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Smart community infrastructures — Guidance on smart transportation by Electric, Connected and Autonomous Vehicles (eCAVs) and its application to on-demand responsive passenger services with shared vehicles

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Infrastructures urbaines intelligentes — Recommandations relatives au transport intelligent par véhicules électriques, connectés et autonomes et application aux services de transport de passagers à la demande avec des véhicules partagés

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Foreword

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The procedures used to develop this document and those intended for its further maintenance are described in the ISO/IEC Directives, Part 1. In particular, the different approval criteria needed for the different types of ISO documents should be noted. This document was drafted in accordance with the editorial rules of the ISO/IEC Directives, Part 2 (see www.iso.org/directives).

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This document was prepared by Technical Committee ISO/TC 268, *Sustainable cities and communities*, Subcommittee SC 2, *Sustainable cities and communities - Sustainable mobility and transportation*.

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Introduction

Public transport using Electric, Connected and Autonomous Vehicles (eCAVs) will be a solution to a range of problems, including passenger need for flexible, demand-responsive transport options and a shortage of drivers in ageing societies.

5G cellular and WLAN technologies provide the necessary vehicle-to-network (V2N), vehicle-to-vehicle (V2V) and vehicle-to-infrastructure (V2I) communications that assist the navigation of autonomous buses.

However, autonomous buses that are wirelessly connected and driverless also address key environmental and road safety considerations in busy and polluted urban areas and therefore are likely to have a significant role in a future transport system. In particular, they can:

— provide comfortable and convenient transport for everyone, especially the young, elderly and disabled;

— reduce congestion and time lost to slow moving traffic, increasing efficiency;

— manage travel demand, relieve parking and optimise the use of road space;

— reduce carbon emissions, pollution and noise in and between cities, promoting health and well-being;

— make cities more attractive and productive places, able to grow sustainably.

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Technology that supports small autonomous vehicles such as pods, one of the Low-Speed Autonomous Transport Systems (L-SATS), for intra-city passenger transport also lends itself to local delivery services. Autonomous delivery pods are designed to carry parcels, groceries and food, making local distribution faster and more cost-efficient.

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Key obstacles to the introduction of autonomous bus and delivery pod services include the ability to introduce autonomous vehicles among regular bus services and manually driven vehicles. Therefore, many autonomous experiments have been increasingly sophisticated bus services on fixed, short routes around safe, off- and on-road spaces.

While trials and pilot schemes exist, they have not been at a scale that really demonstrates the extent to which eCAVs can form the basis of a genuine public transport service.

Nevertheless, a strategic city focus plus open innovation should form the basis of intelligent demand-responsive mobility that offers seamless journeys across multi-modal travel options that include autonomous buses. Key advantages of such transport systems, include:

— adaptability, i.e. eCAVs fit the environment and travel needs of passengers;

— flexible routing and demand responsive journeys;

— real-time information across transport infrastructures;

— city-scale functionality and integration;

— safer and more accessible public transportation.

Rapidly developing pilot projects on autonomous buses can serve the development of smart transportation that helps reach these goals. This document aims to signpost the way towards these goals and offer some focus for the collaborative development of international standards for autonomous public transport services.

ISO Guide 82 has been taken into account in the development of this document with regards to addressing sustainability issues.

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1 Scope

This document provides guidance on the staged implementation of Electric, Connected and Autonomous Vehicle (eCAV) passenger and delivery services, with a special focus on on-demand responsive passenger services with shared vehicles. This document aims to accelerate innovation and deliver smart transportation by eCAV, in and between cities.

Note 1 to entry This document does not designate the technical details of eCAVs, including pods, which are Low-Speed Autonomous Transport System (L-SAT) vehicles. These technical details are provided by ISO 22737.

Note 2 to entry This document targets on-demand responsive passenger services with shared vehicles. ISO 37181 also mentions the advantages of eCAV applications to public transportation.

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2 Normative references

There are no normative references in this document.

3 Terms and definitions

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For the purposes of this document, the following terms and definitions apply.

ISO and IEC maintain terminology databases for use in standardization at the following addresses:

— ISO Online browsing platform: available at https://www.iso.org/obp

— IEC Electropedia: available at https://www.electropedia.org/

3.1
autonomous bus
shared vehicle used for public transport services for passengers provided by Electric, Connected and Autonomous Vehicles (eCAVs)

Note 1 to entry: A taxi vehicle is hired and can, if local regulations permit, be shared by different passenger groups. In contrast, a bus vehicle is shared and can be chartered.

Note 2 to entry: A pod, which is a Low-Speed Autonomous Transport System (L-SAT) vehicle and is characterized by being a small vehicle with low capacity, autonomously transports passengers in different or the same groups and delivers items. Thus, a pod is a bus vehicle.

4 Common considerations for smart transportation by autonomous buses

4.1 Goals of smart transportation

Automobile transportation is on the cusp of the biggest revolution in public roads since the advent of the internal combustion engine. eCAVs will spearhead the development of radically new mobility services. Vehicle-to-everything connectivity improves road safety, enables collaboration between CAVs and allows authorities to orchestrate traffic flow in real time via wireless connectivity with strict assurance for security and privacy.

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This vision of ubiquitous autonomous public transport services requires fully fledged autonomous driving technologies and legal frameworks that are still years away.

However, in the meantime, there is a demand for a set of guidelines and standard approaches:

— to enable both the commercial development and public deployment of eCAVs;

— to provide a policy framework for the provision of tailored and on-demand responsive transportation services using eCAVs;

— to establish broad use cases for eCAVs such as:

  — low speed urban transit;

    NOTE eCAV is one suitable vehicle that is adaptable to smart transportation for compact cities designated in ISO 37157.

  — intercity transfers;

  — tailored transport solutions to suit the needs of the young, elderly and people with disabilities and special needs;

— to promote optimal and efficient public transport and delivery services through the shared use of eCAVs that can act in either a conventional mode, such as scheduled bus and freight services, or a demand-responsive mode, such as taxis and couriers;

— to understand the roles and responsibilities of transport authorities in the planning and development of eCAVs;

— to focus on control systems necessary for eCAV services, including the exchange and interoperability of shared vehicle and passenger data;

— to accelerate the development and integration of supporting digital and physical infrastructures;

— to assure approaches to passenger and pedestrian safety and the security of personal data and build public trust;

— to offer an overview of recent developments;

— to shape and influence testing to ensure that trials also complement other key objectives of city transport strategies, such as active travel and greater reliance upon public and shared transport.

Smart transportation aims to satisfy the following United Nations Sustainable Development Goals (UN SDGs): goal 3 “Good Health and Well-being”, goal 7 “Affordable and Clean Energy”, goal 8 “Decent Work and Economic Growth”, goal 9 “Industry, Innovation and Infrastructure”, goal 11 “Sustainable Cities and Communities”, goal 12 “Responsible Consumption and Production”, goal 13 “Climate Change” and goal 15 “Life on Land”.

4.2 Basic characteristics of eCAVs

eCAV services take many forms:

— large vehicles (conventionally sized buses);

— smaller vehicles for typically 6 to 14 passengers;

— urban pods for 2 to 6 passengers for intracity transit in compact cities and centres;

— autonomous saloon cars for intercity transit (e.g. provision of snacks and drinks for long distance travel, sightseeing);

— eCAV freight that has a particular application in compact urban centres;

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— small-delivery vehicles, designed for pavements and home delivery.

A critical aim of autonomous buses is the ability to offer an on-demand responsive passenger service in dense urban spaces, while larger intercity buses can continue providing a scheduled service. Autonomous public transport in urban spaces is in its very early stages of development. Therefore, to shape the implementation and the transformative impact upon urban life, deep engagement with all relevant transport stakeholders, citizens and passengers should be a priority.

Much collaborative discussion and public engagement will be required to understand the future of road design, traffic management and the adaptation of the rules of the road that would support the adoption of autonomous bus services. It is important to take account of new autonomous technologies and develop user-friendly interaction with the public, leading to trust and acceptance among passengers.

4.3 eCAV as integrated intelligent mobility

4.3.1 General

eCAVs combine three key characteristics that are driverless, electric-powered and remotely connected.

These characteristics reflect critical changes ongoing in the automobile market. Cars are increasingly connected for purposes of geo-positioning, navigation and the monitoring of driving quality. Responding to public concern about air quality, particularly in urban environments, vehicles are increasingly electric powered. And while not yet a consumer trend, around the world much work and investment support the development of autonomous and robotic technologies that drive vehicles autonomously.

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4.3.2 Examples of development of autonomous technologies

4.3.2.1 Pods in Milton Keynes, UK

As part of the UK autodrive project, self-driving pods have been undergoing trials on pavements in Milton Keynes. The Milton Keynes Council has been working to test out a new first/last mile transport solution for local people, shoppers and visitors to the city.

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The pods can travel up to 24 km per hour and last up to 100 km off one charge, operating in the city centre from the central railway station. There are plans for the pods to continue to operate in the city, with a service being offered to residents.

4.3.2.2 Driverless taxi service

What autonomous taxi services have demonstrated is the potential for this technology to develop into a public transport service. This can enable first and last mile mobility options that can help people move around for their business in an efficient and safe way with improved travel options for those who cannot drive or can find it difficult to either use regular buses, cycle or walk.

4.3.3 Framework of four features

These trials bring together the electric, connected and driverless characteristics, but they also have to take into account the context in which they must operate. That framework consists of four features: human behaviour, vehicle requirements, digital infrastructure, and the design and state of roads.

The interventions needed to make these contextual features fit for eCAV services are indicated in Figure A.1, and cover:

— data management and exchange, which are central to the connected characteristic, and relevant to human behaviour and digital infrastructure;

— establishing the mobile connectivity and a suitable operating environment, which are relevant to the road and digital infrastructure;

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— the safe operation and insurance of vehicles bring together aspects of human behaviour and technical vehicle safety of eCAVs.

Therefore, relevant interventions can include rules on:

— personal data protection and privacy;

— security standards on the exchange of data;

— ensuring sufficient fibre backhaul networks to support the edge computing and IoT roadside infrastructures;

— safety standards for autonomous buses and the insurance and liability rules underpinning their services.

Putting in place the right interventions that address the context in which eCAV services operate should support the public and commercial development of autonomous buses and public acceptance of this paradigm shift in urban mobility.

4.4 Key considerations

4.4.1 General

For the development and trials of eCAV transportation services in an actual city, key considerations include the role of transport authorities, legal and regulatory frameworks and service typologies.

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4.4.2 Role of transport authorities

Governments (e.g. city, state, nation) are often the providers of 'infrastructure' and facilitator of trials, particularly when it comes to granting permissions and licenses for eCAV activities and installations.

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The development and operation of vehicles is driven largely by industry and technology, often in collaboration with centres of research and expertise, such as universities with specialities in robotics and artificial intelligence.

Universities also provide objective impact assessments and technical and non-technical advice based upon a pool of expertise and experience, for example, simulating eCAV impacts on existing transport networks.

The collaborative research and development between industry and universities also supports the development of business cases and implementation plans.

There will be a critical role for transport authorities to guide and lead the development of autonomous public transport:

— to be up to date and engaged in all trial activities;

— to provide assurance with regards to safety and testing;

— to shape development of eCAVs to complement other urban transport policy objectives.

Fiscal measures and tax incentives can be offered by governments to encourage research and development and make viable the production of eCAVs for public transport.

4.4.3 Legal and regulatory framework

Essential elements of the legal regulatory requirements are insurance and liability issues, especially who is liable for an accident involving an eCAV and what are the 'meet and greet' rules of the road.

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Common and consistent rules of the road are necessary to enable the widespread commercial development and adoption of services:

— the legal framework for autonomous public transport should be consistent everywhere albeit developed to take account of different terrains and environments and applied technologies in different places;

— regulators and testing organisations need to ensure vehicles are road legal and insured;

— a suitably trained and licenced test driver or test operator should supervise the vehicle at all times and be able to over-ride automated operation if necessary.

4.4.4 Service typology

Services morph and grow over time as a result of innovation and passenger preferences, however, in the short-term, services that are likely to develop include:

— testing, maintenance and repair facilities

  — safe spaces in which to develop and test vehicles;

— autonomous bus services

  NOTE ISO 37154 describes passenger services provided by smart transportation in a general meaning.

  — fixed short routes, e.g. last mile journeys into and out of urban centres that can be scheduled or demand responsive;

— autonomous, shared, demand-responsive, safe and user-friendly passenger services

  — hop on and hop off at designated points and times based upon algorithmic routes that respond to passenger requests;

— intercity autonomous journeys

  — faster scheduled vehicles between city pick up and drop off points, which connect with local autonomous services;

— pods

  — subscription-based services for small vehicles to pick up and drop off passengers at various locations;

— autonomous taxi services

  — on-demand transport services supported by a learning algorithm into which road data are fed.

4.4.5 Public engagement and the dissemination of findings

Dissemination of findings from the early adoption of eCAV services, along with public engagement, is another key role that should be led by authorities related to or in charge of transportation, public roads and city governments. They should work closely with private and public stakeholders in wider communications to inform people about the introduction of such innovation.

eCAVs co-exist with conventional vehicles on public roads. This means that eCAVs are operated under the current regulations and rules (e.g. highway codes, road traffic rules, traffic signs, signals and facilities).

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