Digital Infrastructure Service Role and Functional Model for Urban ITS Service Applications

Junichi Hirose

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Junichi Hirose

Principal international research fellow at
Highway Industry Development Organization, Tokyo 1120014, Japan
junichi.hirose@hido.or.jp

Abstract. Emerging ITS service applications such as parking (including AVPS: Automated valet parking systems), CAV (connected and automated vehicle) (including LSAD: Low speed automated driving), Kerb operations needs digital infrastructure supports for secured and safety operations. And there are several independent related ongoing standardization work items within ISO/TC204, such as HD (high definition) maps, METR (Management for Electronic Traffic Regulations), GDD (Graphic Data Dictionary). Therefore, there is a need of a guidebook style technical report. Creation of such technical report to have a definite need for how those independent standardization works fit in a prospected digital infrastructure service role and functional model for smart city ITS service applications. This role model concept must be extended by authorities/communities to be applied to other smart city services such as energy and telecommunication network.

Keywords: digital infrastructure, ITS, CAV, Kerb, LSAD

1 The purpose of defining role model

1.1 The trend toward smart city

Currently, more than 70% of the world's people live in cities. The proportion of people living in cities is rising around the world as civilizations develop and congregate around cities where employment opportunity most arises. Societies develop more innovatively and more rapidly in cities, adding to their attraction, finally cities present better entertainment opportunities. All adding to their attraction and popularity. Hence the continuing trend. The Economist magazine forecast that by 2045, an extra two billion people will live in urban areas. Due to the concentration of the population that this causes, various issues arise, such as road congestion due to increase in vehicle population, environmental pollution due to exhaust gas and tire erosion. This has caused to increases in the number of delivery trucks and taxis and city center traffic. It is further exacerbated by obstacles to effective use of urban space due to private ownership of cars (parking lots, street parking).

1.2 Emerging issues in the city

The pressures caused by scientific advice that significant action and change of behavior is necessary to ameliorate the adverse effects of climate change require more environmentally friendly use of the transport system.
We recognized that there is also road infrastructure deterioration, lack of provision of information on the use of public transportation, driver shortages due to the increase in the number of elderly people, and inconvenience of multimodal fare payments, and action to improve this situation is urgently needed.
The International Data Corporation forecasts that of the USD81 billion that is spent on smart city technology in 2020, a quarter will go into fixed visual surveillance, smart outdoor lighting, and advanced public transit.
Eventually, this is likely to mean high speed trains and automated driving cars. Consultancy McKinsey forecasts that up to 15 per cent of passenger vehicles sold globally in 2030 will be equipped with fully automated functions, while revenues in the automotive sector could double to USD 6.7 trillion thanks to shared mobility (car-sharing, e-hailing) and data connectivity services (including apps and car software upgrades).
Changing consumer tastes are also calling for new types of infrastructure. Today's city dwellers, for example, increasingly shop online and expect ever faster delivery times. To meet their needs, modern urban areas need the support of last-minute distribution centers, backed by out-of-city warehouses.

1.3 ITS standardization needs

In recent years, studies on the development of ITS mobility integration standards have been active to solve urban issues. There are various movements around the world making efforts to address these issues. We are using ITS technology to try to solve these urban problems, as in the Smart City Pilot Project. Columbus, Ohio was selected by USDOT as a smart city pilot project. Important key factors here are the core architectural elements of smart cities, and urban ITS sharing of probe data (also called sensor data), connected cars, and automated driving. In addition, contemporary issues have been recognized with the introduction of the connected car to the real world in respect of privacy protection, the need to strengthen security measures, big data collection, and processing measures, which are becoming important considerations.

In terms of effective use of urban space, we expect that the introduction of connected cars and automated driving can significantly reduce the requirements for urban parking lots (redistribution of road space). If technology can eliminate congestion, city road area usage can also be replanned - reallocated (space utilization improvement) to improve the living environment of/ quality of life in, the city. In addition, the environment around the road must be improved by authorities' enforcement (e.g., overloaded vehicles). On the other hand, even in rural areas, it is possible to introduce automated driving robot taxis and other shared mobility that saves human load (and is therefore more affordable) and improves the mobility of elderly people.
To achieve this requires the realization of various issues. Some examples are as follows.

- Cooperation with harmonization of de-jure standards such as ISO and industry de facto standards
- Recognition of the significance of international standardization (for example, to reduce implementation costs)
- Recognition of the significance of harmonization activities by countries around the world.
- Cooperation and contribution between ISO/TC22, ISO/TC204 and ISO/TC268.

As mentioned above, automated driving mobility is expected to play a key role both in cities and in rural areas. The main effects are, as described above, reduction of traffic accidents, reduction of environmental burden, elimination of traffic congestion, realization of effective use of urban space.

ITS technology is an essential element for realizing ‘smart’ cities, and it is important to clearly understand the role model of ITS service applications when developing standards to achieve these objectives.

1.4 ISO standardization activities

The published Technical Report ISO/TR 4445 is an important guidebook for the objective with the consideration of emerging direction of mobility electrification, automated driving, and the direction of an environmentally friendly society and incorporating other urban data such as traffic management into the city management can improve the mobility of urban society. The experts in ISO/TC204 recognizes that it is important to create the document describing digital infrastructure service role and functional model which adding such role into ISO/TR4445 role model as supplementary part as emerging ITS service applications such as parking (including AVPS), CAV (including LSAD), kern operations need infrastructure supports for secured and safety operations.

That document describes how ITS sensor data can be structured into valuable data cluster presented on the map data so that ITS service provider can provide services such as automated driving, parking, kerb operations.

That document does not describe smart city use cases for ITS data in any detail, nor does it describe in detail any specific ITS use-cases; but it is focused on the generic role model for digital infrastructure service.

2 Role model of smart city

2.1 ISO/TR4445

As shown in figure 1 below, there are three key actors in the role model of TR4445.

- the service users;
- the service provider(s);
- for any regulated applications: the jurisdiction(s).

The role model provides the general attributes and the responsibilities of the parties.

The authority is the body that has official power to make legal decisions and impose regulations. How this operates varies from country to country according to their constitution or legal structure. Countries have a single authority or delegate such authorities to their constituent states or, independent states concede part of their independent national authority to a common authority union (e.g., European Union) to achieve common goals and interoperability within common conditions, while retaining independent authority in other matters.

Regardless of the differences between jurisdictions is the concept that at any specific location, and time, there is a single authority that has official power to make legal decisions and where it deems applicable to impose regulations in respect of the regulation of ITS service applications.

ITS service applications and smart city applications vary. In jurisdictions, some application services are mandatory or voluntary (but if they are implemented in a specific way). Most services envisaged are safety services, mobility-related services, or commercial services.

A service provider can be described as a party which is providing safety, commercial or regulated ITS or smart city services. Application services are certified by the certification authority (regulatory).

2.2 Needs to add digital infrastructure to TR4445

The Technical Report TR4445 describes the roles and responsibilities of the classes and actors involved in the basic role model in ITS services. To provide emerging ITS services such as automated driving mobility, another role of digital infrastructure and map service provider becomes necessary and creation of TR7872 has been created by ISO/TC204.

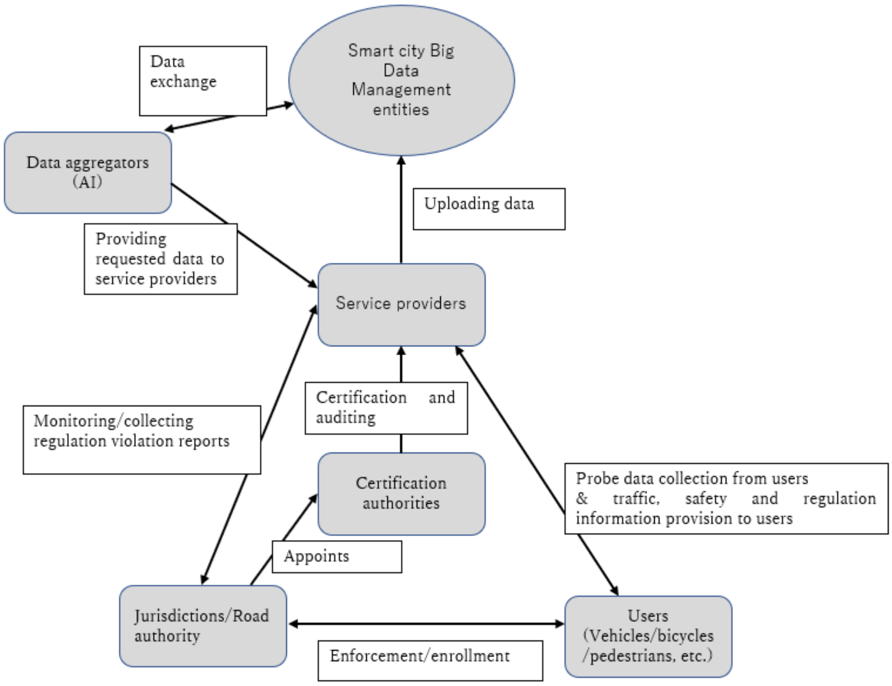

Fig. 1. Role model defined in ISO/TR4445

3 Digital infrastructure

For the creation of TR7872 digital infrastructure, the work has been created in ISO/TC204.

3.1 TR7872

Emerging ITS service applications such as parking (including AVPS: Automated valet parking systems), CAV (connected and automated vehicle) (including LSAD: Low speed automated driving), Kerb operations needs digital infrastructure supports for secured and safety operations. And there are several independent related ongoing standardization work items, such as HD (high definition) maps, METR (Management for Electronic Traffic Regulations), GDD (Graphic Data Dictionary). Therefore, there is a need of create a guidebook style technical report TR7872 which have a definition guide how those independent standardization works fit in a prospected digital infrastructure service role and functional model for smart city ITS service applications. It is especially important work item.

This will help to lead ITS service to digital twin operation for smart city; create digitality formed society twining real physical world to process big data and analysis to send out data stream to real world.
In actual deployment, distributed security technology such as block chain can effectively be adopted in application services, and it will introduce for efficient and speedy transactions.
That document suggests investigating ITS as a component part of a smart city and that the ITS data can focus on data originated by ITS components and available for sharing with other smart city services and commercial interests.

3.2 Concept of TR7872

The big data are connected to other smart city data entities and share the data for the efficient smart city operation in a manner approved and authorized by the authority. This role is required to configure complete roles of actors to support privacy requirements and to fairly manage any business case issues.

The data aggregator will provide timely and value-added data to service provider for its ITS (intelligent transport system) service application provisioning. Data collected for sharing is not forwarded in the same formats or data timing so there is a need to have an entity that can provide standardized data to service provider in a standard data format and data timing. AI can be deployed in application services to create such structured value-added data for service providers.

The word “open architecture platform map data” is meant to be used as "Map data that anyone can use for free", "Map data that is paid/subscribed but has no usage restrictions", "Map data that anyone can modify and re-provide".

The map service will provide an open architecture platform map data and digital infrastructure receives probe data, OEM (original equipment manufacturer the car maker) cloud data, from data aggregator. It combines such data into map and provides map data (such as HD map) cluster in a standard format such as GDF, NDS, etc. for ITS application services.

3.3 Digital infrastructure service provider

The digital infrastructure service provider will receive map data cluster in a standard format from map service provider and receive public infrastructure and enforcing regulation data, such as METR, GDD. from jurisdictions/road authority/municipals. It combines such data into map as data cluster, digital infrastructure data which are consist of dynamic and static data. Digital infrastructure service provider provides those to service provider who performs provisioning of ITS services such as CAV, parking (AVPS), Kerb. Service provider will utilize AI/edge computing tools in some use cases for low latency safety service applications.

The conceptual view of digital infrastructure of a role and functional model is as shown in Figure 2 below.

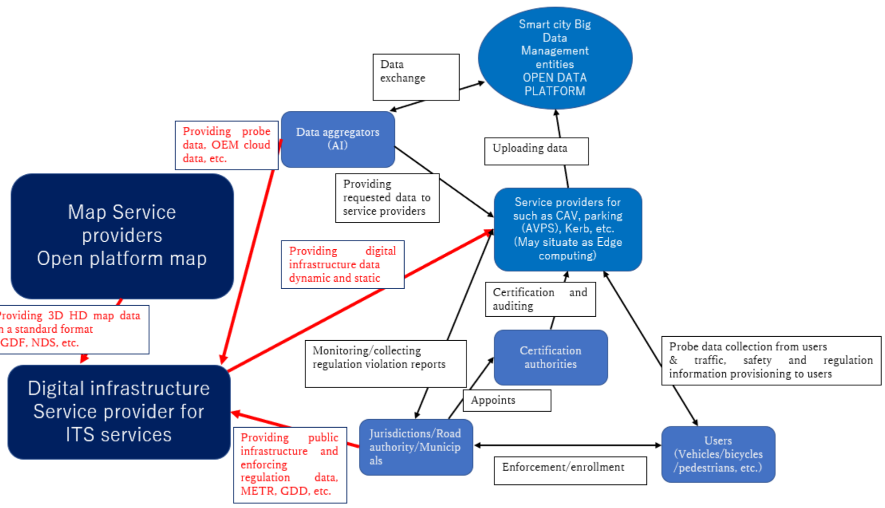

Fig. 2. An image of role model and functional model of digital infrastructure servicer

4 Extended application other than ITS services

The role model concept described here must be extended by authorities/communities to overall integration of other smart-city infrastructure services such as energy and telecommunication networks. Defining role model before planning such services gives boost start to the projects.

References

1. ISO/TR 7872 Intelligent transport systems — Mobility Integration — Digital infrastructure service role and functional model for urban ITS service applications