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Recommendation

ITU-T F.749.6 (04/2023)

SERIES F: Non-telephone telecommunication services

Multimedia services

Requirements of vehicle information for automated driving in vehicle gateway platforms

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Recommendation ITU-T F.749.6

Requirements of vehicle information for automated driving in vehicle gateway platforms

Summary

Recommendation ITU-T F.749.6 specifies the requirements of vehicle information for automated driving in vehicle gateway platforms. Recommendation ITU-T F.749.6 introduces vehicle information for an automated driving system (ADS), followed by two different approaches to represent automated driving system-dedicated vehicle (ADS-DV) by its ownership. Finally, this Recommendation specifies the requirements to support two different approaches to represent ADS-DV.

History

Edition	Recommendation	Approval	Study Group	Unique ID*
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Keywords

ADS, ADS-DV, requirements, vehicle information, VGP.

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Requirements of vehicle information for automated driving in vehicle gateway platforms

1 Scope

This Recommendation specifies the requirements of vehicle information for automated driving in vehicle gateway platforms (VGPs). This Recommendation introduces vehicle information for automated driving systems (ADSs), followed by two different approaches to represent automated driving system-dedicated vehicles (ADS-DVs) by their ownership. Finally, this Recommendation specifies requirements to support two different approaches to representing ADS-DVs.

This Recommendation addresses the following elements.

– vehicle information for automated driving;

– ownership of ADS-DVs;

– requirements.

2 References

The following ITU-T Recommendations and other references contain provisions which, through reference in this text, constitute provisions of this Recommendation. At the time of publication, the editions indicated were valid. All Recommendations and other references are subject to revision; users of this Recommendation are therefore encouraged to investigate the possibility of applying the most recent edition of the Recommendations and other references listed below. A list of the currently valid ITU-T Recommendations is regularly published. The reference to a document within this Recommendation does not give it, as a stand-alone document, the status of a Recommendation.

None.

3 Definitions

3.1 Terms defined elsewhere

This Recommendation uses the following terms defined elsewhere:

3.1.1 automated driving system (ADS) [b-SAE J3016]: The hardware and software that are collectively capable of performing the entire DDT on a sustained basis, regardless of whether it is limited to a specific operational design domain (ODD); this term is used specifically to describe a Level 3, 4, or 5 driving automation system.

3.1.2 ADS-dedicated vehicle (ADS-DV) [b-SAE J3016]: An ADS-equipped vehicle designed for driverless operation under routine/normal operating conditions during all trips within its given ODD (if any).

3.1.3 dynamic driving task (DDT) [b-SAE J3016]: All of the real-time operational and tactical functions required to operate a vehicle in on-road traffic, excluding the strategic functions such as trip scheduling and selection of destinations and waypoints, and including, without limitation, the following subtasks:

1. Lateral vehicle motion control via steering (operational).
2. Longitudinal vehicle motion control via acceleration and deceleration (operational).
3. Monitoring the driving environment via object and event detection, recognition, classification, and response preparation (operational and tactical).

4. Object and event response execution (operational and tactical).

5. Manoeuvre planning (tactical).

6. Enhancing conspicuity via lighting, sounding the horn, signalling, gesturing, etc. (tactical).

3.1.4 dynamic driving task (DDT) fallback [b-SAE J3016]: The response by the user to either perform the DDT or achieve a minimal risk condition (1) after occurrence of a DDT performance-relevant system failure(s), or (2) upon operational design domain (ODD) exit, or the response by an ADS to achieve minimal risk condition, given the same circumstances.

3.1.5 object and event detection and response (OEDR) [b-SAE J3016]: The subtasks of the dynamic driving task that include monitoring the driving environment (detecting, recognizing, and classifying objects and events and preparing to respond as needed) and executing an appropriate response to such objects and events (i.e., as needed to complete the dynamic driving task and/or dynamic driving task fallback).

3.1.6 operation design domain (ODD) [b-SAE J3016]: Operating conditions under which a given driving automation system or feature thereof is specifically designed to function, including, but not limited to, environmental, geographical, and time-of-day restrictions, and/or the requisite presence or absence of certain traffic or roadway characteristics.

3.1.7 platform [b-ITU-T G.1081]: A hardware and/or software architecture that serves as a foundation or base for realizing a certain functionality.

3.1.8 vehicle gateway (VG) [b-ITU-T F.749.1]: A VG is a device in a vehicle that enables communications between a device in the vehicle and another device which may be physically located either inside the vehicle or outside the vehicle (e.g., roadside station, cloud-based server, etc.). A VG provides standardized interfaces and protocols, communications across heterogeneous networks, optimized network selection based on application needs and network QoS, arbitration and integration of network communications, security and switching network connections to maintain service continuity.

3.1.9 vehicle gateway platform (VGP) [b-ITU-T F.749.1]: A VGP is the collection of ICT hardware and software in a vehicle operating as an open platform to provide an integrated runtime environment for delivering the communications services of a VG. A VGP may also provide higher layer communications services such as interaction with the driver through the driver-vehicle access services and so on. Subsystems dedicated solely to vehicle operation are not considered part of the VGP. Supported applications/services include ITS and infotainment.

3.2 Terms defined in this Recommendation

This Recommendation defines the following terms:

3.2.1 automated driving: A set of automation features based on information and communication technology to help driving a vehicle while not requiring the driver's full attention.

NOTE – Automated driving requires software and hardware for localization, perception, behavioural management and control.

3.2.2 vehicle information: Data generated by an ego vehicle.

NOTE – There are various types of vehicle information, including: transmission; fuel type; mileage; and fuel efficiency. Vehicle information for automated driving, in particular, consists of that for perception, map position, planning, controller and diagnosis.

4 Abbreviations and acronyms

This Recommendation uses the following abbreviations and acronyms:

ADS Automated Driving System

ADS-DV	Automated Driving System-Dedicated Vehicle
DB	Database
DDT	Dynamic Driving Task
DTC	Diagnostic Trouble Code
GNSS	Global Navigation Satellite System
ICT	Information and Communication Technology
ID	Identifier
ITS	Intelligent Transport System
LIDAR	Light Detection And Ranging
ODD	Operational Design Domain
OEDR	Object and Event Detection and Response
OS	Operating System
QoS	Quality of Service
RADAR	Radio Detection And Ranging
VIN	Vehicle Identification Number
VG	Vehicle Gateway
VGP	Vehicle Gateway Platform

5 Conventions

The phrase "**is required**" indicates a requirement that must be strictly followed and from which no deviation is permitted if conformance to this Recommendation is to be claimed.

The phrase "**is recommended**" indicates a requirement that is recommended but which is not absolutely required. Thus, this requirement need not be present to claim conformance.

6 Vehicle information for automated driving

Vehicle information refers to all data about a specific vehicle, from its model, year, vehicle identification number (VIN), registration information, to vehicle speed, engine rotations per minute, fuel consumption, location, distance travelled and any diagnostic trouble codes (DTCs) or warning messages. Vehicle information can be used for various purposes. Vehicle information for automated driving is the data that is collected and used by the ADS of the vehicle.

6.1 Vehicle perception information

Vehicle perception information is used to localize an ego vehicle and classify objects around it. Vehicle perception information such as global navigation satellite system (GNSS) location, inertial measurement unit and wheel odometry measurements are combined to determine the current location of an ego vehicle. In addition, vehicle map information sensed by light detection and ranging (LIDAR) and a camera may be incorporated to improve accuracy. Objects around an ego vehicle can be classified into dynamic and static. Vehicle perception information of dynamic objects detected by LIDAR, camera or radio detection and ranging (RADAR) is bounded by boxes, and the trajectory and motions of boxes are tracked to predict their future paths. For static objects, vehicle perception information from LIDAR or a camera may be combined with vehicle map information to identify and localize stationary on-road and off-road objects. Vehicle perception information plays a crucial role in performing OEDR.

6.2 Vehicle map information

Map information is used to develop a representation of the surrounding environment of an ego vehicle. Sources of information include vehicle maps of its occupancy grid, localization and roads in high definition, depending on their capabilities and applications. External sensors such as LIDAR and cameras are used to construct vehicle map information. Existing vehicle map information can be updated recurrently by combination with that of vehicle perception. Vehicle map information may also be used to perform better dynamic object predictions alongside vehicle perception information.

6.3 Vehicle planning information

Vehicle planning information is used to create paths from current locations to destinations. Sources of planning information are perception and map position of a vehicle. Vehicle planning information is separated into three steps: mission planning; behaviour planning; and local planning. Mission planning creates an entire long-term route to destinations, and behaviour planning determines how to manoeuvre by solving short-term decisions along the overall route safely. Local planning is then responsible for reactive and immediate actions by deciding a specific path and velocity profile while considering the long-term route and short-term decision.

6.4 Vehicle controller information

Vehicle controller information is used to actuate the ego vehicle to follow the given planned trajectory provided by the vehicle planning information. Vehicle controller information is divided into a lateral controller and a longitudinal controller. The lateral controller involves steering, such as turning and lane keeping. The longitudinal controller, such as proportional integral derivative control, regulates the throttle position, gear set and brake pedal position to control the desired velocity. Both lateral and longitudinal controller play an important role in maintaining the trajectory of an ego vehicle while following the vehicle planning information provided.

6.5 Vehicle diagnosis information

Diagnosis information is used to monitor and analyse the hardware failure and software inconsistencies of an ego vehicle and provide warnings and alerts if necessary. Vehicle diagnosis information is provided to the driver or the service provider to perform fallback. Vehicle diagnosis information such as DTCs or accident reports also acts as an input to failure mode and effects analysis, hazard and operability study and other safety frameworks for automated driving.

7 Ownership of ADS-DV

ADS-DV is an ADS-equipped vehicle designed for driverless operation, wherein ADS is hardware and software capable of performing the entire DDT on a sustained basis. Meanwhile, a VGP is a collection of ICT hardware and software to provide an integrated runtime environment for delivering the communications services. In this Recommendation, VGP is a component of ADS-DV to support additional requirements for automated driving.

Figure 7-1 is a conceptual diagram of ADS-DV depending on its ownership. A service provider is a company or organization that offers a platform or application that allows users to access and plan their transportation needs using ADS-DV. A user is a person who uses or subscribes to ADS-DV.

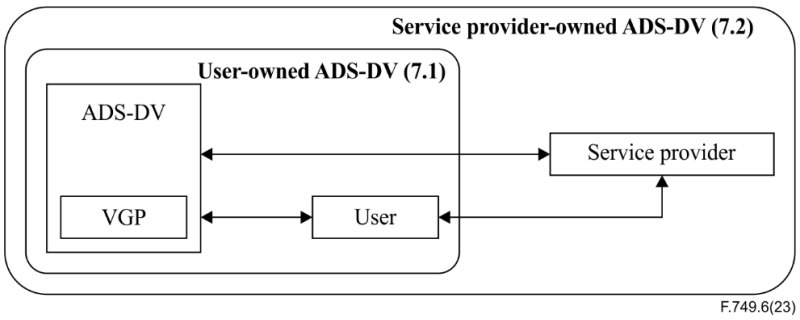

Figure 7-1 – Two approaches to ADS-DV ownership

7.1 User-owned ADS-DV

An ADS-DV is capable of performing various tasks pre-defined by its absent owner. For example, when the user is at work, the ADS-DV visits multiple locations (e.g., supermarkets and petrol stations) and executes tasks. In addition, the ADS-DV diagnoses its condition and alerts the user if maintenance is required.

A trip is a collection of tasks; a task is an action that users command ADS-DVs to execute. A task is defined by the user, ADS-DV, or other third party service providers. The order of tasks within a trip can be configured before or during the trip. In addition, a trip has a specific target time, *t*, which is the time user wants the ADS-DV to arrive.

In Figure 7-2, the user requests service execution to an ADS-DV. The ADS-DV is also capable of automatically commencing trips based on *t*. The ADS-DV checks the trip and determines whether the trip can be completed based on the trip information and the current state of the ADS-DV before *t*. For example, the ADS-DV considers the number, type, location of tasks, traffic conditions and any ongoing tasks to reorganize the tasks in a completable order. The ADS-DV selects the trip with the fastest estimated end time, $t_{ESTIMATE}$.

In some cases, however, it is not possible to complete before *t*. In that case, the ADS-DV responds by informing the user whether the trip is complete. If the trip cannot be completed, the ADS-DV waits for the user to provide further instructions.

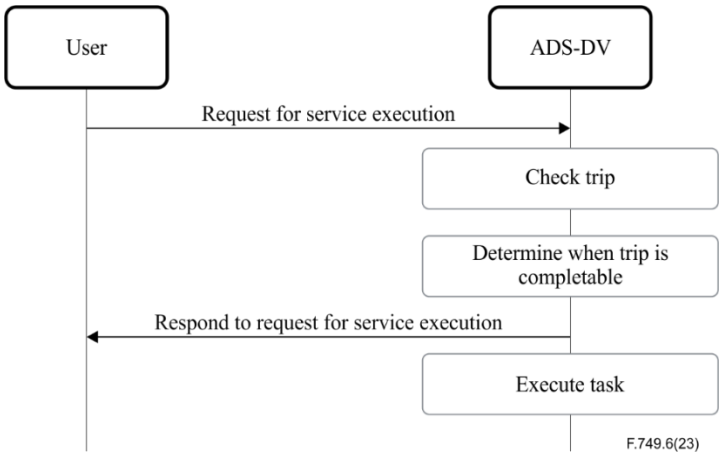

Figure 7-2 – User-owned ADS-DV – Execution

In Figure 7-3, under control of the ADS, the ADS-DV starts the trip according to the request for execution. The ADS-DV periodically updates $t_{ESTIMATE}$ and compares it with *t*. If $t_{ESTIMATE}$ does not exceed *t*, the ADS-DV continues the trip and periodically recalculates $t_{ESTIMATE}$. If $t_{ESTIMATE}$ exceeds *t*, ADS-DV changes the order of tasks and re-calculates $t_{ESTIMATE}$. After that, if $t_{ESTIMATE}$ does not exceed *t*, the ADS-DV continues the changed trip.

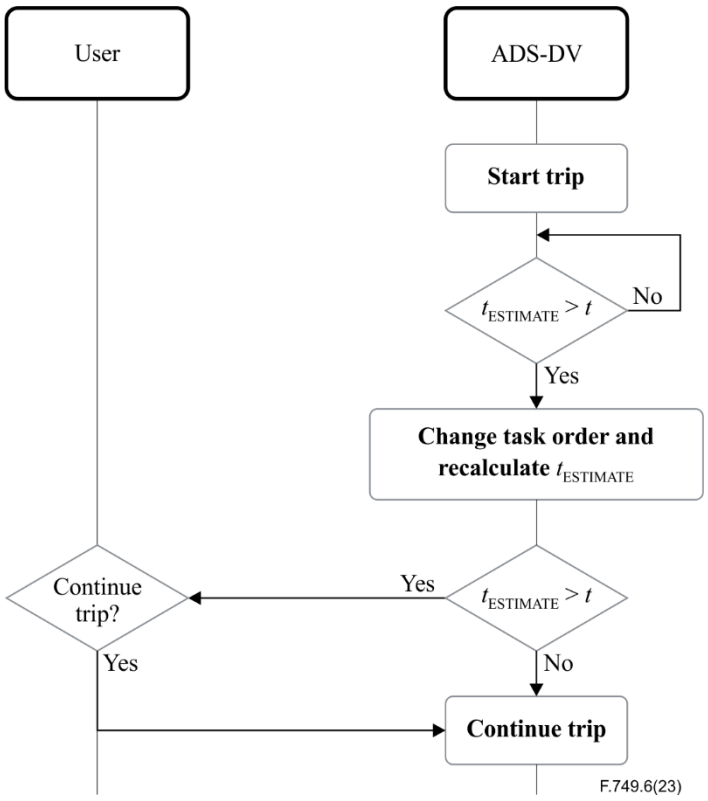

Figure 7-3 – User-owned ADS-DV – Update

If an ADS-DV cannot shorten $t_{ESTIMATE}$, it notifies the user of the estimated time of delay and requests whether to continue the trip. In this case, the user instructs the ADS-DV to continue or stop the trip and return. Alternatively, the user changes *t* or cancels tasks to continue the trip and finish on time before *t*.

As trips performed repeatedly, the difference, t_{Δ}, between the actual end time, t_{END}, and $t_{ESTIMATE}$, which is estimated at the beginning of the trip, is recursively fed back to the ADS-DV. In this way, future trips consider past data so that they can be completed before *t*. In this case, the trigger time, $t_{TRIGGER}$, is defined as a time that ensures ADS-DV successfully arrives at its final destination.

In Figure 7-4, the ADS-DV periodically checks its remaining energy (e.g., petrol or electricity) to determine whether an energy supply is necessary. The ADS-DV calculates energy consumption periodically until the trip is completed and determines whether it is necessary to replenish energy. If the trip has not yet started, theADS-DV adds a task to replenish energy for the upcoming trip. If the trip has already started, however, ADS-DV recalculates $t_{ESTIMATE}$, assuming the energy-replenishing task has been added to the trip. If the recalculated $t_{ESTIMATE}$ exceeds *t*, the ADS-DV notifies the user that an energy replenishment task is required to complete the trip. The user then instructs the ADS-DV to either continue by updating the trip or stop the trip.

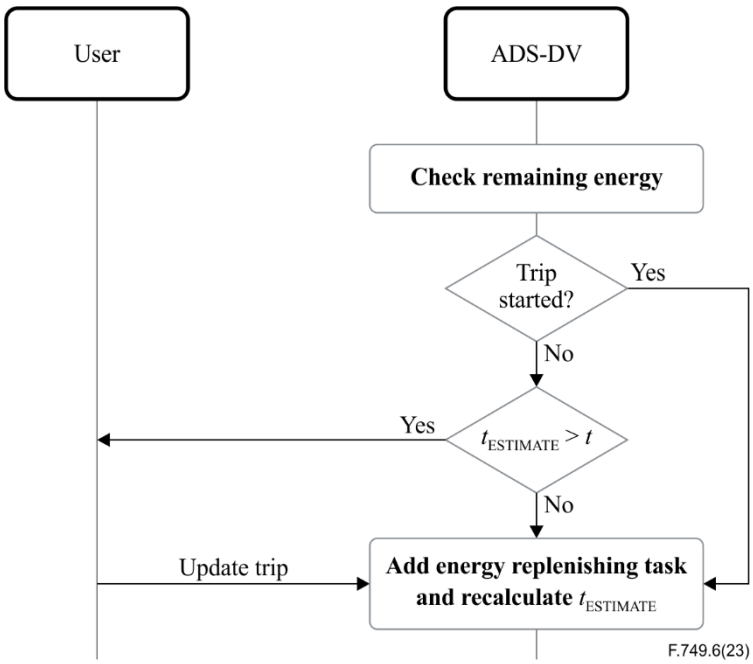

Figure 7-4 – User-owned ADS-DV – Energy replenishment

In Figure 7-5, the ADS-DV periodically diagnoses the state of the vehicle before the trip starts or when there are no upcoming trips to visit repair shops according to the diagnosis result. If maintenance is needed, the ADS-DV makes a reservation for the repair shop to perform maintenance. If needed, this task is added to the ongoing trip.

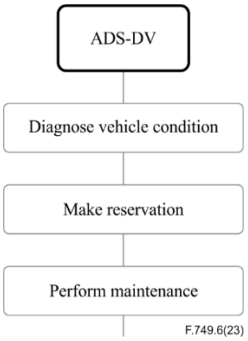

Figure 7-5 – User-owned ADS-DV – Maintenance

7.2 Service provider-owned ADS-DV

When a service provider owns an ADS-DV, the ADS-DV serves as robo-taxis or personal transportation services. A personal transport system needs to be built by a personal transportation service provider owning an ADS-DV.

The user calls the ADS-DV provided by a personal transportation service provider and requests transport to a particular destination. The terminal may provide a user interface to request a personal transportation service. The user interface may be a service request button or a search box, or may include a search box. Alternatively, the interface may include a device for recognizing the voice command of a user. In other words, the user may request a personal service from the transport system by voice command.

The user terminal may provide the user with a window (or a box or bar) to search for the ADS-DV, manage a favourite list of the ADS-DV for personal transport service, and display a result for the service request of the user.

The user may search for the ADS-DV through the search window based on various criteria, e.g., the name, size, type, characteristics, style, shape or colour of the vehicle. The user terminal may transmit search words to the personal transport system, receive a search result from it and display the result according to the request.

The search result provided by the personal transport system may be a list of ADS-DVs that can currently provide the service. The available ADS-DV list may be sequentially listed with matching accuracy against the criteria of users or may be listed in the order closest to their current or calling location. The list of available the ADS-DV may be displayed with matching accuracy or distance from the current or calling location.

The user may select at least one ADS-DV or the autonomous driving operating system (OS) among the search results displayed in the user terminal and add the selected ADS-DV or the autonomous driving OS of the ADS-DV to the favourite list in the user information database (DB). In addition, the user may delete the autonomous driving OS of the ADS-DV or the ADS-DV from the favourite list through the user terminal.

After the trip is terminated, the ADS-DV waits for the call while hovering around the areas where the next service call is likely to occur or moves to a dedicated garage for self-charging or vehicle inspection. In the case of DDT fallback, if necessary, the ADS state is transitioned to the remote control state by connecting to the service provider.

8 Requirements

This clause specifies requirements based on vehicle information for automated driving and the ownership of ADS-DV described in clauses 6 and 7, respectively. An ADS-DV comprises a processor, memory and a communication device, wherein the processor executes a program (method) stored in the memory to perform the following requirements listed in clauses 8.1 and 8.2.

8.1 Requirements of the ADS-DV

8.1.1 User-owned ADS-DV

Requirements for execution (Figure 7-2) follow.

– [Req8.1.1-1] It is required for an ADS-DV to start a trip by controlling the ego vehicle using vehicle perception information, vehicle map information and vehicle planning information, and vehicle controller information.

– [Req8.1.1-2] It is required for an ADS-DV to calculate the estimated end time, $t_{ESTIMATE}$, of the trip according to a predetermined update period using vehicle map information and vehicle planning information.

– [Req8.1.1-3] It is required for an ADS-DV to determine whether the trip is completed within target time, t, according to $t_{ESTIMATE}$, of the trip using vehicle map information and vehicle planning information.

– [Req8.1.1-4] It is required for an ADS-DV to receive a request for execution by the ADS-DV from the user.

– [Req8.1.1-5] It is required for an ADS-DV to determine whether the trip is completable according to the trip information and the current state of ADS-DV using vehicle map information and vehicle planning information.

– [Req8.1.1-6] It is required for an ADS-DV to respond to the request for execution according to whether the trip is completable.

– [Req8.1.1-7] It is recommended for an ADS-DV to include vehicle planning information in the request for service execution to have at least one task be performed by the ADS-DV.

– [Req8.1.1-8] It is recommended for an ADS-DV to include a task type for at least one task and a completion time of the tasks as trip information.

Requirements for updating (Figure 7-3) follow.

– [Req8.1.1-9] It is required for an ADS-DV to constantly control the ego vehicle during manoeuvres based on the trip using vehicle perception information, vehicle map information, vehicle planning information, and vehicle controller information.

– [Req8.1.1-10] It is required for an ADS-DV to change the execution order of tasks included in the trip when it is determined that the trip cannot be completed within target time, t.

– [Req8.1.1-11] It is required that an ADS-DV recalculate $t_{ESTIMATE}$, according to the changed execution order using vehicle map information and vehicle planning information.

– [Req8.1.1-12] It is required that an ADS-DV perform the trip according to the changed execution order when the recalculated $t_{ESTIMATE}$ does not exceed t.

– [Req8.1.1-13] It is required that an ADS-DV transmit a delay prediction notification of the trip to the user when the recalculated $t_{ESTIMATE}$ exceeds t.

– [Req8.1.1-14] It is required that an ADS-DV determine whether to continue the trip based on a selection of the user according to the delay prediction notification.

– [Req8.1.1-15] It is required that an ADS-DV start the trip by controlling the ego vehicle after it is determined that the trip is completable.

– [Req8.1.1-16] It is required that an ADS-DV calculate an expected completion time of the trip according to a predetermined update period using vehicle map information and vehicle planning information.

– [Req8.1.1-17] It is required that an ADS-DV determine whether the trip is completed within a target time according to the expected completion time of the trip and change the execution order of tasks included in the trip according to the determination result.

– [Req8.1.1-18] It is required that an ADS-DV change the sequence of tasks and re-calculate $t_{ESTIMATE}$ when $t_{ESTIMATE}$ exceeds t using vehicle map information and vehicle planning information.

– [Req8.1.1-19] It is required for an ADS-DV to notify the estimated time of delay to thw user if the ADS-DV cannot shorten the $t_{ESTIMATE}$ of the trip.

– [Req8.1.1-20] It is recommended for an ADS-DV to feed back the difference, t_{Δ}, between the actual end time, t_{END}, and $t_{ESTIMATE}$, which is estimated at the beginning of the trip, to ADS-DV as trips are repeatedly performed.

Requirements for energy replenishment (Figure 7-4) follow.

– [Req8.1.1-21] It is required for an ADS-DV to periodically check its remaining energy and whether further supply is required.

– [Req8.1.1-22] It is required for an ADS-DV to add an additional task to replenish energy for the upcoming trip if the trip has not yet started.

– [Req8.1.1-23] It is required for an ADS-DV to recalculate $t_{ESTIMATE}$ if the energy replenishment task is added when the trip has already started using vehicle map information and vehicle planning information.

– [Req8.1.1-24 It is required for an ADS-DV to notify the user that an energy replenishment task is required to complete the trip if the recalculated $t_{ESTIMATE}$ exceeds t.

– [Req8.1.1-25] It is recommended for an ADS-DV to calculate energy consumption periodically until the trip is completed.

Requirements for maintenance (Figure 7-5) follow.

– [Req8.1.1-26] It is required for an ADS-DV to periodically diagnose the state of the vehicle before the trip starts and when there are no upcoming trips using vehicle diagnosis information.

– [Req8.1.1-27] It is recommended for an ADS-DV to request the repair shop to perform maintenance if needed.

– [Req8.1.1-28] It is recommended for an ADS-DV to add an additional maintenance task to the ongoing trip if necessary.

8.1.2 Service provider-owned ADS-DV

A service provider owning an ADS-DV is required to provide a personal transport service. An ADS-DV includes a communication device, an object recognition device, a route search device and a driving control device. The ADS-DV requirements follow.

– [Req8.1.2-1] It is recommended for an ADS-DV that the communication interface transfer information received by the communication device to devices for object recognition, route search and driving control.

– [Req8.1.2-2] It is recommended for an ADS-DV that the communication interface transfer information generated from devices for object recognition, route search, and driving control to the communication device.

– [Req8.1.2-3] It is recommended for an ADS-DV that the communication device communicate between the ADS-DV and the personal transport system of the service provider.

– [Req8.1.2-4] It is recommended for an ADS-DV that the communication device communicate with other vehicles outside the ADS-DV, a mobile device of a passenger and objects on a road.

– [Req8.1.2-5] It is recommended for an ADS-DV that the communication device receive information from and transmits information to the outside using various communication standards (e.g., vehicle to everything), as well as cellular and local area mobile communication (e.g., wireless fidelity).

– [Req8.1.2-6] It is recommended for an ADS-DV that information received from and to be transmitted to the outside go through the communication interface in the ADS-DV.

– [Req8.1.2-7] It is recommended for an ADS-DV that the object recognition device check its current location through sensors (e.g., camera, RADAR, LIDAR, GNSS) installed in, identifies objects around, and predicts the motion of the objects around the ADS-DV using vehicle perception information.

– [Req8.1.2-8] It is recommended for an ADS-DV that the object recognition device determines whether the user is authenticated by the personal transport system by recognizing the face of the user approaching the ADS-DV when it is called.

– [Req8.1.2-9] It is recommended for an ADS-DV that users input their face information into the personal transport system and agree to the object recognition policy of the autonomous vehicle.

– [Req8.1.2-10] It is recommended for an ADS-DV that the route search device use vehicle map information of the operating area of the ADS-DV and various sensors (e.g., GNSS sensor) to wander around a predetermined area for users to board or to move to their calling location.

– [Req8.1.2-11] It is recommended for an ADS-DV that the route search device look for a route to a target location input by the user using the vehicle map information and the sensors, and transmit the route information to the driving control device using vehicle planning information.

– [Req8.1.2-12] It is recommended for an ADS-DV that the vehicle map information include maps of the occupancy grid, positioning and road details.
– [Req8.1.2-13] It is recommended for an ADS-DV that the occupancy grid map be used to identify dynamic objects and predict their motion or behaviour.
– [Req8.1.2-14] It is recommended for an ADS-DV that the positioning map be used to identify distances to nearby objects.
– [Req8.1.2-15] It is recommended for an ADS-DV that a detailed road map be used in a route search to a destination by the appropriate device.
– [Req8.1.2-16] It is recommended for an ADS-DV that the driving control device control the ADS-DV according to route information transmitted from the route search device using vehicle information from map readiong, planning and controller.
– [Req8.1.2-17] It is recommended for an ADS-DV that the control of the ADS-DV include longitudinal and lateral direction controls using vehicle controller information.
– [Req8.1.2-18] It is recommended for an ADS-DV that the driving control device control the ADS-DV according to a driving manner selected by the user using vehicle controller information.
– [Req8.1.2-19] It is recommended for an ADS-DV that the driving control device control the ADS-DV so that the user can feel the speed as quickly as possible within the traffic regulations of the road when the user inputs “sporty” as the driving manner using vehicle controller information.
– [Req8.1.2-20] It is recommended for an ADS-DV that the driving control device consider not only the route information to the destination, but also the instruction received from the personal transport system and adjust the driving speed, lane, etc. by identifying surrounding objects in real time using vehicle perception information.

8.2 Requirements of the service provider

The service provider requirements include the following.

– [Req8.2-1] It is required for the service provider to provide a personal transportation service comprising a processor, a memory and a communication device.
– [Req8.2-2] It is required for the processor to execute a program stored in the memory to receive a request for a personal transportation service using an ADS-DV from a user terminal.
– [Req8.2-3] It is required for the processor to execute a program stored in the memory to analyse a call pattern of the user for the ADS-DV.
– [Req8.2-4] It is required for the processor to execute a program stored in the memory to determine a recommended ADS-DV to provide the personal transportation service to the user based on the analysis result of the call pattern.
– [Req8.2-5] It is recommended for the processor to query a call history of the user and an idle ADS-DV around a call location of the user and analyse the call pattern based on the call history and the idle ADS-DV when the processor analyses a call pattern of the user for the ADS-DV.
– [Req8.2-6] It is recommended for the processor to query a favourite list of the user for the ADS-DV when the processor analyses a call pattern of the user for the ADS-DV, where the favourite list includes an ADS-DV or an autonomous driving OS for the ADS-DV preferred by the user.
– [Req8.2-7] It is recommended for the processor to analyse the call pattern based on the favourite list, the call history, and the idle ADS-DV around the call location when the processor analyses the call pattern based on the call history and the idle ADS-DV around the call location.

– [Req8.2-8] It is recommended for the processor to receive a search request for an ADS-DV from the user terminal when the processor receives a request for a personal transportation service using an ADS-DV from a user terminal, where the search request includes at least one of the following items: a name; a size; a type; characteristics; a style; a shape; and a colour of the ADS-DV.

– [Req8.2-9] It is recommended for the processor to execute the program to further transmit at least one available ADS-DV to the user terminal in response to the search request, where at least one available ADS-DV is listed in an order of matching accuracy for search criteria of the user or in an order close to the current or calling location of the user.

– [Req8.2-10] It is recommended for the processor to execute the program to further determine a waiting route for each ADS-DV based on the analysis result of the call pattern.

– [Req8.2-11] It is recommended for the processor to execute the program to further receive a request for the waiting route from an idle ADS-DV without a passenger and within which no call has been received, and transmit the waiting route determined by the analysis result of the call pattern to the idle ADS-DV.

– [Req8.2-12] It is recommended for the recommended ADS-DV to include an idle vehicle with no passengers or a scheduled idle vehicle from which a passenger is about to disembark.

– [Req8.2-13] It is recommended that a user interface be provided to request a personal transportation service. The user interface may be a service request button or a search box. Alternatively, the user interface may include a device for recognizing the user's command. In other words, the user may request a personal transportation service from the personal transport system by voice command.

– [Req8.2-14] It is recommended that the user be provided with a window (or box or bar) to search for the ADS-DV, manage a favourite list of the ADS-DV for the personal transportation service, and display a result for the service request of the user.

The service provider manages a vehicle information DB, a user information DB, a call pattern analysis device and a control device. The related requirements include the following.

– [Req8.2-15] It is recommended that vehicle information about the ADS-DV be stored in the vehicle information DB of a service system such as a personal transport system.

– [Req8.2-16] It is recommended that the vehicle information include a vehicle registration number, a VIN or a vehicle serial number.

– [Req8.2-17] It is recommended that the vehicle information include information to be used during autonomous driving (self-driving-related information), where the self-driving-related information may include object recognition information, map information, driving route information, vehicle control information and vehicle diagnosis information.

– [Req8.2-18] It is recommended that the vehicle information include whether the passenger is in the vehicle and vehicle reservation information.

– [Req8.2-19] It is recommended that the VIN be an identifier (ID) uniquely assigned to each ADS-DV, such as a chassis number, and is used for mapping with the user information DB.

– [Req8.2-20] It is recommended that self-driving-related information, which is determined to be necessary for safe autonomous driving (e.g., vehicle diagnosis information), be periodically uploaded to the personal transport system.

– [Req8.2-21] It is recommended that driving route information be periodically uploaded to the personal transport system.

– [Req8.2-22] It is recommended that object recognition information inside or outside the vehicle be periodically uploaded to verify users riding in the ADS-DV to the personal transport system.

– [Req8.2-23] It is recommended that driver information of the ADS-DV in the vehicle information DB, where the driver information of the ADS-DV may include accident history and driving tendency (safety or speed priority, etc.), be stored.

– [Req8.2-24] It is recommended that information necessary for the personal transport system be stored in the user information DB to manage users of the personal transportation service, where the user information DB may include an ID, a personal identification number, and personal information (phone number, e-mail address, etc.).

– [Req8.2-25] It is recommended that a favourite list of the user be stored in the user information DB.

– [Req8.2-26] It is recommended that the user manage the autonomous driving OS of the ADS-DV or the ADS-DV in the favourite list through the user terminal.

– [Req8.2-27] It is recommended that the user input a preferred ADS-DV or preferred autonomous driving OS to the user information DB and manage the ADS-DV of a predetermined number or less as the favourite list.

– [Req8.2-28] It is recommended that the personal transportation service provider supply the service based on the favourite list of the user.

– [Req8.2-29] It is recommended that users add their preferred ADS-DV or add a specific type of ADS-DV to their favourites list.

– [Req8.2-30] It is recommended that a call history of the ADS-DV or usage history of the personal transportation service be stored in the user information DB, where the call history of a user may include an OS, a size (light car, small, semi-medium, medium, semi-large, large, etc.), a type (sedan, sports utility vehicle, wagon, hatchback, etc.), a name (model name, etc.) and manufacturers.

– [Req8.2-31] It is recommended that the call pattern analysis device analyse a call pattern of the user by using machine learning technology (e.g., deep learning) based on the favourite list and the call history in the user information DB.

– [Req8.2-32] It is recommended that the call pattern analysis device be installed on a server in which the personal transport system operates, not the ADS-DV, since the object recognition device of the ADS-DV can identify a user using deep learning.

– [Req8.2-33] It is recommended that the call pattern analysed by the call pattern analysis device to the control device, where the control device may determine waiting routes (or waiting location, mooring area) of the individual ADS-DV based on a plurality of call patterns, be transmitted.

– [Req8.2-34] It is recommended that the control device manage the locations and routes of the ADS-DV in the personal transport system based on real-time traffic information collected from the ADS-DVs and may determine the waiting route of each ADS-DV based on the calling pattern of the plurality of call pattern of the users.

– [Req8.2-35] It is recommended that the control device recommend the ADS-DV to the corresponding user using the calling pattern of the specific user determined by the calling pattern analysing device, information in the vehicle information DB, and information about the corresponding user in the user information DB.

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