Transportation Association of Canada

# Lexicon of Terms: Connected and Automated Vehicles

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**This lexicon of key terms related to connected and automated vehicles has been assembled from several sources, and is intended to guide the understanding and use of common technical terms by Canadian practitioners in a manner consistent with prominent publications.**

**Sources:**

- **SAE International, *Taxonomy and Definitions for Terms Related to Driving Automation Systems for On-Road Motor Vehicles* (J3016) (2018)**
- **Transport Canada, *Testing Highly Automated Vehicles in Canada: Guidelines for Trial Organizations* (2018)**
- **University of Virginia Center for Transportation Studies, "Glossary of Connected and Automated Vehicle Terms, v1.0" (2018)**

**Active safety system.** A vehicle system that senses and monitors conditions inside and outside the vehicle for the purpose of identifying perceived present and potential dangers to the vehicle, occupants, and/or other road users, and automatically intervenes to help avoid or mitigate potential collisions via various methods, including alerts to the **driver**, vehicle system adjustments, and/or active control of the vehicle subsystems (brakes, throttle, suspension, etc.).

**Adaptive cruise control (ACC).** A feature that offers speed control, based on input from lasers, radar, cameras or a combination thereof, to keep a constant distance between a vehicle and the vehicle ahead of it. Some versions also offer some braking capabilities.

**ADS-dedicated vehicle.** A vehicle designed to be operated exclusively by a **level** 4 or **level** 5 **automated driving system** for all trips within its given operational design domain limitations (if any).

**Advanced driver assistance system (ADAS).** An electronic system in motor vehicles that supports **driver** avoidance of a collision or lessens impact of a collision, using technologies that correspond to a **level** 1 or 2 **driving automation system** (e.g. automatic emergency braking, forward collision warning, **adaptive cruise control**, lane departure warning, lane keeping assistance, blind spot monitoring).

**Automated driving system (ADS).** The hardware and software that are collectively capable of performing the entire **dynamic driving task** on a sustained basis, regardless of whether it is limited to a specific **operational design domain**; this term is used specifically to describe a **level** 3, 4 or 5 **driving automation system**.

**Automated highway system (AHS).** An **intelligent transportation system** facility designed primarily for **automated vehicles** following pre-determined routes; they could reduce the distance normally required between vehicles and thus increase road capacity, and would typically be combined with **advanced driver assistance system** technologies.

**Automated vehicle (AV).** A vehicle that features a **driving automation system**. *Due to its lack of specificity and the potential for confusion, usage of this term as other than a general concept is discouraged.*

**Autonomous vehicle.** *Due to its lack of specificity and the potential for confusion, usage of this term is discouraged.*

**Basic safety messages (BSM).** Data broadcasted from vehicles through **vehicle-to-vehicle** and **vehicle-to-infrastructure communication**, 10 times per second, with core elements describing a vehicle's position and motion.

**Cellular vehicle-to-everything (C-V2X).** A wireless communication technology allowing **vehicle-to-everything communication** through smart phones or other devices; it is based on the cellular standards set (3GPP), operates in the 5.9 GHz band and in the traditional mobile broadband licensed spectrum, and has two communication modes (the *PC5 interface* is independent of the cellular network, and the *Uu interface* uses the cellular network).

**Connected vehicle (CV).** A vehicle that communicates wirelessly with its occupants, other vehicles, roadside infrastructure, other travellers and/or the cloud, using modes such as **dedicated short-range communications** or **cellular vehicle-to-everything** communications.

**Connected vehicle applications.** Applications that take advantage of a **connected vehicle** environment. The Architecture Reference for Cooperative and Intelligent Transportation (ARC-IT) website divides them into twelve categories:

- *Commercial vehicle operations* – includes applications and service packages that are relevant to the operation, safety and management of commercial vehicles
- *Data management* – includes service packages from various data sources including **connected vehicles** to support performance monitoring and other uses of historical data
- *Maintenance and construction* – includes service packages that track maintenance and construction vehicles and supports dissemination of these activities
- *Parking management* – includes service packages that monitor and manage parking spaces and provides real-time information on park and ride services to support travelers' decision making
- *Public safety* – includes service packages to support basic public safety, call-taking and dispatch services and provides information to support dynamic routing of emergency vehicles
- *Public transportation* – includes service packages to monitor automated transit vehicle location, perform automated dispatch of transit services and allows travelers to request trips and request itineraries
- *Support* – includes service packages to provide monitoring, management and control services to other applications and devices operating within a **connected vehicle** environment
- *Sustainable travel* – includes service packages to monitor individual vehicle emissions and support environmentally efficient operation of traffic signals and lanes
- *Traffic management* – includes service packages to support infrastructure- and vehicle-based surveillance and the use of **connected vehicle** information to improve the operation of traffic systems

- *Traveler information* – includes service packages to disseminate traveller information for route planning and guidance
- *Vehicle safety* – includes service packages that leverages sensors and safety messages transmitted between **connected vehicles** to support and augment vehicle safety
- *Weather* – includes service packages for collecting road weather data and detecting environmental hazards to alert **drivers**

**Constant distance gap (CDG).** A constant distance-based separation gap maintained between vehicles, even when the speed of vehicles changes during **platooning**.

**Constant time gap (CTG, also referred to as time to collision).** A constant time-based separation gap maintained between vehicles, proportional to their speed.

**Conventional driver.** A **driver** seated in what is normally referred to as the driver's seat.

**Conventional vehicle.** A vehicle designed to be operated by a **conventional driver** during part or all of every trip.

**Cybersecurity (also, cyber security).** The use of processes, practices, hardware and software to protect networks, computers, programs and data from attack, damage or unauthorized access.

**Data authentication.** A process used to verify that data received are identical to data sent, or to verify that a program is not infected by a virus.

**Dedicated short-range communications (DSRC).** A wireless communication technology allowing **vehicle-to-everything communication** through smart phones or other devices; it is based on the Wi-Fi standards set (IEEE 802.11), and operates in the 5.9 GHz band.

**Digital certificate.** A set of data that uniquely identifies an entity, contains the entity's public key and possibly other information, and is digitally signed by a trusted party, thereby binding the public key to the entity.

**Disengagement.** The deactivation of an **automated driving system** when a failure of the system occurs, when safe operation of the vehicle requires the **conventional driver** or **remote driver** to assume immediate operation of the vehicle, or when the system requires deactivation for the safety of the vehicle, its occupants or other road users.

**Driver.** A user who performs, in real-time, part or all of the **dynamic driving task** and/or **dynamic driving task fallback** for a particular vehicle.

**Driverless operation.** Operation of an **automated driving system**-equipped vehicle in which no on-board user is present, or in which on-board users are not **drivers** or **dynamic driving task fallback**-ready users.

**Driverless vehicle.** *Due to its lack of specificity and the potential for confusion, usage of this term is discouraged.*

**Driving automation system.** The hardware and software that are collectively capable of performing part or all of the **dynamic driving task** on a sustained basis; this term is used generically to describe any system capable of **level** 1 to 5 driving automation.

**Driver support feature.** A general term for **level** 1 and 2 **driving automation system** features.

**Dual-mode vehicle.** An **automated driving system**-equipped vehicle that is designed for both **driverless operation** and operation by a **conventional driver** for complete trips.

**Dynamic driving task (DDT).** All of the real-time operational and tactical functions required to operate a vehicle in on-road traffic, excluding strategic functions such as trip scheduling and selection of destinations and waypoints, and including without limitation: lateral vehicle motion control via steering; longitudinal vehicle motion control via acceleration and deceleration; monitoring the driving environment via object and event detection, recognition, classification and response preparation; **object and event detection and response**; manoeuvre planning; and enhancing conspicuity via lighting, signaling and gesturing, etc.

**Dynamic driving task fallback.** The response by a human **driver** or an **automated driving system** to either perform the **dynamic driving task** or achieve a **minimal risk condition** after **automated driving system** failure or disengagement, or upon exiting the **operational design domain**.

**Electronic control unit (ECU).** An in-vehicle unit that controls one or more electrical systems such as the engine control unit or the **human-machine interface**.

**Far infrared sensors (FIRS).** Devices that capture the heat profile of living beings in low-light situations, and can help detect pedestrians, cyclists or wildlife when visibility is poor.

**Floating car data (FCD).** Data describing a vehicle's location and motion, used to determine the fluidity of operations on a road network.

**Freight signal priority (FSP).** A traffic signal priority method giving the right-of-way to trucks based on current and projected movements.

**Fully automated vehicle.** A vehicle equipped with a **level** 5 **automated driving system** that does not have a limited **operational design domain** and is capable of performing the entire **dynamic driving task** in any condition without requiring human intervention.

**Highly automated vehicle (HAV).** A vehicle equipped with a **level** 3 to 5 **automated driving system** that is capable of performing the entire **dynamic driving task** on a sustained basis within its specified **operational design domain**.

**Human-machine interface (HMI).** Hardware and software that enable two-way communication between a vehicle and its occupants through (for example) touchscreens, voice recognition or mobile device integration.

**Incident scene pre-arrival staging guidance for emergency responders (RESP-STG).** An application to safely and efficiently guide public safety responders to the scene of an incident.

**Internet of vehicles (IoV).** The integration of inter-vehicle, intra-vehicle, and vehicular mobile networks, enabling wireless information exchange between vehicles, roadside infrastructure, humans and the Internet.

**Interoperability.** The ability of a system to function in different locations through communication with other systems; or the ability of one system to replace another without degrading the service provided; or the ability of two different systems to integrate/interact correctly and in a safe manner to produce the desired outcome (e.g. multi-brand **platooning** that requires different truck systems to work together to form a platoon).

**Intelligent Transportation System (ITS) Architecture.** A framework for interrelated systems to deliver transportation services, defining how systems function and how information is exchanged among travellers, vehicles, roadside devices, and control centres. The *ITS Architecture for Canada* and the U.S.-focused *Architecture Reference for Cooperative and Intelligent Transportation* (ARC-IT) provide a starting point for creating regional and project-level architectures.

**Level (of driving automation).** As defined by SAE International in "Standard J3016: Taxonomy and Definitions for Terms Related to On-Road Motor Vehicle Automated Driving Systems," the six levels of driving automation are:

- *Level 0—No Driving Automation.* The performance by the **driver** of the entire **dynamic driving task**, even when enhanced by **active safety systems**.
- *Level 1—Driver Assistance.* The sustained and **operational design domain**-specific execution by a **driving automation system** of either the lateral or longitudinal vehicle motion control subtask of the **dynamic driving task** (but not both simultaneously), with the expectation that the **driver** performs the remainder of the **dynamic driving task**.
- *Level 2—Partial Driving Automation.* The sustained and **operational design domain**-specific execution by a **driving automation system** of both the lateral and longitudinal vehicle motion control subtasks of the **dynamic driving task**, with the expectation that the **driver** completes the object and event detection, recognition, classification and response subtask and supervises the **driving automation system**.
- *Level 3—Conditional Driving Automation.* The sustained and **operational design domai**n-specific performance by an **automated driving system** of the entire **dynamic driving task** with the expectation that the **dynamic driving task fallback**-ready user is receptive to **automated driving system**-issued requests to intervene, as well as to **dynamic driving task** performance-relevant system failures in other vehicle systems, and will respond appropriately.
- *Level 4—High Driving Automation*. The sustained and **operational design domain**-specific performance by an **automated driving system** of the entire **dynamic driving task** and **dynamic driving task fallback**, without any expectation that a user will respond to a request to intervene.
- *Level 5—Full Driving Automation.* The sustained and unconditional (i.e., not **operational design domain**-specific) performance by an automated driving system of the entire dynamic driving task and **dynamic driving task fallback** without any expectation that a user will respond to a request to intervene.

**Light detection and ranging (LIDAR).** An on-vehicle technology that uses pulsed lasers to create a detailed, three-dimensional and 360-degree map of physical objects in the environment.

**Local coordination.** The instruction of **automated driving system**-equipped vehicles to speed up or slow down to facilitate clustering or cooperative **adaptive cruise control**.

**Minimal risk condition.** The condition that a human **driver** or **automated driving system** resorts to when an **automated driving system** system fails, or when a human **driver** fails to take over the **dynamic driving task** when requested.

**Mobility-as-a-service (MaaS, also referred to as transportation-as-a-service or TaaS**). The integration of transportation services from public and private providers (e.g. public transit, bike share, ride-hail, carshare, scooter) through a unified gateway (e.g. typically a mobile application) for trip planning, management and payment.

**National transportation communications for ITS protocol (NTCIP).** A family of standards that allows electronic traffic control equipment from different manufacturers to operate as a system, thus reducing reliance on specific equipment vendors and one-of-a-kind software.

**Object and event detection and response.** The perception by a **driver** or vehicle system of circumstances that are relevant to the immediate **dynamic driving task**, and the appropriate response by a **driver** or **automated driving system**.

**Obstacle detection.** An **advanced driver assistance system** feature that detects objects or other road users ahead of the vehicle and alerts the **driver** to brake if a collision is imminent.

**Operational design domain.** The specific conditions under which an **automated driving system** or feature is intended to function, such as those defined by roadway type (e.g. low-speed road, freeway), geographic area (e.g. downtown, corporate campus), environmental conditions (e.g. daytime, dry road surface), or other variables.

**On-board equipment (OBE).** An in-vehicle device that collects data and/or acts as an interface for **intelligent transportation system** services (e.g. tolls, navigation, trip planning, travel information).

**Platooning.** The coordination of two or more vehicles to decrease headway between them and allow simultaneous acceleration and braking, enabled by wireless communication and automation technologies; can increase effective road capacity, and reduce fuel consumption and **driver** workload.

**Remote driver.** A **driver** who is not seated in a position to manually exercise in-vehicle braking, accelerating, steering, and transmission gear selection input devices (if any) but is able to operate the vehicle.

**Request to intervene.** The notification by an **automated driving system** to the human **driver** that they should perform the **dynamic driving task fallback**.

**Roadside equipment (RSE).** A piece of **intelligent transportation system**-related hardware at the side of the road that exchanges data with vehicles or enables travelers to access **intelligent transportation system**-related services. The term describes a broad set of field equipment that includes the more narrowly-defined **roadside unit**.

**Roadside unit (RSU).** A **dedicated short-range communications** transceiver along a road or pedestrian route that communicates with the on-board equipment of nearby vehicles (e.g. broadcasting or exchanging data, providing channel assignments and operating instructions).

**Security credential management system (SCMS).** An advanced security system that facilitates trusted **vehicle-to-everything communications** by ensuring message authenticity, integrity and privacy.

**Self-driving vehicle.** *Due to its lack of specificity and the potential for confusion, usage of this term is discouraged.*

**Signal phase and timing (SPaT).** Data describing the current state of a traffic signal (e.g. green light) and the time until it will change for each active approach and lane.

**Transit signal priority (TSP).** A traffic signal priority method giving the right-of-way to transit vehicles based on current and projected movements, as well as schedule adherence or passenger loads.

**Vehicle-to-infrastructure (V2I) communication.** The exchange of information between vehicles and infrastructure; may be used to inform vehicle users of issues including traffic conditions or weather warnings.

**Vehicle-to-pedestrian (V2P) communication.** The exchange of information between vehicles and pedestrians or cyclists.

**Vehicle-to-vehicle (V2V) communication.** The exchange of information between vehicles, often referring specifically to communication of basic safety messages in the 5.9 GHz band.

**Vehicle-to-everything (V2X) communication.** The exchange of information between vehicles and other parties, including but not limited to **vehicle-to-infrastructure**, **vehicle-to-pedestrian**, and **vehicle-to-vehicle communication**.

**Vulnerable road user.** A pedestrian, cyclist, motorcyclist, or user of a personal mobility device (e.g. motorized wheelchair, scooter) who is using the roadway.

**Wireless access for vehicular environments (WAVE).** A short-range communication system in vehicular environments to support **vehicle-to-infrastructure** and **vehicle-to-vehicle communications**, as well as other **intelligent transportation system** applications.

**Zero-occupant vehicle (ZOV, also referred to as an unoccupied vehicle or UOV).** A **fully automated vehicle** operating without a **conventional driver** or passenger.