HOW AUTOMATION WILL CHANGE WHERE AND HOW WE MOVE

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CEA Plenary | March 4, 2025

Who uses automated or autonomous items on a daily basis?

Agenda

01 What types of technology are we talking about?

02 Use Cases – where are they being used and why?

03 What can be done to prepare?

Connected Autonomous/Automated Vehicles (CAVs)

V2V
VEHICLE-TO-VEHICLE

- Road Condition
- Speed
- Lane changes

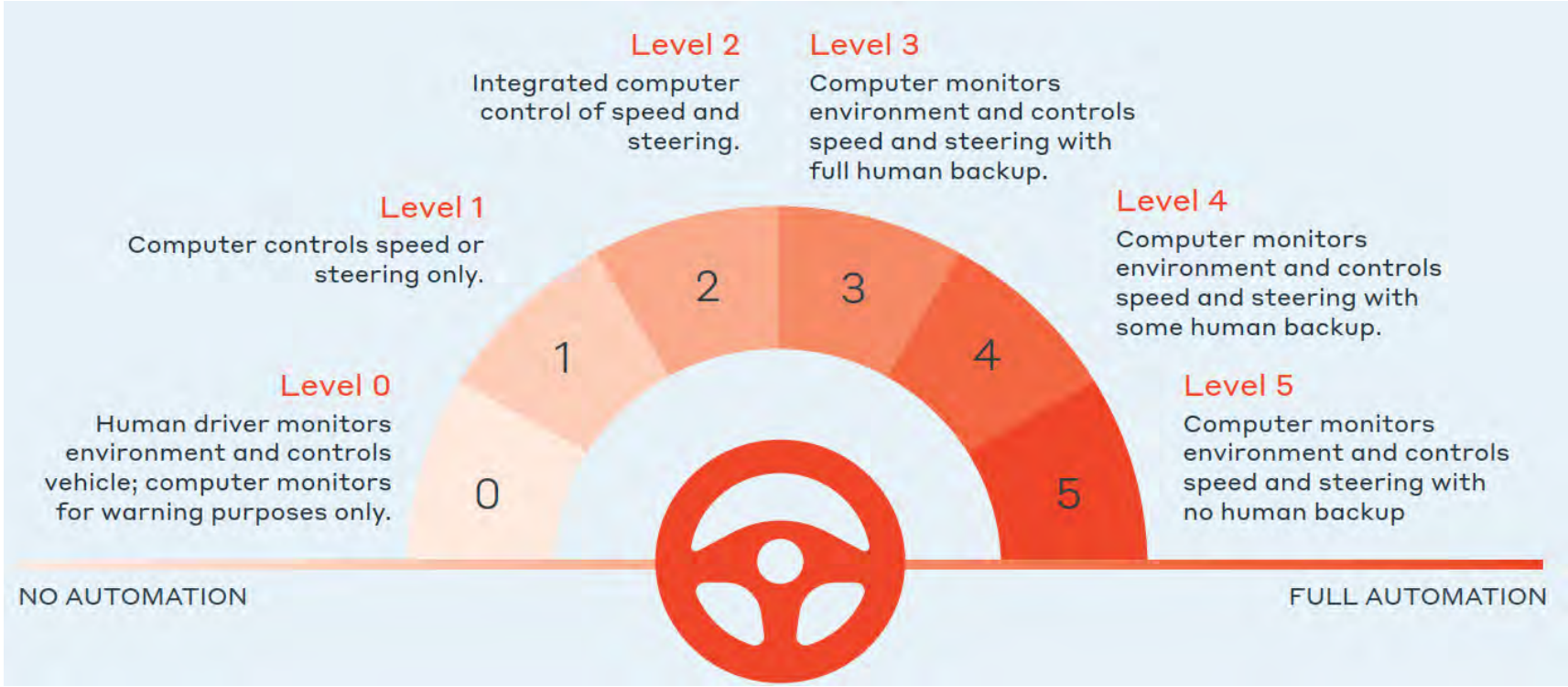
V2I
VEHICLE-TO-INFRASTRUCTURE

- Road Condition
- Signal timing
- Traffic conditions
- Lane closures/detours

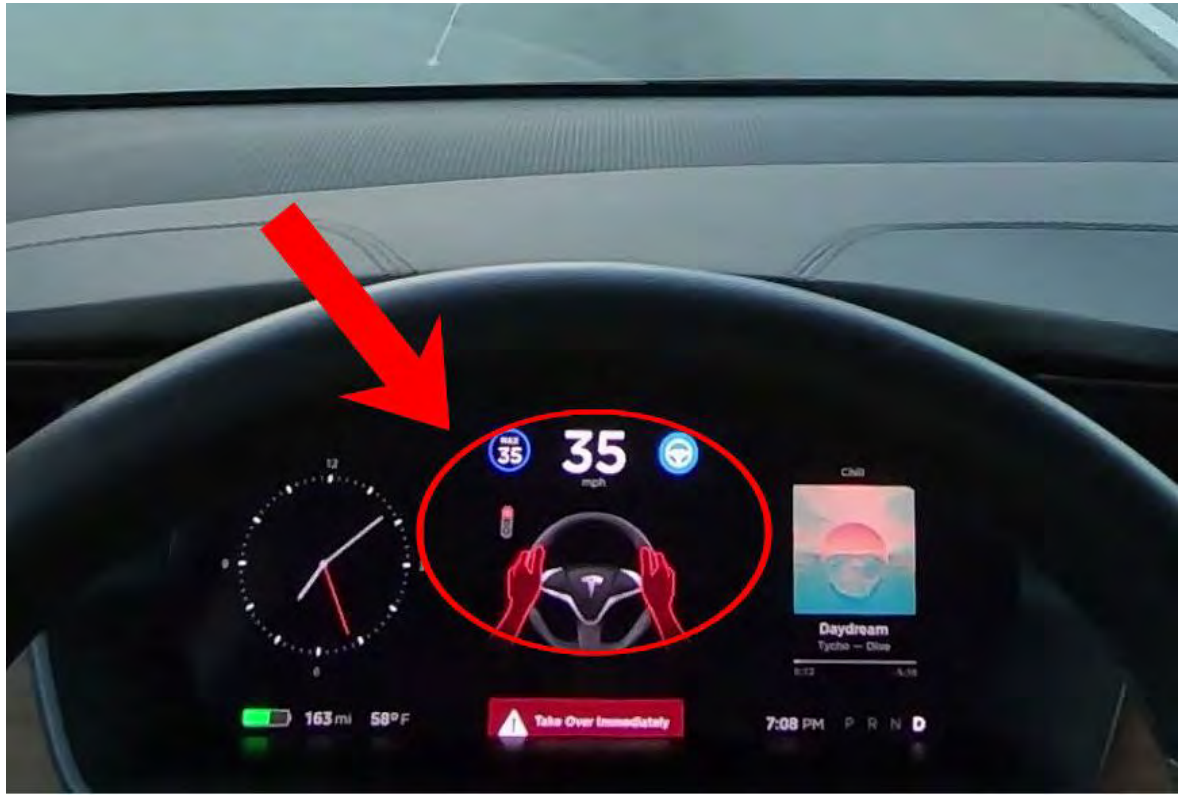
V2X
VEHICLE-TO-X

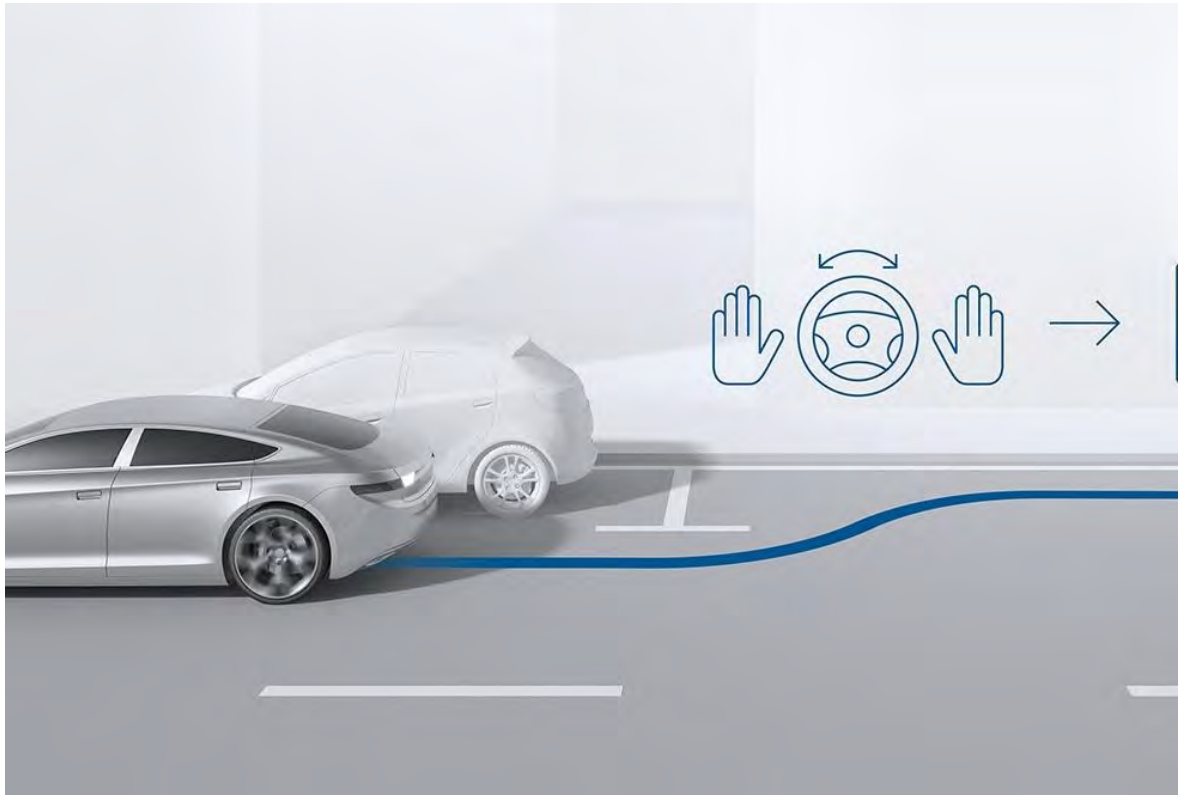
- Vulnerable user location, notification
- Centralized data

Connected Autonomous/Automated Vehicles (CAVs)



What is automated?





What is autonomous?

What makes a CAV?

Autonomous sensors

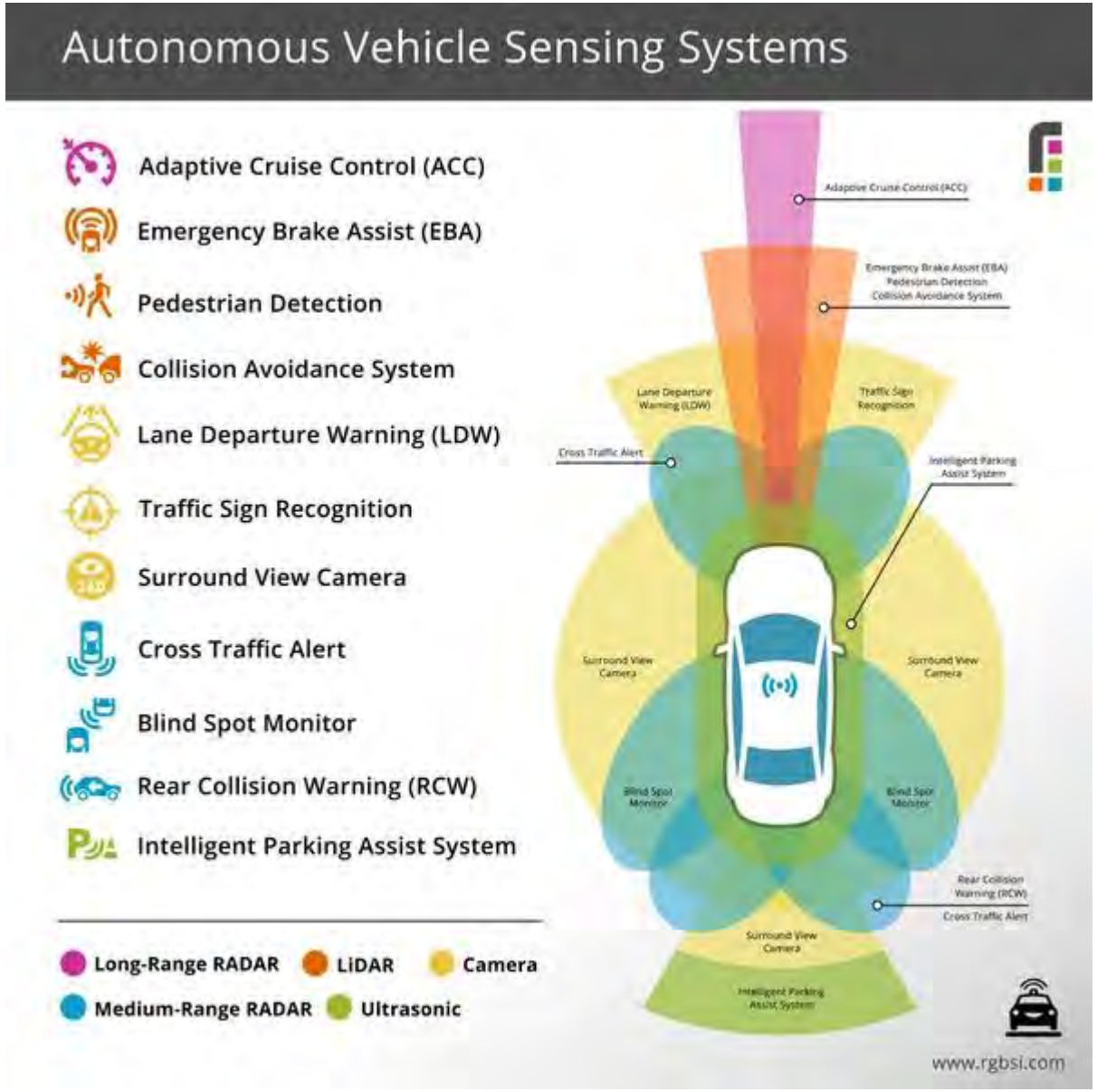
- Long range & Medium range RADAR
- LIDAR
- Cameras – various

Vehicle sensors

- Tire pressure
- Temperature
- GPS
- Traction
- Engine controls

Connected

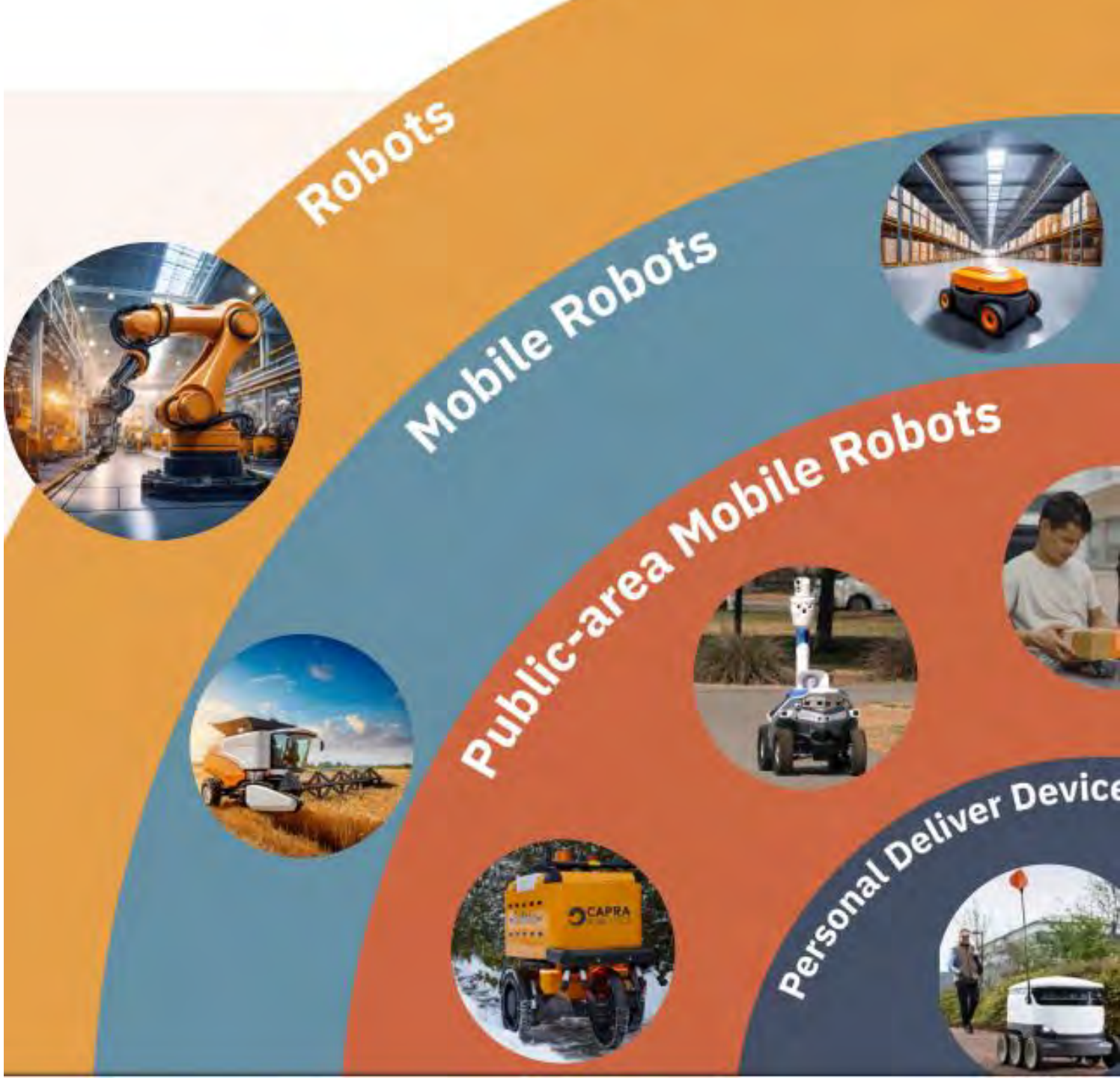
- 5G
- OBU with SCMS
- HMI
- GNSS/GPS



https://blog.rgbsi.com/sensor-fusion-autonomous-driving-systems-part-2

What is a Public Area Mobile Robot – PMR?

ISO/TR 4448:1 2024 Intelligent Transport Systems – Public-area mobile robots (PMR) Part1: Overview of paradigm defines them as **“a wheeled or legged (ambulatory) ground-based device that is designed to travel along public, shared, pedestrianized pathways without the use of visible human assistance or physical guides”**



Use Cases

Walk & Cycle
Sidewalks, Multi-use Paths

Drive
Roads, Highways

Move
Everywhere else

WALK & CYCLE

Crossing Guard Robot - Detroit

Use Case - determine whether a portable, off-grid pedestrian crossing solution like this could **address safety concerns when pedestrians cross unprotected areas** of roadway. Piloted June – July 2023

Considerations – Deemed effective but cost a concern

Technology Provider– Snowbotix & Smart Technology

Source

Source

PMRs – Personal Delivery Devices, Toronto

Use Case – Geoffrey deployed 2019 -2021 for efficient, contactless food delivery.

Considerations - City of Toronto banned food delivery robots in 2021 due to safety concerns raised by the Accessibility Advisory Committee until a Provincial Pilot is put in place.

Technology Provider – Tinymile, Bell (5G)

PMRs – Grass Maintenance, City of Calgary

Use Case – Piloted for 30 days beginning mid- May 2024 to cut grass at a park

Considerations – Support efficiency and help address labour shortages. Quieter than typical mowers.

Technology Provider – Echo


DRIVE

AV Highway, Japan

Use Case –The transport ministry will launch priority lanes for autonomous vehicles on a roughly 100-kilometer section of the Shin-Tomei Expressway to conduct test runs of self-driving trucks, starting on March 3. Runs for ~ 1 year.

Considerations – Create a road network that can handle Level 4 autonomous driving, or unmanned driving under certain conditions, amid labor shortages in the logistics industry.

Technology Provider – Open

Robosweepers, Singapore

Use Case - Piloted 2 autonomous sweepers in June 2024. Each of the company's two initial autonomous sweepers has 12 cameras and five light detection and ranging (Lidar) remote sensing systems that use laser pulses to map the surroundings and navigate. Nov 2024 – license granted by LTA for operation

Considerations – Driver onboard during pilot. Centralized support for operations. Hope to address labour shortages.

Technology Provider - WeRide

Autonomous Ride Hailing, Phoenix, San Francisco, LA, Austin

Use Case – Autonomous, electric and shared mobility. Mission to be the worlds most trusted driver. In operation to the public since 2020 in Phoenix

Considerations – major headlines with failures, eliminate safety risk of driver, efficiency

Technology Provider – Waymo (partnered with Uber)

Autonomous Transport as a Service, Ontario

Use Case - autonomous middle mile logistics, delivers goods safely and efficiently using its fleet of light and medium duty trucks between distribution centres and stores. SAE Level 4, Class 4,5

Considerations – increased consumer demand, decreased labour force driving demand. Repetitive trips reduce unexpected situations.

Technology Provider – Gatik, Isuzu with Loblaws

Source

Truck Platooning, Alberta

Use Case - Queen Elizabeth II Highway from Calgary to Edmonton through April 2022. Platooning tested between Leduc and Ai d i . AE L v l 2, Class 8. P v n saf b t didn't s f l s avings as xp t d

Considerations – C mpl t d f f ad t s ting in advan at TC's t s t sit i n Blainvill QC and t s ting in wint ndi ti ns n hw y.

Technology Provider – Alberta Motor Transport Association, Bison Transport, Pronto, the University of Alberta, Solaris Fatigue Management, Tantus, PMG Technologies, Esso Commercial Cardlock and support from Alberta Transportation.

LTE Antenna for vehicle to vehicle and vehicle to server/cloud communications

GNSS/GPS Antennas for accurate positioning of the truck

Forward-facing camera on the windshield to detect objects (vehicles and lane markings, etc.)

Driver-facing camera to monitor the driver for attention

Forward-facing radar to detect vehicles

Cooperative truck platooning trial on Canadian public highway under commercial operation in winter driving conditions
Luo Jianghttps://orcid.org/0009-0006-0570-7509, Javad Kheyrollahi, Charles Robert Koch, and Mahdi Shahbakhti

MOVE

Autonomous Wheel Chair, Winnipeg

Use Case - Winnipeg Richardson International Airport was the first airport in North America to trial the autonomous mobility devices (2019) and is now the first location in the continent to implement this ground-breaking technology as a full-time service.

Considerations – timeliness, autonomy

Technology Provider – WHILL, Scootaround

EV Charging Robot – Markham DZ

Source

Use Case - Portable Level 2 EV charging unit being at YorkU Condominiums (residential) and Cineplex Building (commercial) in Jan/Feb 2025.

Considerations –Eliminate cost-prohibitive initial infrastructure costs. Reimagine the charging experience through Charging-as-a-Service model that helps EV owners in existing buildings that lack the charging infrastructure due to high retrofit costs and low EV adoption.

Technology Provider – Kiwi Charge

Source

LoDoMus & Dave, Denver

Use Case - Patrol parking facility in Denver for parking violations and security.

70% drop in theft and vandalism.

Considerations – airport applications help people find their car

Technology Provider – Knightscope

Autonomous Transit

Use Case – AV Shuttle pilots for FM/LM (Beaumont 2019), CTfastrak 15 km limited access busway (Connecticut ongoing)

Considerations – AV shuttles challenge in Canadian environment, controlled facilities - automated depot operations, dedicated corridors

Technology Provider – EasyMile, New Flyer, Robotic Research

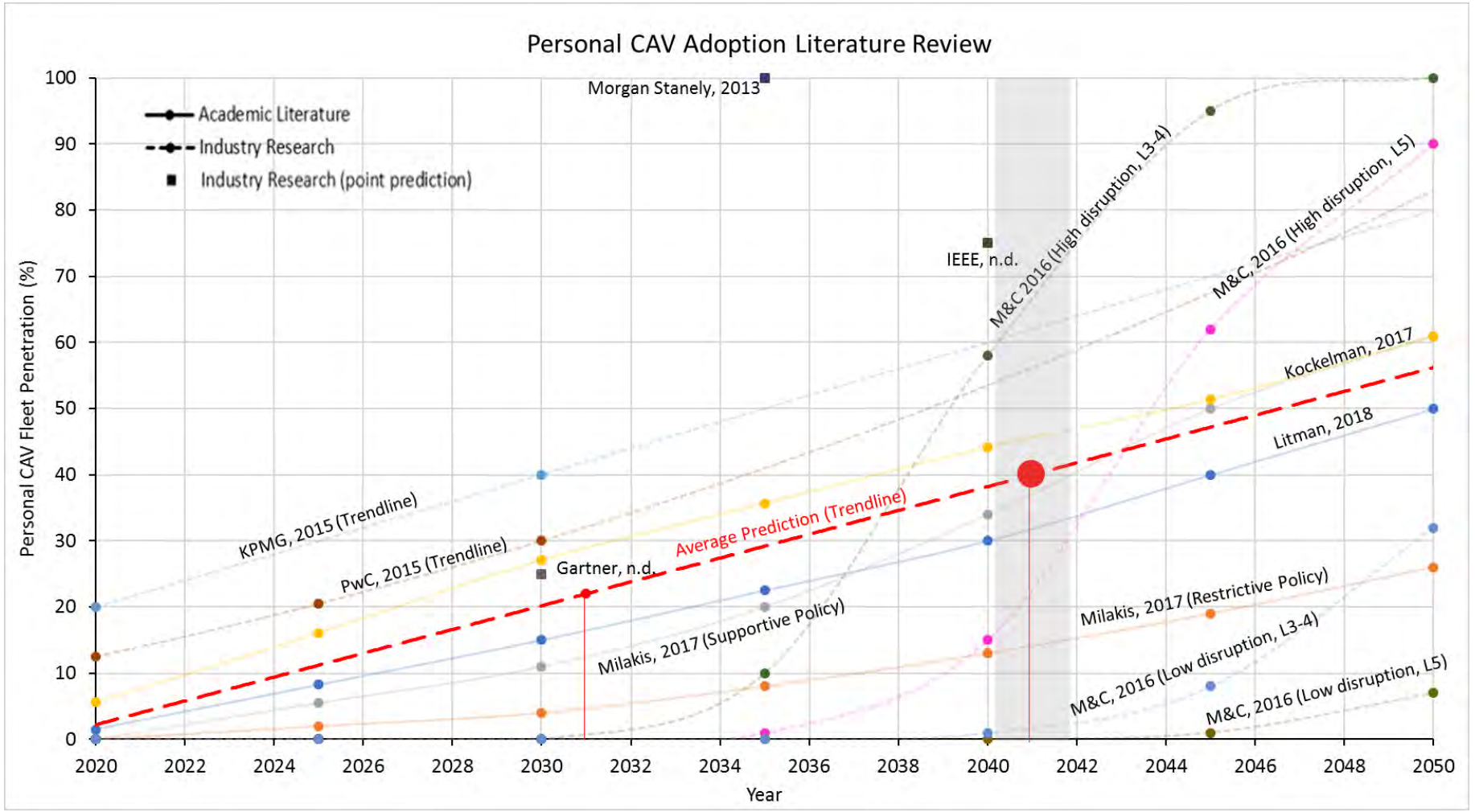
WHAT CAN BE DONE TO PREPARE

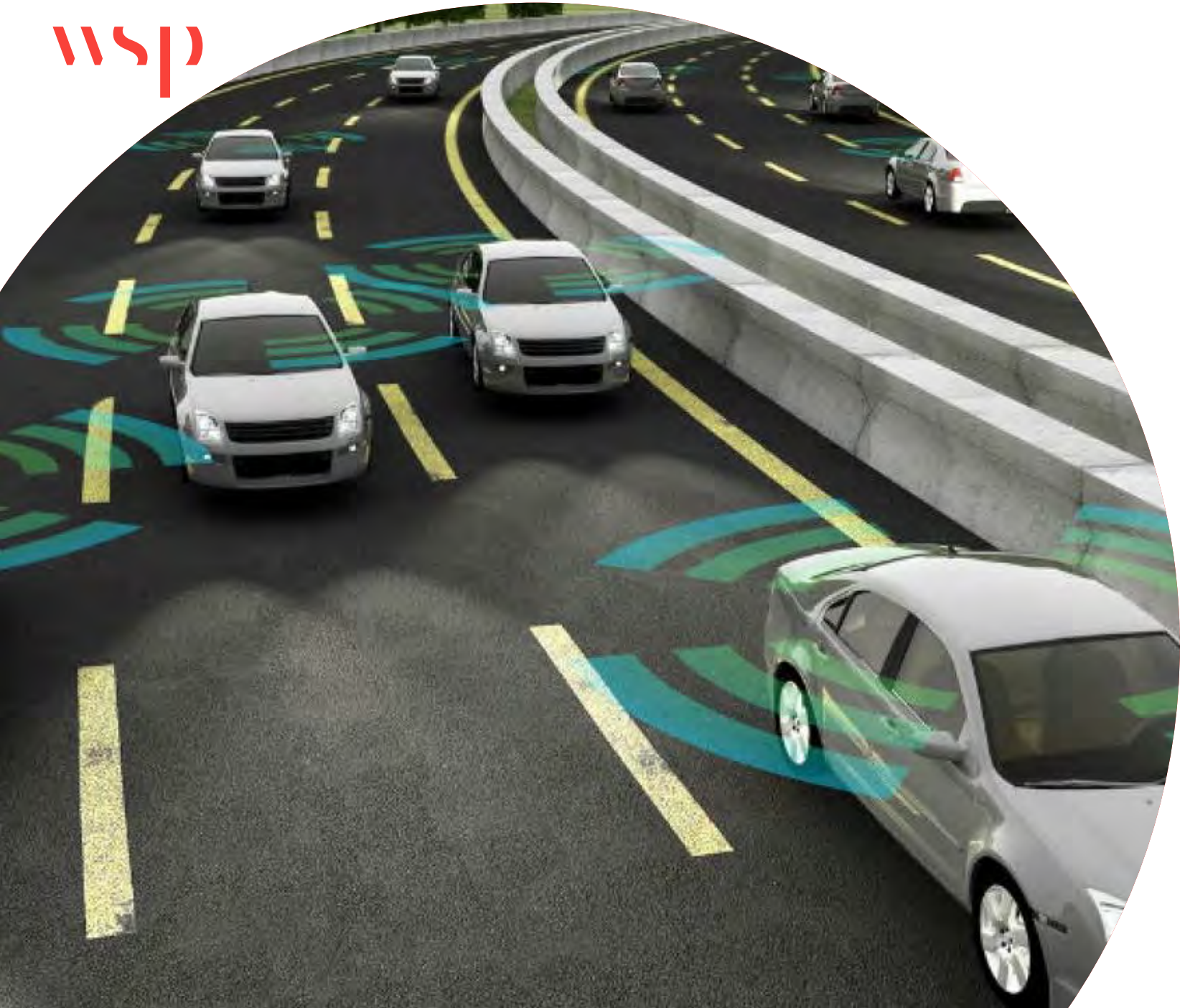
How close to implementation are we?

	Technology readiness	Market readiness	Customer readiness
PMRs			
CAV - Ridesharing			
CAV - Personal vehicles			
CAV - Commercial vehicles			

PREPARING FOR CAVS

CAV Readiness: Timelines





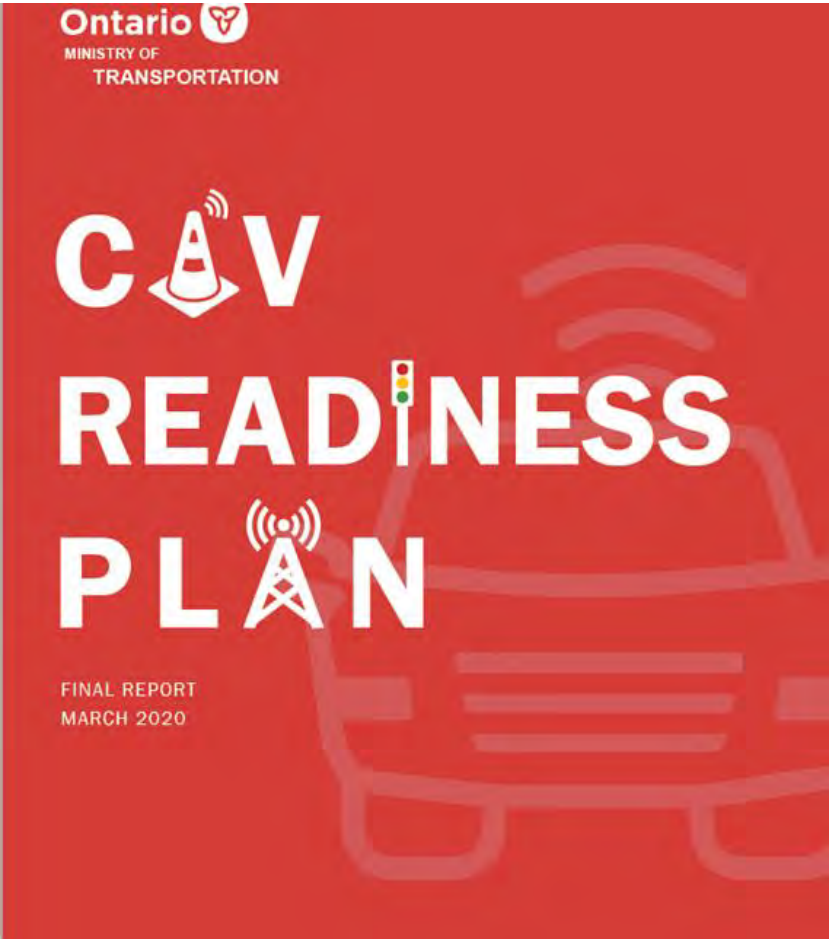
CAV Implications

Infrastructure Readiness: How does this change parking? Are dedicated lanes required for safety in mixed deployment?

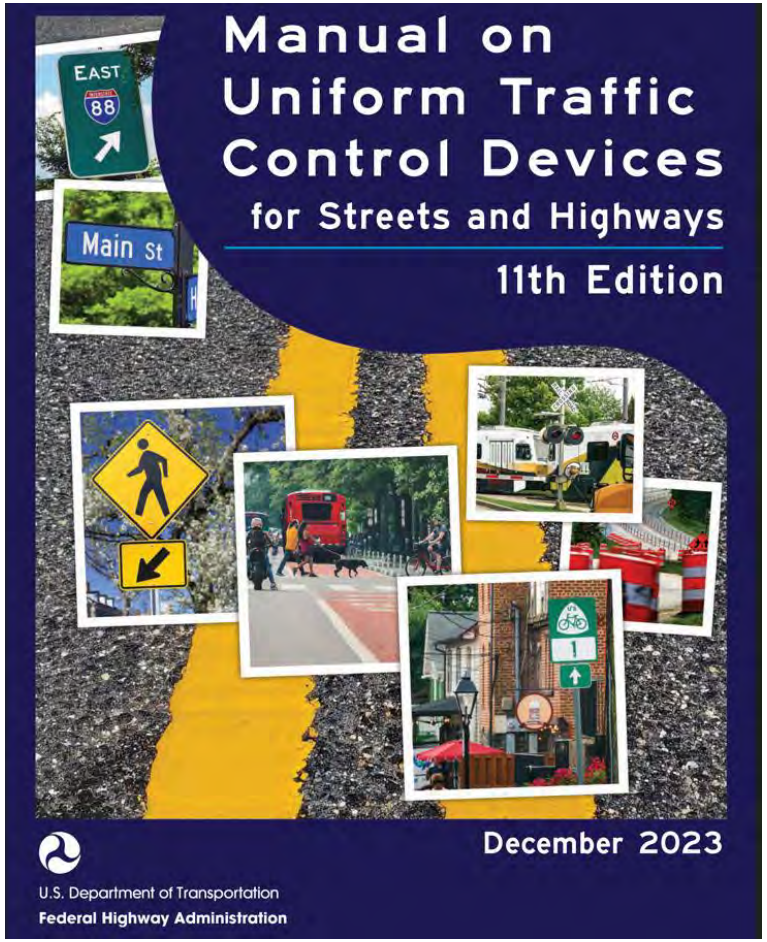
Operational Readiness: What new opportunities exist for managing congestion?

Institutional Readiness: What new standards are needed for geometric design? How will data be managed?

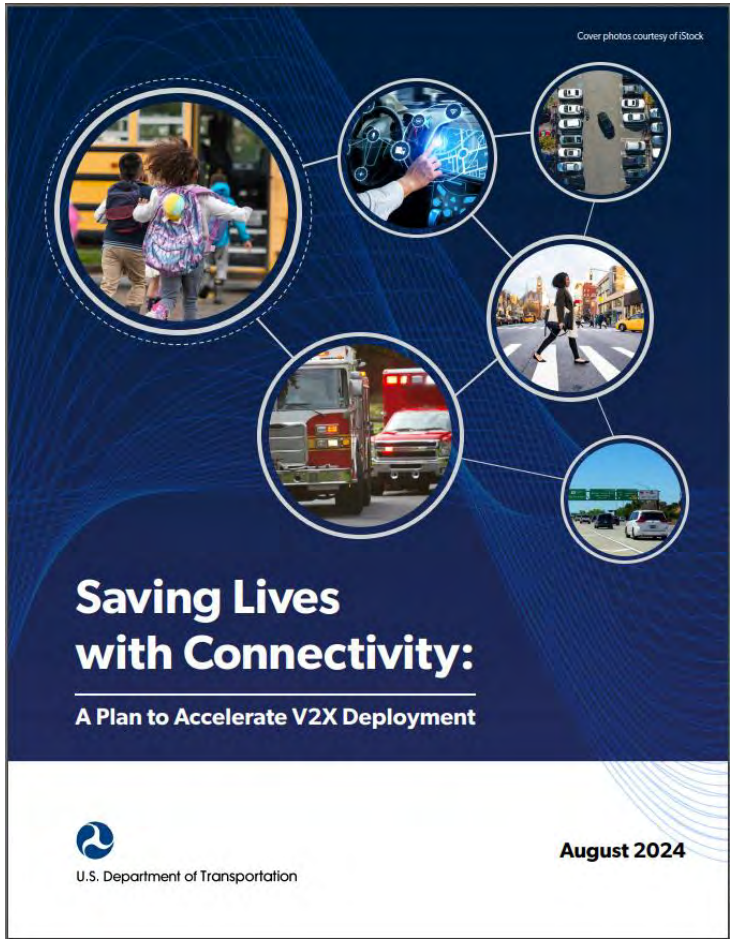
Leverage existing material



CAV Readiness Plan

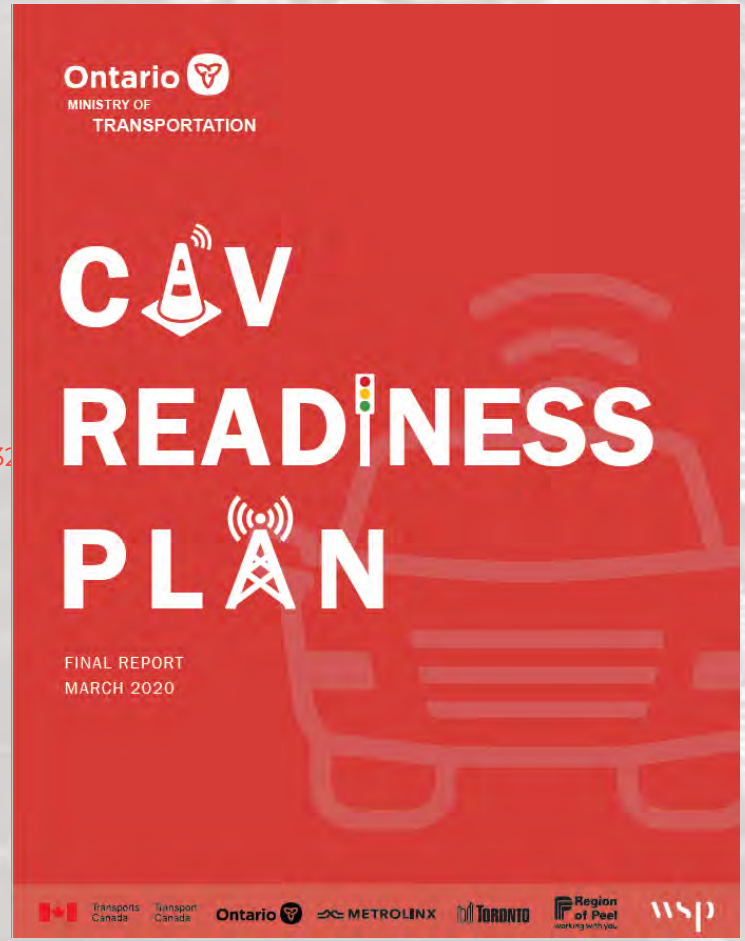


US MUTCD



US V2X Deployment Plan

https://www.ovinhub.ca/wp-content/uploads/2020/05/CAV-Readiness-Plan-Final-Report-2020-04-03-1.pdf



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5 Alternative Future Scenarios

1. Base Scenario
2. High Average Occupancy
3. Low Average Occupancy
4. High Goods Movement
5. Low Goods Movement

8 Personas

1. The Assistive Device User
2. The Child
3. The Commuter
4. The Delivery Truck Driver
5. The Stay at Home Parent
6. The Shift Worker
7. The Transit User
8. The Retiree

Readiness Guidelines (~ 200)

1. Infrastructure
2. Operational
3. Institutional
4. Public Lever

5 Programs

1. CAV Development Streams
2. Development of CAV Modelling Tools
3. Pilot Projects Program Management
4. Data Needs and Management
5. Development of a Regional Mobility Platform Strategy

Regional Collaboration – CAV Liaison Committee

What is a Readiness Guideline?

Types of Guidelines

Infrastructure Readiness

- Communications, Privacy and Cybersecurity
- Technology
- Physical Infrastructure

Operational Readiness

- Data Needs and Data Management
- Inter-Regional Delivery
- Intra-Regional Delivery
- Mobility Services
- Network Management and Operations (M&O)
- Public Fleet M&0
- Transit Management M&O

GOALS & OBJECTIVES

- Provide general rules
- Suggest principles to support project planning
- Tasks (tactics, items, things) that need to be done for a future with CAVs

Pilot Programs

Types of Guidelines

Institutional Readiness

- Freight Safety and Regulations
- Regional Collaboration
- Safety
- Standards
- Transit Service Planning
- Transportation Planning

Public Lever

- Bonus/ Malus Policy
- Traffic Laws and Regulations
- Physical Infrastructure Regulations

CAV Saturation

Few CAVs
(Pilots, Platooning on key highways)

Mixed

Primarily CAVs

Example Guidelines

Grouped by Readiness type

20 Guideline Categories

Brief Introduction

4 INFRASTRUCTURE READINESS

4.1 TECHNOLOGY (T)

The term 'technology' refers to any type of electronic equipment that may be present at the roadside (existing intelligent transportation system equipment or Roadside Units (RSUs)), located on a person (e.g. cell-phones or wearable devices) or other infrastructure that the CAV may interact with. Currently there is inconsistency in how technology is used across the country or even across the region or province. For example, agencies may use different text or pictogram formats to present information via Variable Message Sign (VMS), while signals indicating a protected left turn may include a green arrow or a flashing green light. Human drivers navigate the network interpreting static and real-time information to make decisions. **With CAV, information can be communicated directly between RSUs and the vehicle to support decision making.** A communication standard needs to be defined to ensure all CAV receive the same information from all connected infrastructure and provide data in a common format. V2I can be used for data collection, increasing safety at intersections, detecting pedestrians and cyclists and transferring information (e.g. road and traffic conditions, signal phases etc.) to and from the vehicles. Interfaces between connected technology and personal technology (e.g. smart phones, wearable, hearing aids, etc.) will also be required.

The Technology Guideline spans all levels of CAV saturation on the transportation network. It starts with pilot programs to identify needs and test the capability of connectivity and then continues to expand geographically and functionally as CAV saturation increases.

Elements of this Technology guideline include the following:

T-01 **Prepare a Provincial ITS architecture to align with updates to the National ITS architecture** that include requirements for CAV. This architecture could include:

T-01A Inclusion of RSUs (V2I) and interactions with traffic management and transit management centres (V2X) to leverage connectivity to support safety, enhance signal applications, as well as facilitate congestion management, freight and fleet management, incident detection, weather monitoring, traveller information and speed management etc.

T-01B Inclusion of CAV as dynamic data collection points as they traverse the transportation network, providing new opportunities to dynamically manage the network. CAV could potentially replace the need for data collection elements, including incident detection systems, traffic data collection systems (e.g. travel time, volume, speed), as well as weather and road surface conditions monitoring.

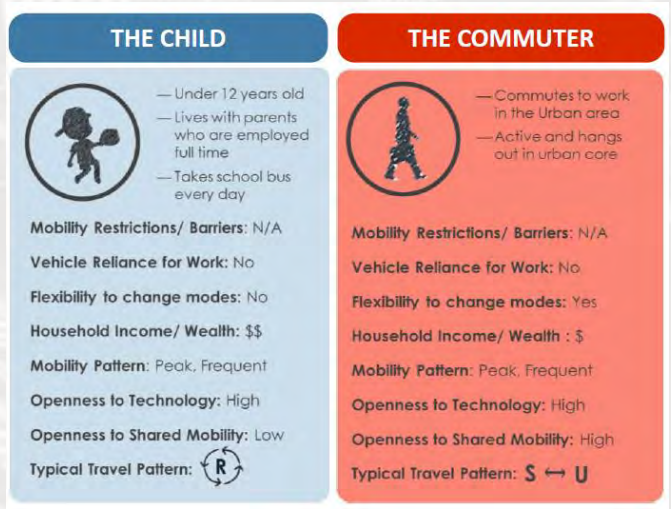
T-02 **Prepare a Concept of Operations document** that outlines how CAV data will be managed to support and enhance the existing network operations (see also NMO-01). It will consider the need for V2I technology to collect and broadcast information to CAV. Initially, the ConOps may identify how technologies may be tested as part of pilot programs along various representative transportation corridors and then identify a future state where the increasing levels of CAV on the road facilitate two-way connectivity (V2I2V) and connectivity with the traffic management centre (V2X). The Concept of Operations will consider the following:

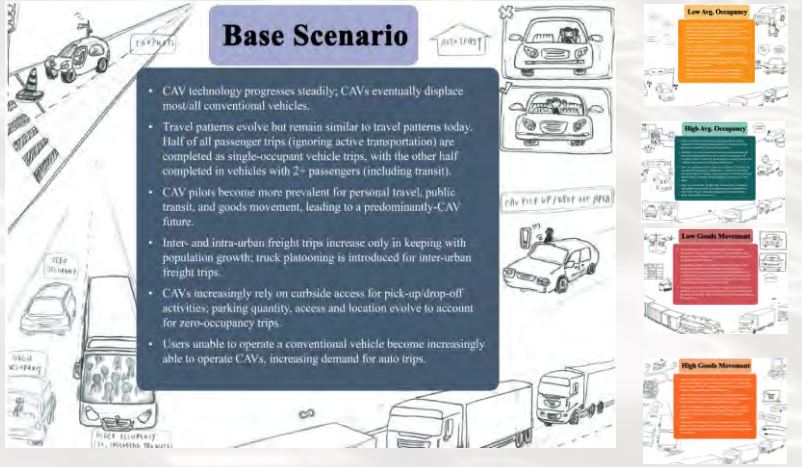
T-02A Real-time road and traffic conditions, including travel time, delay (including border delay), lane closures, routing and incidents. It may

Coded Guidelines (E.g. CPC-01, CPC-01A, etc.)

CAV Saturation Rate (Few, Mixed and Primarily CAV)

The 8 personas and 5 scenarios were used to assess thoroughness of guidelines.





How to use a guideline

Physical Infrastructure (PI-01 to PI-03)

- Evaluate existing infrastructure, review updates required to maintenance standards, review improvements necessary to roadway infrastructure.
  - Road markings, cross sections of highways, arterials, intersections, curbsides, transit stations, stops, parking facilities etc
- Assess existing infrastructure related to commercial CAV operations and urban freight delivery
  - Impact of platooning vehicles, automated deliveries
- Input to capital planning

Planning for physical infrastructure changes

Guideline	Interest				
	Federal	Provincial	Regional	Municipal	Transit
Physical Infrastructure (PI)					
PI-01		✓	✓	✓	✓
PI-02		✓	✓	✓	✓
PI-03		✓	✓	✓	✓

How to use a guideline

TPP-01

Review and update transportation planning and research initiatives, **as well as planning documents**, to account for increasing levels of CAV saturation and identify needs for a safe transportation network.

TPP-02

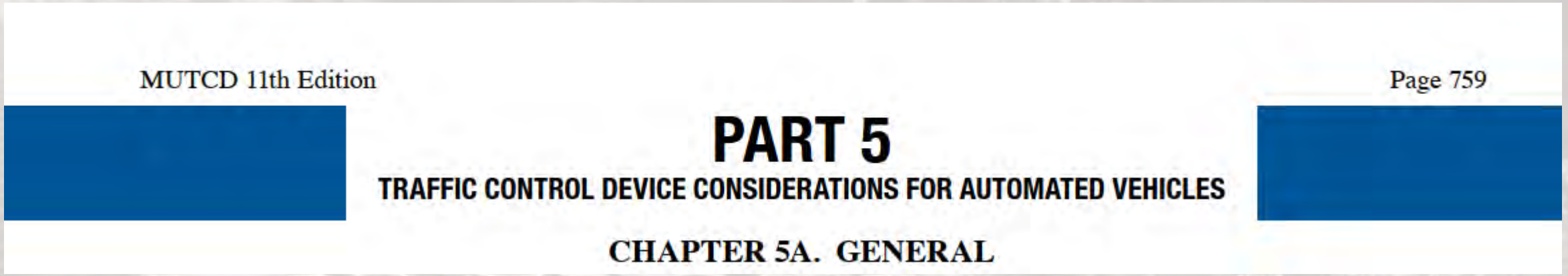
Update transportation planning, travel demand modelling and traffic simulation practices and requirements to consider CAV and leverage new data available through updated revealed preference and stated preference surveys. Collaboration between different agencies across the province would be required to ensure these updates are consistent and reflect the needs of all users.

BMP-03

Develop a policy to influence an increase in development and adoption of electric CAV to reduce the environmental impact of transportation within the region. These incentives can be in the form of financial credits to electric CAV users, priority parking with free electric charging stations, and improved availability of electric vehicle charging stations throughout the transportation network.

Planning a TMP update

Any agency who is updating a Transportation Master Plan or other Planning Strategy

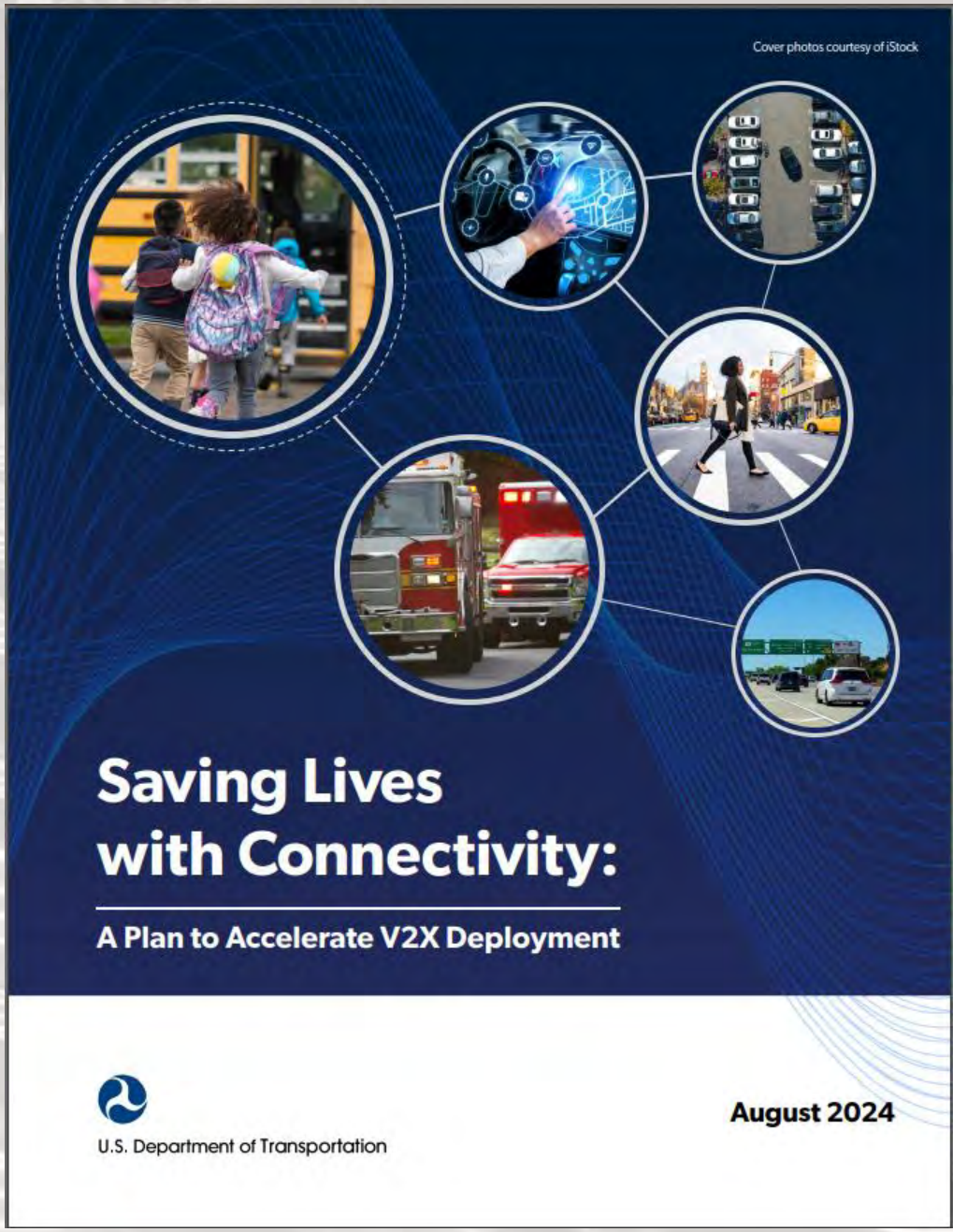


US MUTCD – Dec 2023

- Traffic Control Devices
- Signs
- Markings
- Highway Traffic Signals
- Temporary Traffic Control
- Traffic Control for Highway-Rail and Highway – Light Rail
- Traffic Control for Bicycle Facilities

US V2X Deployment Plan (Aug 2024)

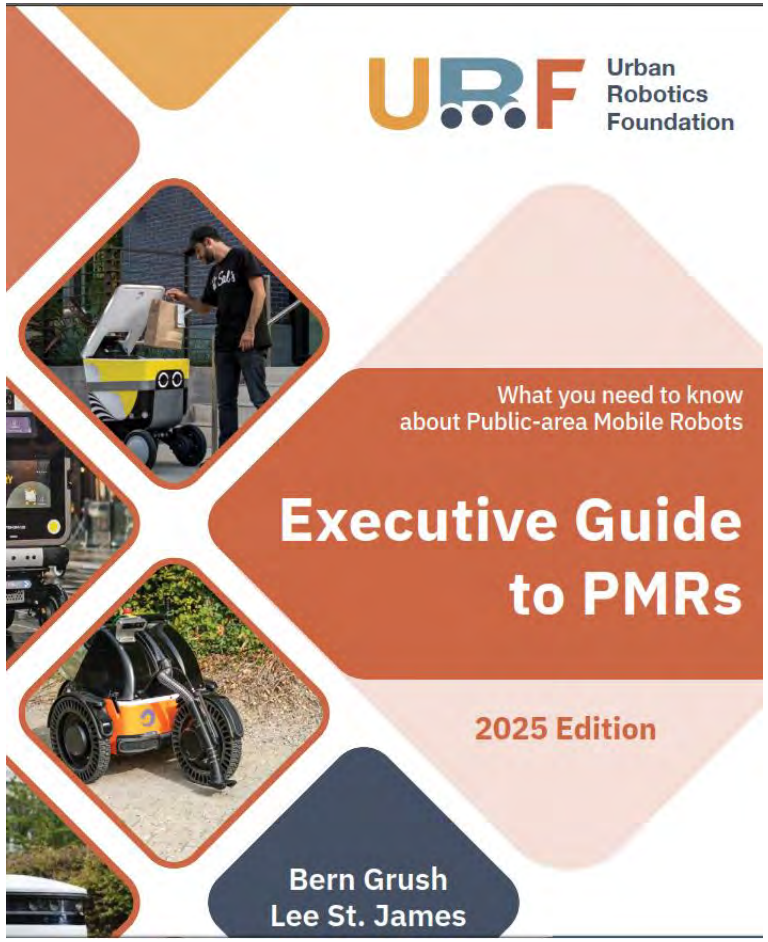
- 2028
  - top 75 metro areas have 25% of signalized intersections V2X enabled
  - 20% of freeways
- 2031
  - 40% of all intersections
  - 50% of all freeways



PREPARING FOR PMRS

Leverage existing material

ISO 4448



Urban Robotics Foundation

ISO 4448

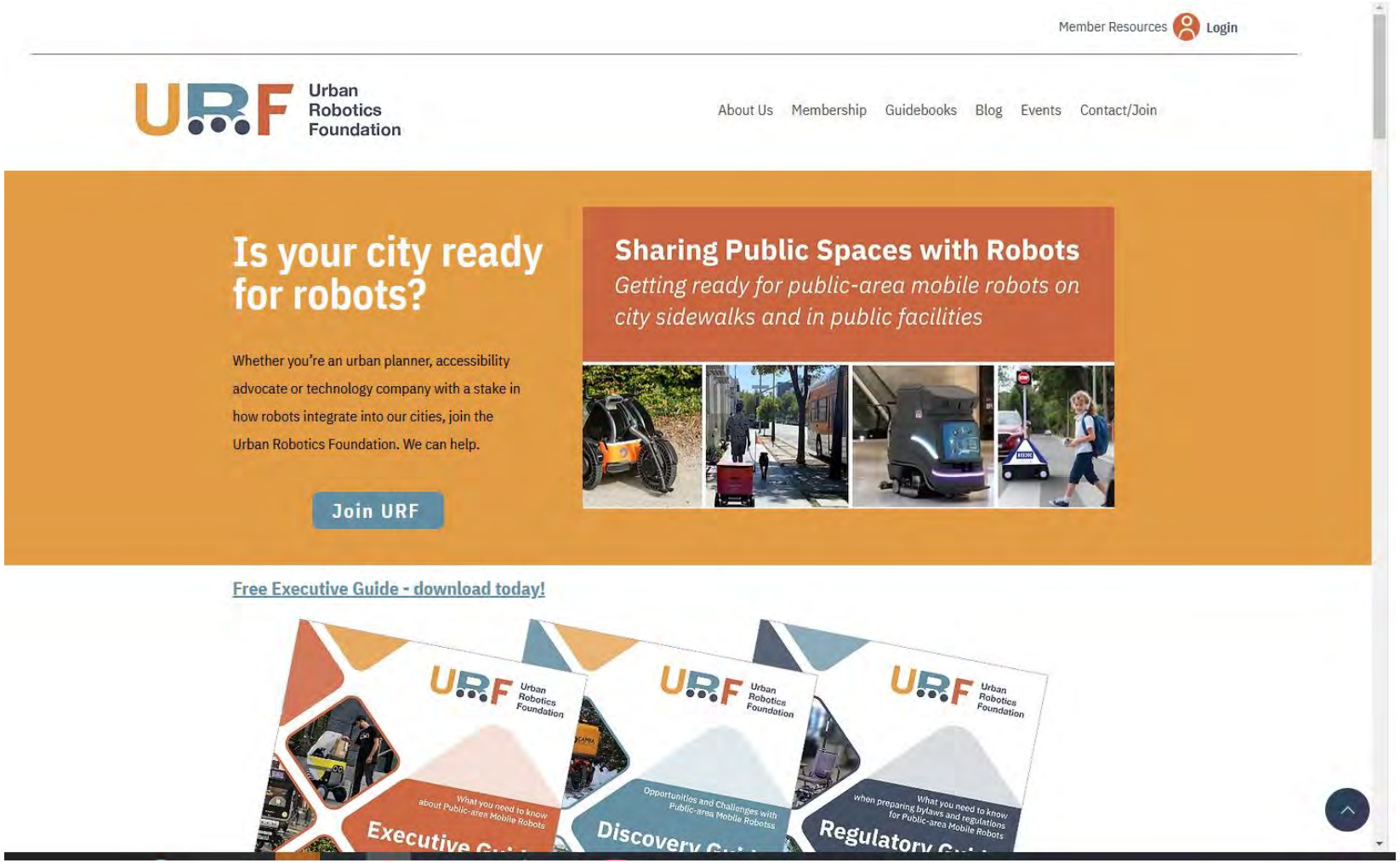
The purpose of the ISO 4448 series is to:

1. define the operating and behavioural systems needed to organize and expedite the flow of vehicular and robotic ground traffic in cities, specifically with regard to the loading and unloading of goods and passengers at the kerbside;
2. define the allocation and movement of PMRs for short-haul delivery, garbage removal, sweeping, washing, snow removal, repair, food trucks, public works tasks and human transportation in public spaces, among other services conducted on pathways or crosswalks.

Table 3: Structure of Draft Technical Standard ISO-4448

Theme	Parts
Definitions and profiles	1. Overview of paradigm 2. Data definitions and general concepts 3. Security, privacy, testing & data: Threat, vulnerability and risk profiles
Machine behaviours	4. Loading & unloading of goods and passengers 5. Access on human pathways 6. Journey planning sufficiency 7. Behaviour on human pathways 8. Robot-to-human communication signals 9. Journey data recorder
Operational context	10. Suitability of pathway infrastructure 11. Environmental worthiness 12. Post-crash procedures 13. Mapping maintenance
Personal & safety	14. Personal assistant robots for tasks and goods 15. Personal assistant robots for human transport 16. Safety and reliability

Leverage Urban Robotics Foundation



Plan a trial, develop policy

Readiness: Careful planning is needed for trials, limited deployments, and eventual larger-scale, multi-fleet, mixed logistics and maintenance operations. This is a critical endeavor that should include:

- Consulting with community stakeholders to understand the priority use-cases
- Selecting suitable communities for trials
- Determining changes needed to bylaws; setting up frameworks for licensing and permits
- Understanding required infrastructure investments
- Analyzing data, reporting, and planning for subsequent deployments

Leverage your ecosystem, encourage innovation, undertake pilots

Grand Prairie

- Automated snow removal pilot

Edmonton

- ActiveAurora CV Test Bed
- Electric Autonomous (ELA) Shuttle Pilot
- Robird – Autonomous Bird Control at Airport

Calgary - Edmonton

- Cooperative Truck Platooning Pilot

Calgary

- Dianomix, Last Mile Autonomous Delivery Pilot
- Autonomous grass mower
- 16th Ave North V2I Pilot
- Electric Autonomous (ELA) Shuttle Pilot


PROACTIVE
REACTIVE

Future is Bright

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THANK YOU

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