CUTRIC National Smart Vehicle Demonstration and Integration Trial

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

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Why a municipally-led CAV trial?

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

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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)
e-LSA Manufacturers

NAVYA

2getthere

FPInnovations

EasyMile
## e-LSA Manufacturer Profile: 2getthere

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<table>
<thead>
<tr>
<th></th>
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<tbody>
<tr>
<td><strong>Headquarters</strong></td>
<td>Netherlands</td>
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<tr>
<td><strong>Founded</strong></td>
<td>1994</td>
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<tr>
<td><strong>Passenger Capacity</strong></td>
<td>22 (8 seated, 14 standing)</td>
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<td><strong>Top Speed</strong></td>
<td>60 km/h</td>
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<td><strong>Operating System</strong></td>
<td>TOMS</td>
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e-LSA Manufacturer Profile: NAVYA

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<thead>
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<th>France</th>
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<tr>
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<td>2014</td>
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<tr>
<td>Passenger Capacity</td>
<td>15 (4 seated, 11 standing)</td>
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<tr>
<td>Top Speed</td>
<td>25 km/h</td>
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<td>Operating System</td>
<td>NAVYA LEAD</td>
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**e-LSA Manufacturer Profile: EasyMile**

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<td>Founded</td>
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<tr>
<td>Passenger Capacity</td>
<td>15 (6 seated, 9 standing)</td>
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<td>Top Speed</td>
<td>12-14 km/h</td>
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<td>Operating System</td>
<td>EZ Fleet</td>
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## Current Industry Stakeholders

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<tr>
<th>e-LSA OEMs:</th>
<th>Charging System OEMs:</th>
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<tbody>
<tr>
<td>2getthere</td>
<td>ABB</td>
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<tr>
<td>NAVYA</td>
<td>SIEMENS</td>
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<tr>
<td>EASY MILE</td>
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<tr>
<td>FPI Innovations</td>
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<td>eCAMION</td>
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<td>ELIX</td>
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<tr>
<th>Operators:</th>
<th>Other:</th>
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<tbody>
<tr>
<td>PW Transit Canada</td>
<td>Nova Bus</td>
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<tr>
<td>Bomardier the evolution of mobility</td>
<td>New Flyer</td>
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<tr>
<td>Thales</td>
<td></td>
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<td></td>
<td>SMARTCONE Technologies Inc</td>
</tr>
<tr>
<td></td>
<td>ePantero</td>
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Autonomous Vehicles
Are Autonomous Vehicles Here??
Automotive vs. TNC vs. Shuttle

Auto:

TNC:

Shuttle:

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Where Are we Really?

How Does a Waymo Merge into Traffic?
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

<table>
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<tr>
<th>Sensory System</th>
<th>Localization &amp; Navigation System</th>
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<tbody>
<tr>
<td>Front-facing radar, sonars, cameras</td>
<td>Cameras</td>
</tr>
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![Tesla Sensory System](image)
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

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CV Technology Overview

- **WiFi**
  - 2.4/5 GHz
- **Dedicated Short Range Communication (DSRC)**
  - 5.9 GHz
- **Long-Term Evolution (LTE)**
- **Cellular Vehicle-to-Everything (C-V2X)**
  - 5G
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

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)

IEEE 1609.3-2016: 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
Frequency Allocation WiFi / DSRC

- **WIFI**: Free of usage for all applications - Laptop, smart phones, settopboxes, etc.
- **ITS G5 (EU) WAVE (US)**: Traffic safety & efficiency

**IEEE 802.11b/g**

2.4 GHz

**IEEE 802.11a/n/h**

5 GHz
Comparison of V2X communication technologies

**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

- 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

SAE J2735 Message Type & Applications

J2735 Messages
- BSM
- MAP
- SPAT
- SRM
- SSM
- TIM
- PSM

CV Applications
- Emergency Electronic Brake Light
- Forward Collision Warning
- Do Not Pass Warning
- Intersection Movement Assist
- Time-To-Change
- Red Light Violation Warning
- Wrong Way Entry
- Emergency Preemption
- Transit Signal Priority
- Speed Limit Warning
- Work Zone Warning
- End of Ramp Deceleration Warning
- Pedestrian Collision Warning

Unrestricted © Siemens Industry, Inc. 2018
Michael Venus / RC-US MO MM-ITS
Sitraffic ESCoS – Roadside Unit

Hardware Specifications

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
• Government initiated and funded
• Arms-length non-profit entity
• Open access to data for government, academia, and industry
Contact – Questions and CVs

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