TECHNICAL REPORT

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Intelligent transport systems — Use cases for sharing of probe data

Systèmes de transport intelligents — Cas d'usages pour le partage des données de sondage

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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).

Attention is drawn to the possibility that some of the elements of this document may be the subject of patent rights. ISO shall not be held responsible for identifying any or all such patent rights. Details of any patent rights identified during the development of the document will be in the Introduction and/or on the ISO list of patent declarations received (see www.iso.org/patents).

Any trade name used in this document is information given for the convenience of users and does not constitute an endorsement.

For an explanation of the voluntary nature of standards, the meaning of ISO specific terms and expressions related to conformity assessment, as well as information about ISO's adherence to the World Trade Organization (WTO) principles in the Technical Barriers to Trade (TBT), see www.iso.org/iso/foreword.html.

This document was prepared by Technical Committee ISO/TC 204, *Intelligent transport systems.*

Any feedback or questions on this document should be directed to the user's national standards body. A complete listing of these bodies can be found at www.iso.org/members.html.

Introduction

When discussing transportation systems, much attention has been paid to safety, comfort, impacts on the environment and energy efficiency. The use of probe data (specified in ISO 22837) is a key factor in dealing with the above issues.

Probe vehicle data are collected through various vehicles in an ITS system, but the data are typically used only for a specific application by the service provider. To boost efficiency, it is recommended that the vehicle probe data be shared by various service applications through common databases.

Current probe vehicle systems collect and use data, but do not share data with other ITS service applications. Vehicle probe data are valuable for all related services and limiting the use of such data to within one service only ought to be avoided for efficient data use. Sharing probe data among service providers enhances quality of service, as the probe data collected through the sensors and other sources can be utilized by other service providers.

As an example, shared common database can be used for new services, such as an advanced notification safety information provision service, by utilizing roadside sensor data collected by a road authority. Many other new services can be added as the number of CAV (connected and automated vehicle) increases.

This document describes probe data sharing use cases so that additional service can be developed by sharing probe data collected by various probe vehicle systems.

The functionalities of a probe vehicle system (PVS) can be implemented in an ITS station unit according to ISO 21217 and support application protocols specified in other standards. Examples of such protocols are the local dynamic map (LDM) specified in ISO/TS 18750, and generic ITS station facilities layer services specified in ISO/TS 17429. The service architecture classifies ITS services including PVS, and this classification also defines service domains for cooperation between PVSs.

It is noted that this document does not prescribe a physical communication medium for transmitting data/information to or from vehicles. This document is intended to be independent of any communication medium and to be compatible with any medium that is selected by the system developers.

In addition, this document focuses only on the framework for vehicle probe data sharing use cases.

Intelligent transport systems — Use cases for sharing of probe data

1 Scope

This document describes various use cases for the sharing of probe vehicle data as a common platform for smart city instantiation. When modernizing a city towards a smart city, it is necessary for information flows across various fields, such as transportation, healthcare, energy, water and other government services, to be effectively managed and shared. Despite efforts from many cities, integrating all databases related to all services has proven to be a cumbersome task. One challenge is the lack of a systematic way that can be modelled for data sharing. The ITS data sharing model for vehicle probe data can serve as the basis for instigating this type of work. To elaborate how vehicle probe data work can be applied to achieve this objective, this document:

— gathers use cases and examples of vehicle probe data sharing around the world, and

— provides use cases for data sharing that are appropriate for smart city ITS mobility solutions.

By examining these use cases and current and planned data sharing practices around the world, this document demonstrates how this mechanism can help implement many smart city applications.

This document also shows that by combining the vehicle probe data with roadside sensor data, and other important public and private data sources, the services can be operated more effectively.

Data collection methods and data or information provisioning are beyond the scope this document. Specifically, this document does not describe items related to the vehicle probe data collection nor the vehicle probe data provision activities as specified by other existing standards such as ISO 19414.

2 Normative references

The following documents are referred to in the text in such a way that some or all of their content constitutes requirements of this document. For dated references, only the edition cited applies. For undated references, the latest edition of the referenced document (including any amendments) applies.

ISO 14812:—[1]), *Intelligent transport systems — Vocabulary*

ISO 19414, *Intelligent transport systems — Service architecture of probe vehicle systems*

ISO 22837, *Vehicle probe data for wide area communications*

ISO 24100, *Intelligent transport systems — Basic principles for personal data protection in probe vehicle information services*

3 Terms and definitions

For the purposes of this document, the terms and definitions given in ISO 14812, ISO 19414, ISO 22837, ISO 24100 and the following 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 http://www.electropedia.org/

1) Under preparation. Stage at the time of publication: ISO/DTS 14812:2021.

3.1
data sharing
activity between two or more service providers where the data can be combined and processed to create data for new application services

4 Use cases for the probe vehicle systems data sharing framework

4.1 The conceptual framework for vehicle probe system data sharing

Various probe data systems are deployed and successfully operated by service providers independently. However, most likely, the vehicle probe data collected by one ITS systems can only be used for a specific application by the service provider and are not shared among other applications. In exploiting applications and services for a smart city, such data cannot be used effectively, for the purpose of solving smart city mobility issues, for example. Part of the issue is that the service providers often work in their own specific application silos and fail to see the value of data sharing from a holistic viewpoint.

It is recommended that the vehicle probe data be shared among stakeholders; this sharing could support various potential fields of services for smart city service applications via a common database. Ideally, all the data in each application supporting a smart city ought to be exchanged through all fields of services with a common format. However, this is not feasible as most of the vehicle probe data systems in place are deployed at different times and provided by different vendors. In the case of the probe vehicle system, for example, aside from the data gathered from certain applications or services which do follow a set of standards, most of the data collected requires transformation or conversion to ensure data interoperability. From a data access efficiency viewpoint, the best place to implement these data conversions is at the common database.

Although data interoperability is essential when adopting the common database for probe data, data ownership and privacy protection need to be taken into consideration as high priority issues. Probe data might need to be gathered from sources applying proprietary means. Some service providers can consider that such data bear much value and can be reluctant to grant the access to those data freely. Furthermore, some probe data can be associated with an individual and needs to be specially protected according to personal privacy protection regulations.

This document describes useful use cases for sharing vehicle probe data and provides useful examples currently used and planned around the world. This document provides role model descriptions of data sharing only, and does not cover data collection, nor data provision.

The conceptual framework of the vehicle probe system, as shown in Figure 1 below, depicts the relations among stakeholders, such as a service provider, vehicles including connected and automated vehicles (CAV), roadside systems and the roadside operation authorities. The key is to have a common database so that all the service data, regardless of their origins can be fed and stored in the common database. Since the implementation of such a framework for probe data systems can vary, the framework depicted in Figure 1 is for reference only and cannot include all the stakeholders and outlines of their roles.

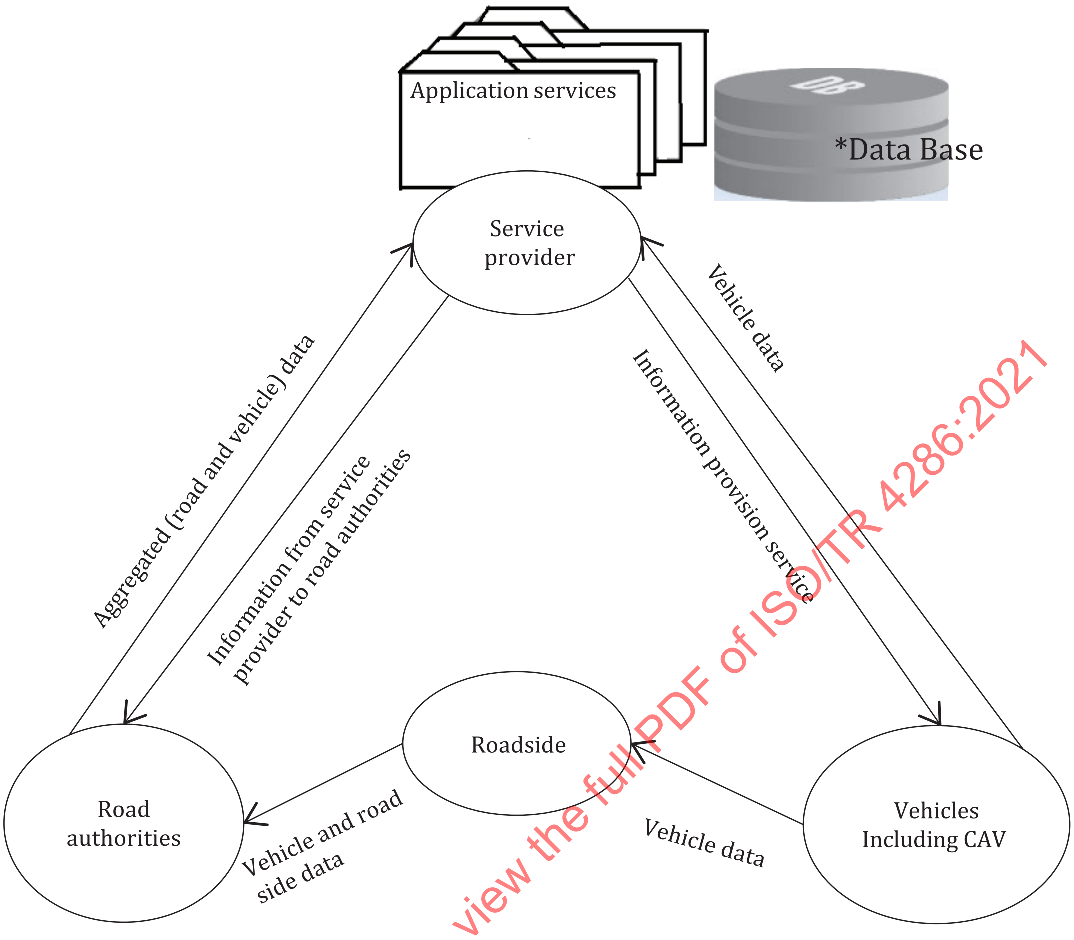
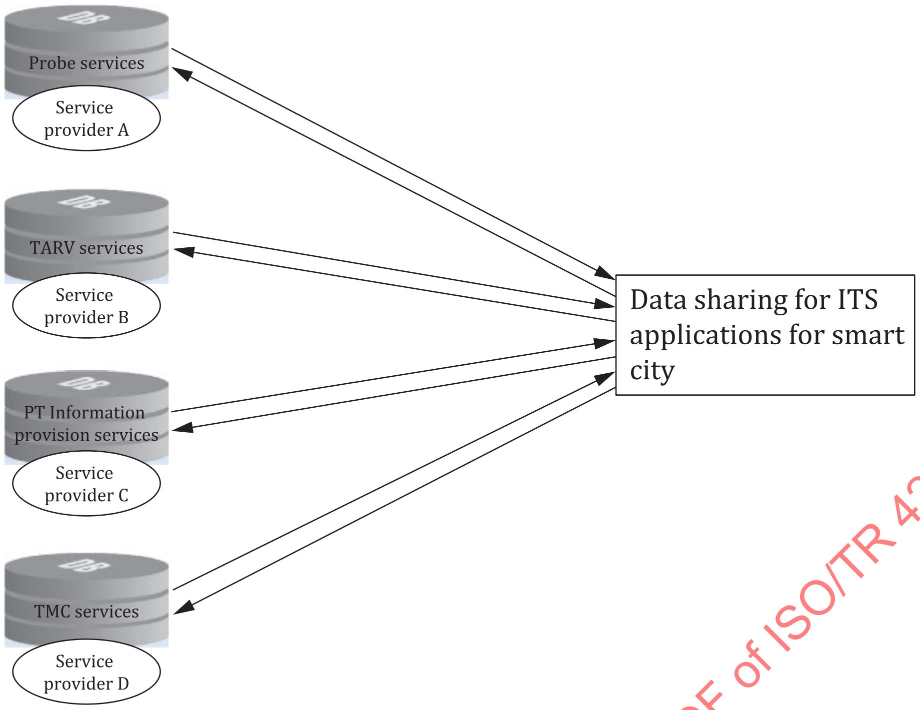


Figure 1 — Reference vehicle probe system framework

As shown in Figure 1, the service provider, through the pre-provision process, requests vehicle data from a vehicle and the vehicle provides vehicle data to the service provider accordingly. The service provider stores data into the database and executes application services with the support of the database, and the processed information of those services are provided back to the vehicle. Likewise, the service provider can exchange information with road authorities. In some cases, the service provider can collect probe data from the vehicle through a road authority. In such a case, the vehicle data are collected by roadside sensors and passed to the road authority. Data collected through other roadside sensors can also be collected by the road authority. The road authority can then aggregate those data and send them to the service provider. In return, the service provider can provide the processed valuable information to the road authority.

4.2 Concept of data sharing of vehicle probe data

Although a common database can help the service provider improve its operational efficiency in its service realm, the real benefit to a probe vehicle system can be further amplified only if multiple probe databases in the probe vehicle system are also shared. Figure 2 provides a conceptual view of how multiple databases are shared in a probe vehicle system. The databases shown on the left are the ones associated with each service provider, such as probe service and other services.



NOTE 1 Service provider A database has vehicle probe data as per ISO 19414.

NOTE 2 Service provider B database has vehicle probe data from commercial vehicle of TARV as per ISO 15638.

NOTE 3 Service provider C database has public transport data as per ISO 17185.

NOTE 4 Service provider D database has traffic management centre data as per ISO/TS 19468.

Figure 2 — The conceptual view of data sharing in a vehicle probe system

The data from TMC (traffic management centre) in Figure 2 includes examples of currently available road authority's traffic data.

Sharing probe data among current service providers and additional service providers enables the creation and realization of additional new application services.

ISO/TS 21177 and ISO/TS 21184 cover secured access to sensor and control networks of ITS stations in general. A standardized data format based on standardized data types is specified to enable data exchange between ITS stations and ITS applications. Secure certificate-based Access Control is specified in ISO/TS 21177, combined with ISO/TS 21184 using configuration data. Required data models are specified in ISO/TS 21184.

4.3 Probe data sharing benefits

4.3.1 Introduction

The observations detailed in the following subclauses can be derived through probe data sharing.

4.3.2 Benefits of data sharing

Through the shared common database, where maintenance service is maintained as an advanced service and various functions including the Internet connection can be used, the opportunity to use the data sharing function has become a common use case for smart city solutions. The merit of this data sharing function can be summarized into the following two points:

a) Easy exchange of data — Data can be converted into common data format and exchanged quickly and reliably without going through the store and distribute processes. In addition, it is possible to apply various security settings, such as setting access rights for the users for each data element, which can enhance data security.

b) Simple management of data — As data can be managed centrally, data management is simplified. In addition, there can be minimum time lag while updating the data.

4.3.3 Model of data sharing function

To use the data sharing function among service providers, it is required to set up users and user groups according to the role of the users and the controlled accessible data.

As shown in Figure 3, users often have multiple roles, and consideration needs to be given to the grouping method and security setting.

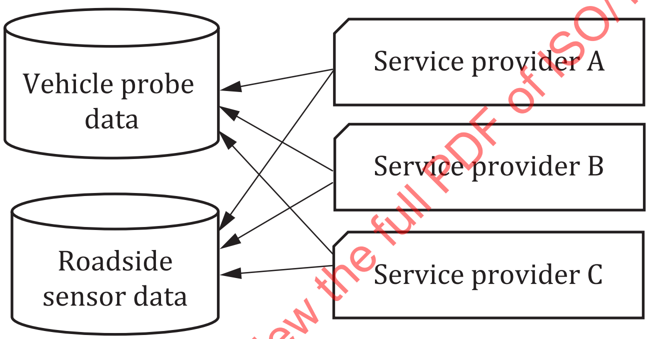


Figure 3 — Multiple roles of users (service providers)

4.3.4 Standards

Existing probe data standards and sharing policy standards already defined by the local authority can be utilized.

4.3.5 Applicability of data distribution technologies

ISO/TR 23255 can be used as reference document.

4.3.6 Metadata

Metadata sharing policies already defined by the local authority can be utilized.

4.3.7 Storage and access

General storage and access to shared data integration already defined by the local authority can be utilized.

4.3.8 Data ownership and IPR

Clear guidelines already defined by the local authority can be utilized for identifying data ownership and licencing, including IPR, of probe data, supporting data and processing tools.

4.3.9 Challenges

There are several challenges which need to be analysed and solved when deploying probe data sharing among multiple service provider entities:

— It is important to define the rules regarding data storage to respect data privacy.

— The entity in charge of maintaining and processing the collected probe vehicle data and its liability need to be defined.

— The governance rules for such an entity need to be defined.

— Decision-making on the policy needs to be done, whether it is a centralized entity framework or a cloud framework that can be completed through multiple decentralized entities.

5 Definition of service domains utilizing shared probe data

5.1 General

Sharing of probe vehicle data among current service providers and additional service providers can support the implementation of new service applications needed for smart city services. For example, data sharing could eventually be implemented to satisfy infrastructure assessment needs and to improve safety within cities.

Possible service applications can include:

— critical safety information provision,

— safety driving support,

— infrastructure planning,

— dynamic traffic management,

— traffic rule enforcement,

— dynamic map updates, and

— emergency evacuation support.

Where applicable, probe data sharing definitions already defined by the local authority can be utilized.

For deployment, further research or development of data sharing is recommended.

5.2 Referenced target use cases

5.2.1 General

ITS service applications largely rely upon the big data collected through the applications and services of a smart city that are held and maintained by a smart city data management entity. Those ITS services can be grouped into two categories: the services provided by jurisdiction or the road operator; and the services by the public and private service providers. The applications offered and managed by the jurisdiction or the road operator can be classified in four groups as “infrastructure operation management”, “traffic management”, “road traffic operation management” and “enforcement”. The applications provided by the service providers can be offered through public or private sectors. The classification of an ITS service and applications can be shown in Figure 4.

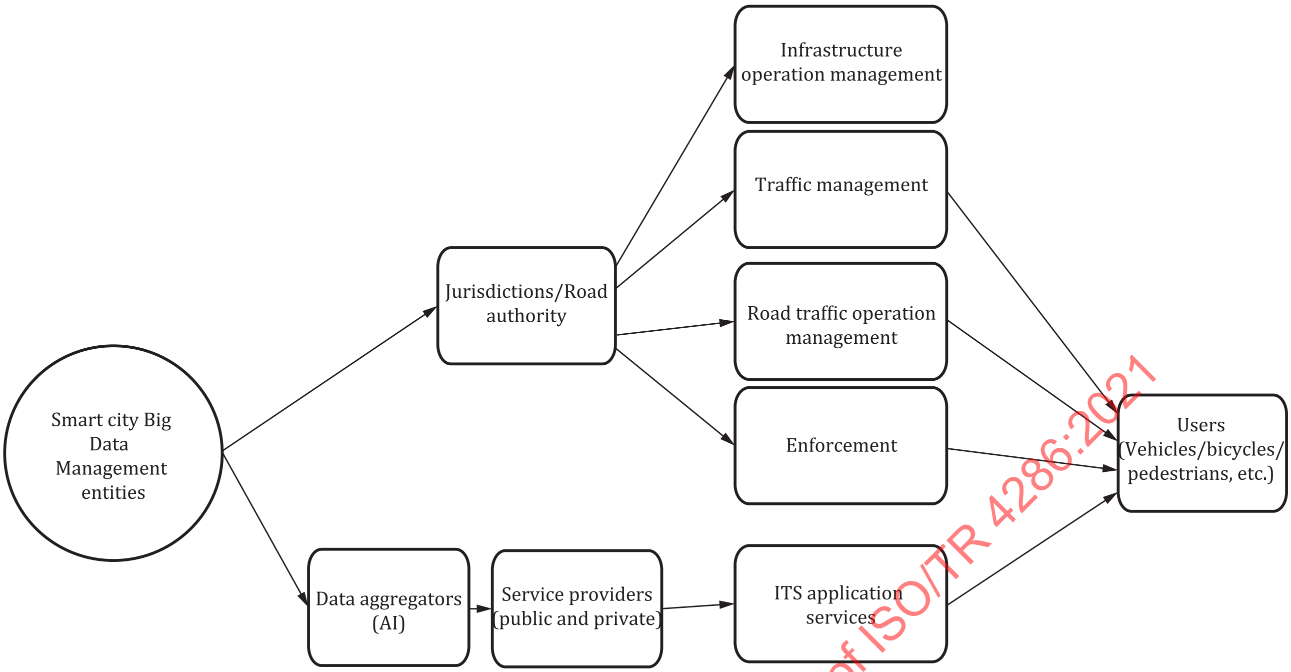


Figure 4 — Classification of smart city ITS service and its applications

Numerous emerging ITS service applications for smart city deployment have been growing rapidly in recent years. The following list provides examples of those applications:

— Traffic management applications to ease traffic congestion and maintain safety in urban areas

— Road traffic operation applications to realize efficient and safer use of infrastructure

— EFC support for Urban-ITS traffic management to realize dynamic road pricing

— Weigh in motion to ease heavy goods transport vehicles

— Dangerous goods/hazardous materials transport management to enforce geo-fencing

— Disaster information provisioning systems for safer and more timely evacuation activities

— Infrastructure services applications for efficient and automated maintenance works

— Access control in urban areas to control vehicle entry to certain areas

— Traffic signal (SPaT-MAP): signal phase and timing, and road topology message information provisioning for safer and more efficient traffic flow in the urban area

— Law enforcement applications for regulated freight vehicles such as overloaded vehicle shutout from certain urban areas

— Remote digital tachograph monitoring to maintain safe freight transport vehicle movement

— Heavy vehicle air quality controls and geo-fencing in certain urban areas

— Emission control of vehicles entering certain urban areas to enforce geo-fencing in certain areas of the smart city

— Autonomous vehicle applications such as monitoring, emergency controls, override command, regulated information provisioning

— Urban/suburban/expressways mobility modes-specific safety information provisioning and traffic monitoring

— Dynamic map management including probe data collection, data aggregation, managing digital twin in the cloud and provisioning of safety information

— Electronic fee collection from services such as parking, event admission, car sharing

— Vehicle remote maintenance applications such as over the air software updates

— Freight vehicle management applications supporting efficient and safer transport fleet operations

— Electric vehicle charging applications such as booking, monitoring and fee collections with security management

— Fuel cell vehicle charging applications like those previously mentioned

— Intelligent parking such as an automated valet parking supporting system

— Car sharing management including booking, matchmaking between user and driver, safety information provisioning

— Public transit information provisioning to users on timely and dynamic real time basis

— Taxi fleet management applications such as booking, matchmaking between users and drivers, safety information provisioning

— Dynamic map-utilizing service applications for automated driving buses, shuttles and freight vehicles for efficient and safer operations

— Tourist information/advice provisioning service applications for inbound users

— Bicycle/motor cyclists' ITS service applications such as vulnerable road user safety information provision services

Major use cases and business cases for smart city ITS service applications, currently available and future ones are shown here for information only. The example uses cases shown in this document are each referenced with a URL link information; however, there is no intention to promote those use cases as a standard but for references only. Further applications can be expected to be developed in the future depends on how the smart city ITS regulators can implement their initiative with the local government.

The example use cases are grouped according to the classifications shown in Figure 4.

5.2.2 Infrastructure operation management

The use cases that fall into the "Infrastructure operation management" category shown in Figure 5 are infrastructure service applications focusing on service vehicle operational efficiency and automated maintenance.

NOTE Infrastructure operation management services applications are effective for efficient and automated maintenance works. Examples can be found at: https://www.e-nexco.co.jp/en/activity/safety/.

Figure 5 — Infrastructure operation management use case

In this case, road maintenance service vehicles operations, such as a snowplough dispatching operation, become safer and more efficient with proper monitoring and controlling from adding back-office management.

5.2.3 Traffic Management

The "traffic management" use case (see Figure 6) can be applied to all vehicles, freight vehicles, and automated vehicles.

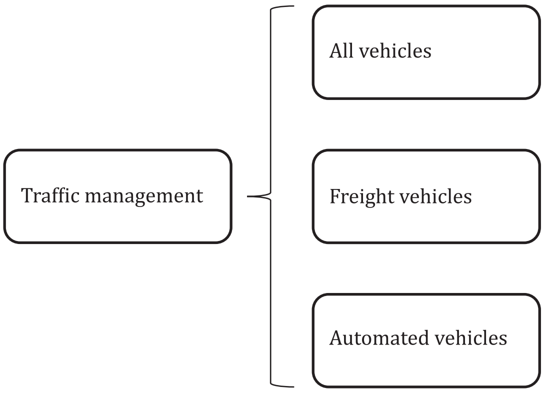


Figure 6 — Traffic management use cases

For all vehicles, traffic management applications to ease traffic congestions and maintain safety in urban area are effective.

For automated vehicles, automated driving vehicle support applications such as monitoring, emergency control, override command and regulated information provisioning are effective.

EFC support for Urban-ITS traffic management is effective for realizing dynamic road pricing.

The examples include:

1) Traffic management applications to ease traffic congestion and maintain safety in urban areas, in which the smart city ITS traffic centre monitors traffic conditions and controls both signals and road signs to ease traffic congestion.

2) EFC support for smart city ITS traffic management to realize dynamic road pricing, in which the smart city traffic centre controls traffic by changing toll fees dynamically to divert traffic flows to other road networks. In such cases, the traffic centre also provide feedback to toll operators to adjust toll fees to maintain the quality of service (QoS) of the toll road operations.

   An example can be found at: https://www.e-nexco.co.jp/en/activity/safety/.

3) Autonomous vehicle support applications, which monitor road conditions, assist emergency control, respond to override command and update regulated information provisioning. In such an example, the automated driving vehicle relies mainly on its own sensor data, but the safety level can be increased with support from the infrastructure.

   Example can be found at: https://medium.com/davnetwork/an-open-network-of-autonomous-vehicles-could-solve-the-last-mile-problem-cda15f6a09d5.

5.2.4 Road traffic management

The road traffic operation management use case is shown in Figure 7. The road traffic operation applications improve the efficiency and make it safer to use the infrastructure by allowing the road authority to control the traffic volume of the road, especially on the expressways.

Figure 7 — Road traffic operation management use case

Road traffic operation management applications are effective for realizing efficient and safer use of infrastructure.

They are normally implemented through controlling the volume of the vehicles entering the road with ramp metering.

An example can be found at: https://www.e-nexco.co.jp/en/activity/safety/.

5.2.5 Enforcement

Enforcement is a broad subject for smart city ITS. This subject can be further divided into two categories: enforcement for all vehicles and enforcement for freight vehicles as shown in Figure 8.

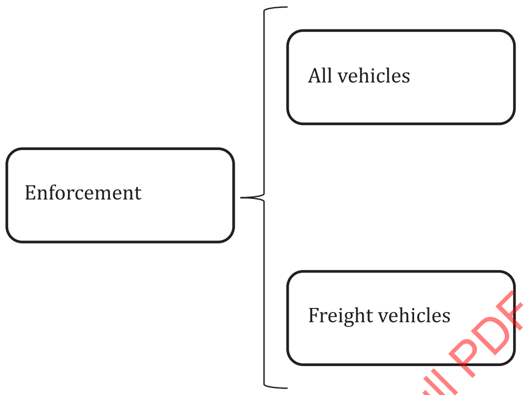


Figure 8 — Enforcement use cases

For all vehicles, access control in urban areas to enforce vehicle entry to certain areas is effective.

For freight vehicles, weigh in motion (WIM) to ease heavy goods transport vehicles, dangerous goods/hazardous materials transport management to enforce geo-fencing and law enforcement applications for regulated freight vehicles such as overloaded vehicle shutout from urban areas are effective.

Applications such as remote digital tachograph monitoring to maintain safe freight transport vehicle movement, heavy vehicle air quality controls and geo-fencing in urban areas and emission control of vehicles entering urban areas to enforce geo-fencing in certain areas of the city are also effective.

The use cases include:

1) Access control in urban areas to control vehicle entry to certain areas, in which the smart city ITS enforcement controls the traffic volume by controlling the access of each vehicle to the city centre.

   An example can be found at: https://constructionreviewonline.com/2014/12/vehicle-access-security-systems/.

2) Emission control of vehicles entering urban areas by enforcing geo-fencing in restricted areas of the city, in which the smart city ITS enforcement centre monitors and controls the traffic volume to keep the air clean near the city centre.

   An example can be found at: https://news.mit.edu/2019/lightweight-vehicle-electric-emissions-0826.

3) Weigh in motion to ease heavy goods transport vehicles, in which the smart city ITS enforcement agency monitors or detects overloaded vehicles to keep road traffic safe.

   An example can be found at: https://www.q-free.com/products/high-speed-low-speed-weigh-in-motion/.

4) Dangerous goods or hazardous materials transport management to enforce geo-fencing, in which the smart city ITS enforcement agency monitors and controls the vehicles carrying dangerous goods or hazardous cargos and keeps those vehicles from entering city centre for safety reasons. Furthermore, by monitoring those vehicles, the first responders can be despatched timely to the accident site in case of emergency.

   An example can be found at: https://aittraining.com.au/event/licence-to-transport-dangerous-goods-by-road-tlilic0001-6/.

5) Law enforcement applications for regulated freight vehicles such as overloaded vehicle shutout from smart city ITS area, in which the smart city ITS enforcement agency monitors or controls the speed, size and load of the vehicle to keep the road traffic safe.

   An example can be found at: http://www.vanjee.net/news_detail/newsId=436.html.

6) Remote digital tachograph monitoring to maintain safe freight transport vehicles movement, in which the smart city ITS enforcement agency monitors or controls the commercial vehicle and ensures the operator of the vehicle conforms with the regulations and laws, such as maintaining minimum resting time, to keep the road traffic safe.

   An example can be found at:

   https://www.aplicom.com/services/remote-download-of-digital-tachograph-data/.

7) Heavy vehicle air quality controls and geo-fencing in smart city areas, in which the smart city ITS enforcement agency monitors or controls the emission of the monitored heavy vehicle to keep high-polluting vehicles out of the city.

   An example can be found at:

   https://www.researchgate.net/institution/Sterlitech_Corporation/post/5b3e8d8035e5381f432c43ed_Monitoring_PM25_for_Air_Quality_Control.

5.2.6 The role of service providers

The role of service providers, public or private, can be examined in the four categories as shown in Figure 9.

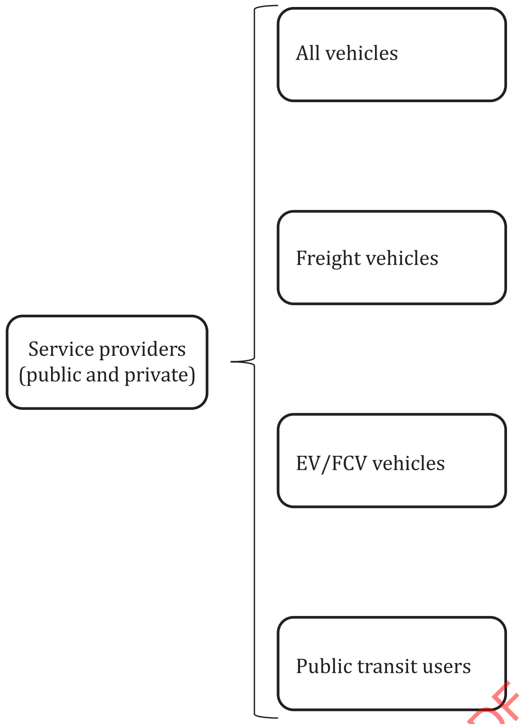


Figure 9 — The role of service providers

For all vehicles, the following applications are effective:

— disaster information provisioning systems for safer and more timely evacuation activities,

— traffic signal (SPaT-MAP): signal phase and timing and road topology messages information provision for safer and more efficient traffic flow in urban areas,

— urban/suburban/expressways mobility modes-specific safety information provisioning and traffic monitoring,

— dynamic map management, including probe data collection, data aggregation, managing digital twin in the cloud and provisioning safety in formation provisioning to the vehicles,

— electronic fee collection from services such as parking, event admission, car sharing, vehicle remote maintenance applications such as over the air soft updating, intelligent parking such as automatic valet parking supporting systems,

— car sharing management including booking, fee collection, battery monitoring and maintenance,

— dynamic map-utilizing service applications for automated driving bus, shuttle and freight vehicles for efficient and safer operation.

For freight vehicles, freight vehicle management applications supporting efficient and safe transport fleet operation is effective.

For EV/FCV vehicles, electric vehicle charging applications such as booking, monitoring, fee collection and security, and fuel cell vehicle charging applications similar to EV are effective.

For public transit users the following applications are effective:

— public transit information provisioning to users on a timely and dynamic real time basis,

— taxi fleet management applications such as booking, matching between user and driver, and safety information provisioning,

— tourist information/advice provisioning service applications for inbound users,

— bicycle/motor cyclists' ITS service applications, such as vulnerable road user safety information provisioning services.

The examples used to examine the role of the service providers are as follows:

1) Disaster information provisioning systems for safer and more timely evacuation activities: the service provider offers information needed to the vehicle in case of emergency and instructions for the vehicle to evacuate from the disaster area.

   An example can be found at:

   https://www.e-nexco.co.jp/en/activity/safety/.

2) Traffic signal (SPaT-MAP): the signal phase and timing and road topology messages information provision for safer and more efficient traffic flow in smart city ITS areas: the service provider offers traffic signal timing information to the vehicles to help maintain the vehicle emission level low and to assist a safe driving behaviour for the driver.

   An example can be found at:

   https://www.iotone.com/term/signal-phase-and-timing-spat/t438.

3) Urban/suburban/expressways mobility modes-specific safety information provisioning and traffic monitoring: the service provider offers mobility-specific safety information to each vehicle and monitors vehicle behaviour to keep the city centre safe.

   An example can be found at:

   https://www.meti.go.jp/meti_lib/report/2015fy/000326.pdf.

4) Dynamic map management including probe data collection, data aggregation, managing digital twin in the cloud and provisioning safety in formation provisioning to the vehicles: the service provider collects vehicle probe data, updates the dynamic map at the centre and monitors traffic on the digitally structured infrastructure platform (also called the “digital twin” or the “twin of real traffic”) so that the service provider can provided specific safety information to each vehicle in a timely manner.

   An example can be found at:

   https://itsforum.gr.jp/Public/E3Schedule/p31/Cellular_system_E201906.pdf.

5) Electronic fee collection from services such as parking, event admission, and car sharing: the service provider monitors vehicles entering the parking facility, event facility, or a car sharing facility (can be road curb side) and collects fees from the users of those services.

   An example can be found at:

   https://vietnamnews.vn/society/421719/caav-proposes-to-halt-airport-fee-collection-for-cars.html.

6) Vehicle remote maintenance applications such as over the air software updating: the service provider provides remote maintenance services to the vehicle users by performing software updates when the vehicle is idle.

   An example can be found at:

   https://link.springer.com/chapter/10.1007/978-3-319-66972-4_12.

7) Intelligent parking such as automatic valet parking supporting systems: the service provider provides automated valet parking services by monitoring and controlling each vehicle parked

inside or in a nearby area to the parking facility. Verifying user rights and payment process are included in the service.

An example can be found at:

https://www.youtube.com/watch?v=dfnHGPGv5AU.

8) Car sharing management including booking, fee collection, battery monitoring and maintenance: the service provider provides service information required for car sharing applications to the car or ride sharing service entity and to the car share users for booking confirmation, fee collection, and issuing of receipts.

   An example can be found at:

   https://global.toyota/en/detail/14097157.

9) Dynamic map utilizing service applications for automated driving bus, shuttle and freight vehicles for efficient and safe operations: the service provider monitors and controls the automated vehicles and records the status for passengers, goods for an efficient and safe operation.

   An example can be found at:

   https://www.researchgate.net/figure/An-illustration-of-the-automated-buses-demonstrated-in-La-Rochelle_fig1_304530355.

10) Freight vehicle management applications supporting efficient and safe fleet operation: the service provider monitors freight vehicles by collecting vehicle probe data and provides safety information to the vehicles. A vehicle owner can monitor and control the routes and monitor the surroundings of the vehicle to maintain efficient pick-up or drop-off schedules and safety for both the driver and the goods.

    An example can be found at:

    https://www.ieiworld.com/smart-transportation/jp/fleet-management-solution.php.

11) Electric vehicle (EV) charging applications, such as charging stall booking, monitoring, fee collection and security: the service provider offers an EV user the availability and status information of the charging facility for timely booking and use.

    An example can be found at:

    https://www.dreamstime.com/hands-holding-smartphone-charging-app-electric-car-recharging-batteries-modern-vector-illustration-autonomous-plug-image147182505.

12) Fuel cell vehicle (FCV) charging applications: the service provider offers a FCV user the availability and status information of the charging facility for timely booking and use.

    An example can be found at:

    http://large.stanford.edu/courses/2016/ph240/mok1/.

13) Public transit information provisioning to users in a timely and dynamic real-time basis: the service provider provides timely, real-time public transit information to the users for a stress-free use of public transit service.

    An example can be found at:

    https://www.rambus.com/blogs/well-always-have-paris-but-not-the-metro-ticket-2/.

14) Taxi fleet management applications such as booking, matching between user and driver, and safety information provisioning: the service provider offers the taxi user service which provides users the information to support a timely booking and use. The owner of the taxi fleet can perform easy and efficient management. A driver can pick up or drop off users by using the information provided

by the matching service for accuracy in both the persons and locations provided by the service provider.

An example can be found at:

https://www.sintrones.com/fleet-management.html.

15) Tourist information or advice provisioning service applications to visitors: the service provider provides the inbound tourists the information or advice provisioning service which provides users the information needed for their timely touring activities.

An example can be found at:

https://ecbonist.ecbo.io/en/ecbo_cloak_usersegments_for_owner/.

16) Bicycle or motor cyclists' ITS service applications, such as vulnerable road user safety information provisioning services: the service provider provides safety information to the bicycle or motorcycle users in a timely manner. Vehicle or infrastructure sensor data are used and V2X communication is indispensable for this service.

An example can be found at:

https://roadsafetyfacts.eu/what-role-do-road-users-and-infrastructure-play-in-improving-safety/

6 Data sharing use cases

The actual data sharing use cases provided by several countries are shown in Annexes A to F for reference.

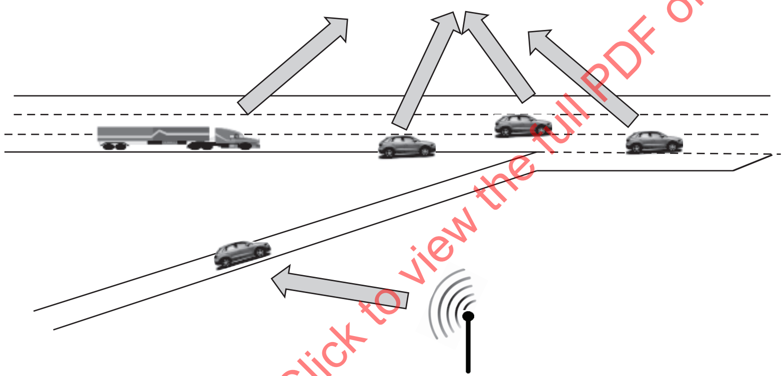
Annex A
(informative)

Japan use case

The data sharing use case shown in this annex and depicted in Figure A.1 was provided by Japan's HIDO (Highway Industry Development Organization). The use case describes a planned service application in Japan using a probe data system called ETC2.0 which is currently deployed. Its probe vehicle data are used for an automated driving vehicle merging support safety application service. Data sharing between the traffic control system and the probe vehicle data system is necessary.

This is an example of an information provision service. Further details on the service are available (in Japanese) at:

http://www.nilim.go.jp/lab/bcg/kisya/journal/kisya20180119.pdf



NOTE 1 Vehicle probe data in the main line are collected through a DSRC- I2V antenna at the roadside.

NOTE 2 Main line traffic/infrastructure information is provided to the merging vehicle through a DSRC-I2V antenna.

NOTE 3 The objective is to support automated driving vehicles in merging into main line traffic safely.

Figure A.1 — Vehicle merging support use case

Annex B
(informative)

Australia use case

The data sharing use case described in this annex was provided by the ARRB (Australian Road Research Board). The use case is called “The National Freight Data Hub” and was established by ARRB on 2019-04-10 under the title “DIRDC FREIGHT DATA REQUIREMENTS STUDY INSTITUTIONAL ARRANGEMENTS”. The report is available at:

https://imovecrc.com/wp-content/uploads/2019/04/Appendix-D-DIRDC-Freight-Data-Requirements-Study-Institutional-Arrangements.pdf

The purpose of this report is to consider how datasets and information related to Australia’s freight supply-chain industry could be collected, hosted, and disseminated and under what governance arrangements.

Annex C
(informative)

Singapore use case

The data sharing use case highlighted in this annex is called "Use of Dedicated Short-Range Communication (SRC) Beacons for Information Dissemination to Autonomous Vehicles" and was provided by the Singapore LTA (Land Transport Authority).

Reference documents concerning this use case are as follows:

— https://www.lta.gov.sg/content/ltagov/en/newsroom/2018/3/2/testing-of-future-traffic-management-systems-commences-at-major-traffic-nodes.html

— https://www.imda.gov.sg/-/media/imda/files/regulation-licensing-and-consultations/ict-standards/telecommunication-standards/radio-comms/imda-ts-dsrc.pdf

— https://www.itu.int/en/ITU-T/extcoop/cits/Documents/Workshop-201707-Singapore/010%20-%20Alan-Quek-Singapore%20Autonomous%20Vehicle%20Initiative%20(SAVI).pdf