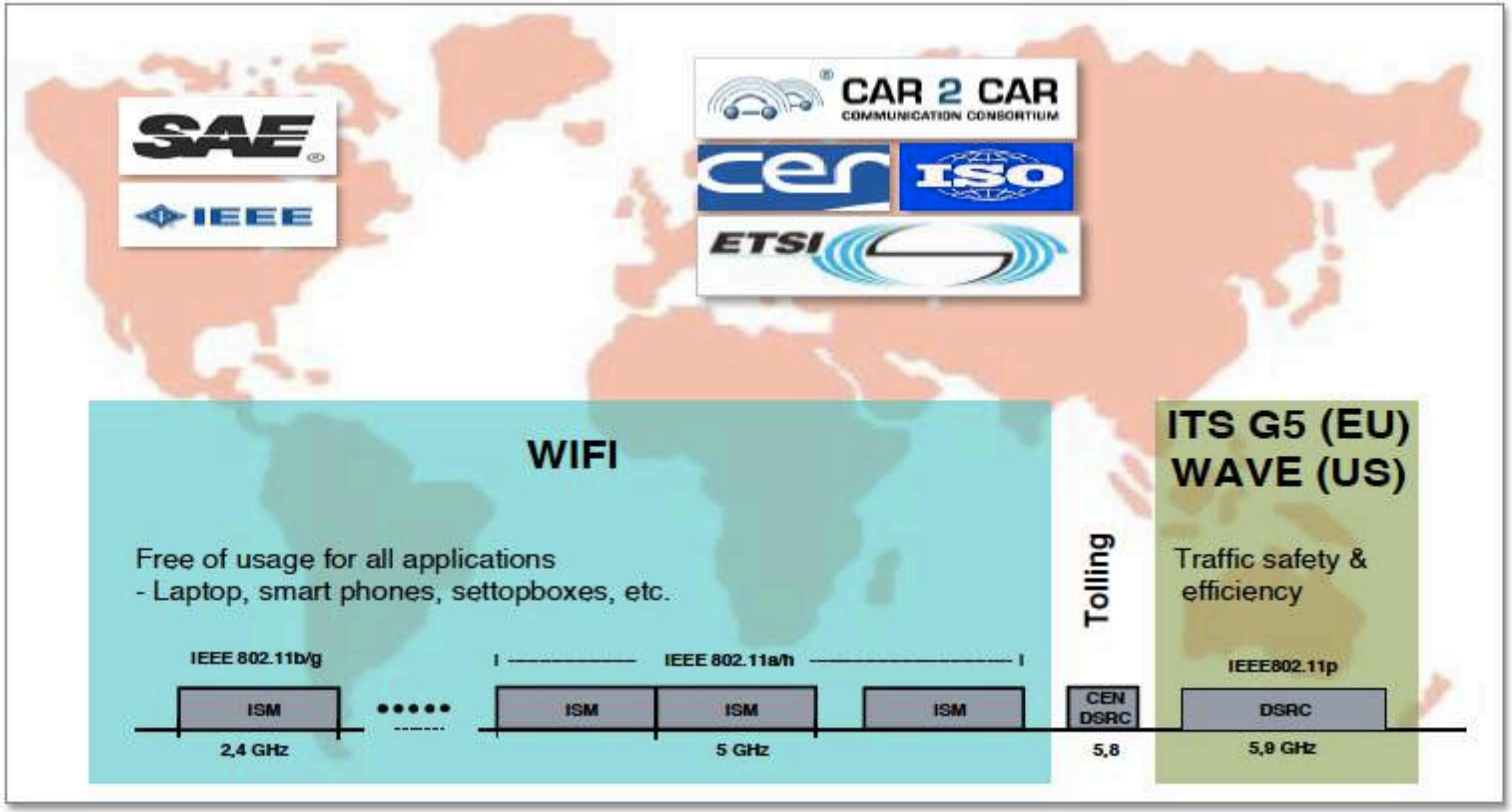

Comparison of V2X communication technologies

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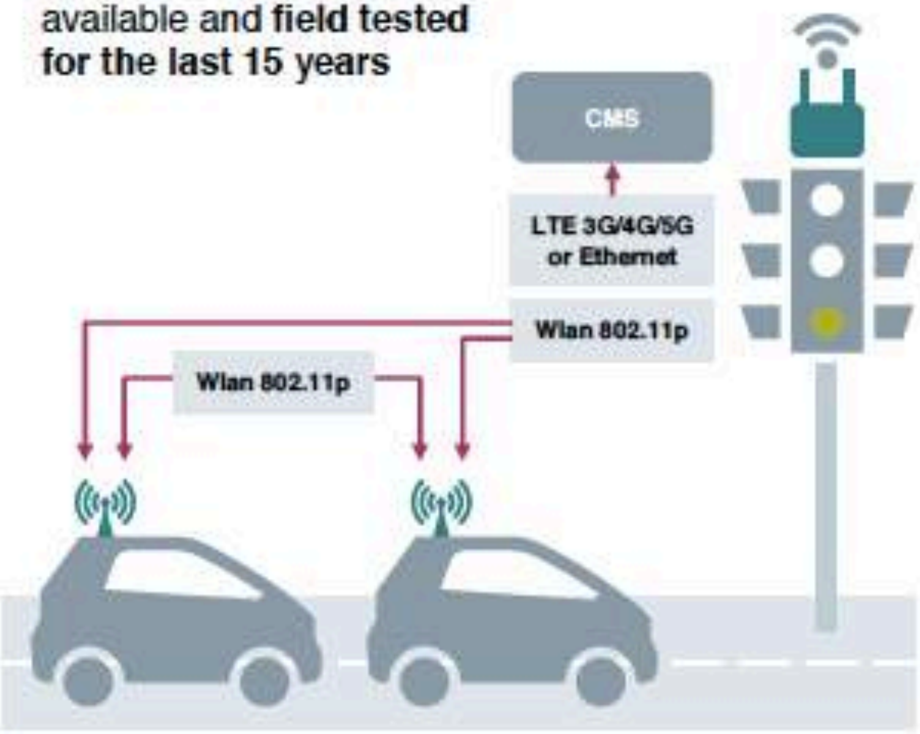
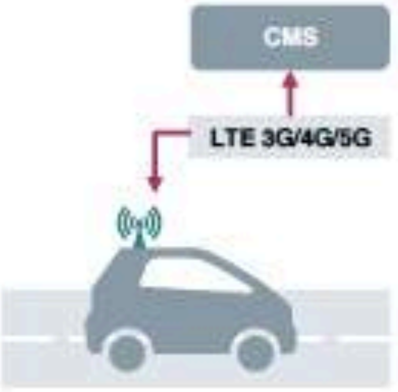
WLAN 802.11p (DSRC)

- Low-latency device-to-device communication
- Not dependent on mobile infrastructure
- **Developed explicitly for V2V/V2I**
- Commercial modules available and **field tested for the last 15 years**



LTE 3G/4G

- No device-to-device
- Backend/subscriber service necessary
- **Latency/reliability depends on network utilization (500ms – 6s)**



WLAN 802.11 b/g/n/ac

- Frequency: 2,4/5 GHz
- Access point required
- Security: WPA/WPA2

SAE J2735 DSRC Message Dictionary

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- MessageFrame
- BasicSafetyMessage (BSM)
- CommonSafetyRequest
- EmergencyVehicleAlert
- IntersectionCollisionAvoidance
- MapData (MAP)
- NMEAcorrections
- PersonalSafetyMessage (PSM)
- ProbeDataManagement
- ProbeVehicleData
- RoadSideAlert (RSA)
- RTCMcorrections (RTCM)
- SignalPhaseAndTiming (SPaT)
- SignalRequestMessage (SRM)
- SignalStatusMessage (SSM)
- TravelerInformationMessage (TIM)
- TestMessage

Source: https://www.transportation.institute.ufl.edu/wp-content/uploads/2017/04/HNTB-SAE-Standards.pdf

SAE J2735 Message Type & Applications

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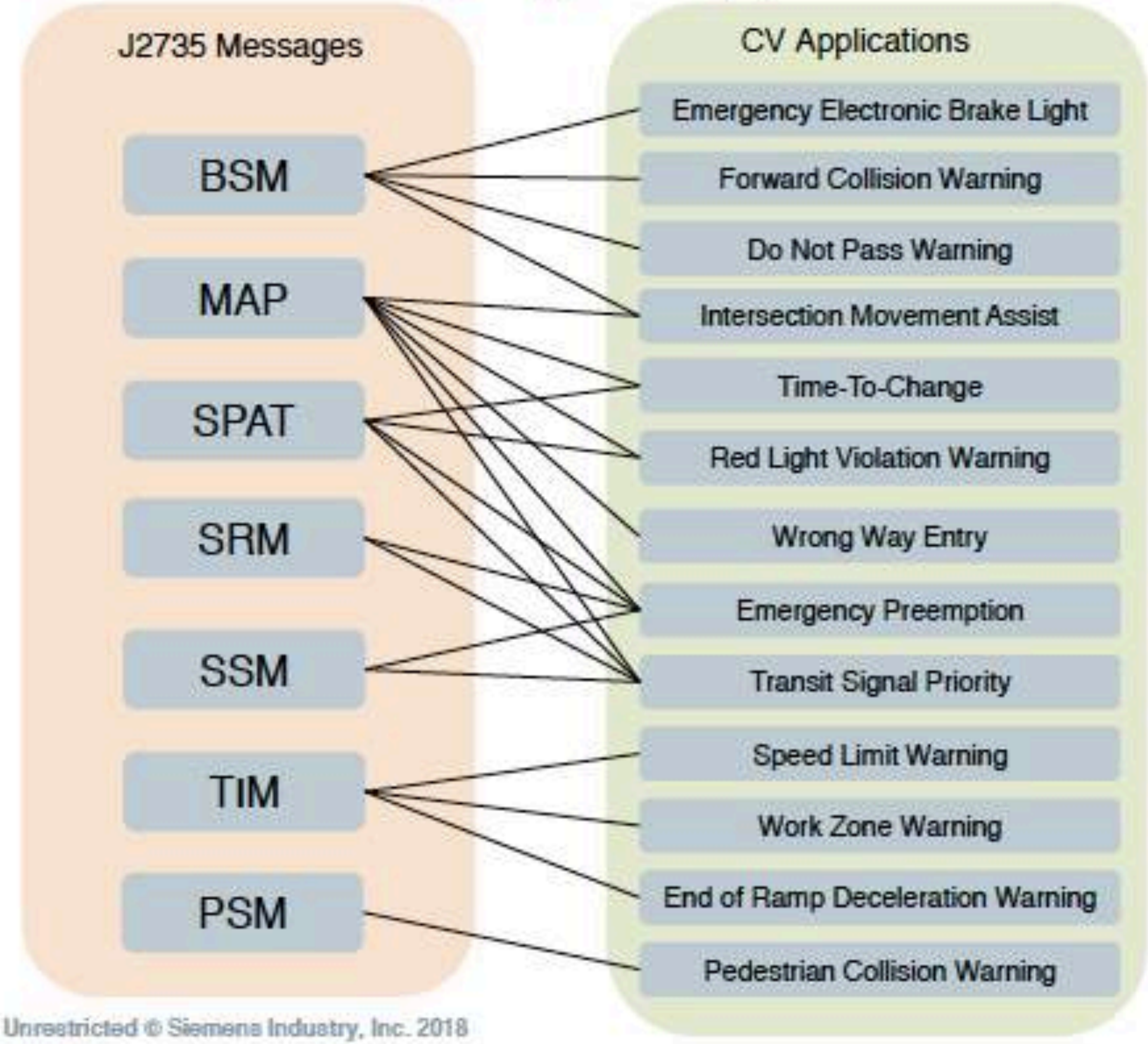

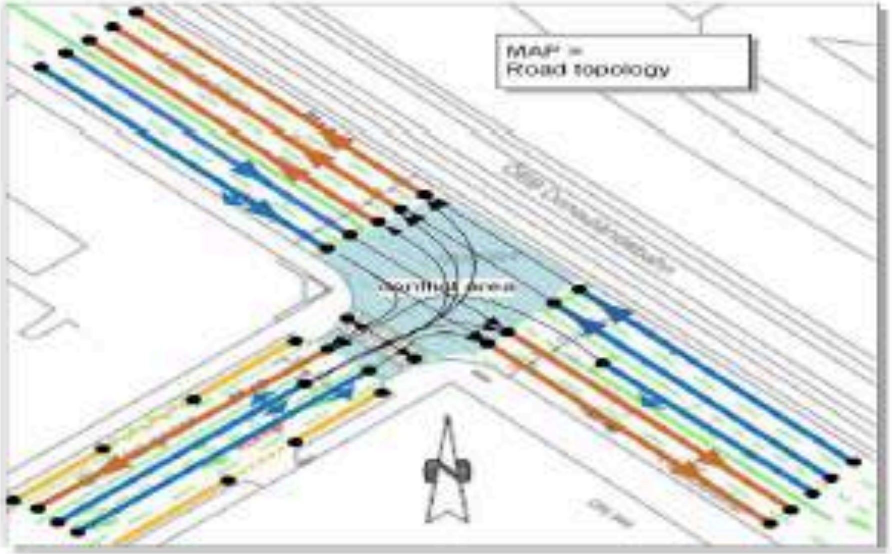

Sitraffic ESCoS – Roadside Unit

Hardware Specifications

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CPU/Memory
- Dual Core i.MX6 at 800 MHz
- 1 GB RAM

Interfaces
- 2 x DSRC/WAVE
- 2 x RJ45 10/100 MBit Ethernet
- 1 x 802.11 b/g/n Wifi & Bluetooth 4.0
- 1 x RS232
- 1 x LTE Cat4

Power Supply
- PoE+ 802.3at (25.5W)

Antennas
- 2 x DSRC (5.9GHz), 1 x Std Wifi (2.4GHz), 1x GPS, 2 x LTE

Mechanics
- Dimensions (WxHxD): 308 x 80 x 270 mm
- Weight: approx. 4kg

Environmental
- Operating temperature (PoE): -40 .. +74°C
- IP67

USDOT RSU Specification v4.1

- DSRC Control Channel
- DSRC Safety Channel
- Power over Ethernet
- GPS Time and Location Service

Additional features

- DSRC dual-radio
- LTE for fast backhaul communication
- WiFi/BT radio for ped crash avoidance
- Two Ethernet
- RS232 for legacy detectors

Creating a Data Trust

Case Study: Los Angeles

- Liability for "Truth on the Ground"
- Equality of service for all
  - Accessibility, service for lower socioeconomic populations
- Mobility Data Specifications on GitHub
  - Data standard and API specification for any MaaS provider on the public right of way
  - Implements real-time data sharing measurement and regulations
  - Ensures government has the ability to enforce, evaluate and manage providers

Data Trust

- Government initiated and funded
- Arms-length non-profit entity
- Open access to data for government, academia, and industry

Contact – Questions and CVs

Kristina Mlakar
kristina.mlakar@cutric-crituc.org