

Recommendation

ITU-T Y.4225 (07/2024)

SERIES Y: Global information infrastructure, Internet protocol aspects, next-generation networks, Internet of Things and smart cities

Internet of things and smart cities and communities –
Requirements and use cases

Requirements and capability framework of digital twin for intelligent transport system

ITU-T Y-SERIES RECOMMENDATIONS

Global information infrastructure, Internet protocol aspects, next-generation networks, Internet of Things and smart cities

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Recommendation ITU-T Y.4225

Requirements and capability framework of digital twin for intelligent transport system

Summary

Recommendation ITU-T Y.4225 specifies the requirements and capability framework of digital twin for intelligent transport system.

Digital twin (DT) for intelligent transport system (ITS) can provide a digital representation of the physical transportation world. With meaningful and full-scale understanding of historical, real-time, and statistical traffic related data in digital twin for intelligent transport system (DT-ITS), the awareness of physical transportation is significantly enhanced, problems of transportation system can be discovered in advance, various traffic situations can be simulated, different long term, medium, short term strategies can be properly decided, and a lot of applications supported by intelligent transport systems can be better provided and be more intelligent.

History*

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Digital twin, intelligent transport system.

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Recommendation ITU-T Y.4225

Requirements and capability framework of digital twin for intelligent transport system

1 Scope

This Recommendation specifies the requirements and capability framework of digital twin (DT) for intelligent transport system (ITS). The scope of this Recommendation includes:

- Introduction of digital twin for intelligent transport system;
- Requirements of digital twin for intelligent transport system;
- Capability framework of digital twin for intelligent transport system.

Additionally, relevant use cases of digital twin for intelligent transport system are provided in Appendix I.

NOTE – Implementation related aspects – e.g., concerning system capacity and resource utilization – are out of the scope of this Recommendation.

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.

- [ITU-T X.1752] Recommendation ITU-T X.1752 (2022), *Security guidelines for big data infrastructure and platform*.
- [ITU-T Y.4105] Recommendation ITU-T Y.4105/Y.2221 (2010), *Requirements for support of ubiquitous sensor network (USN) applications and services in the NGN environment*.

3 Definitions

3.1 Terms defined elsewhere

This Recommendation uses the following terms defined elsewhere:

3.1.1 device [b-ITU-T Y.4000]: With regard to the Internet of things, this is a piece of equipment with the mandatory capabilities of communication and the optional capabilities of sensing, actuation, data capture, data storage and data processing.

3.1.2 digital twin [b-ITU-T Y.4600]: A digital representation of an object of interest.

NOTE – A digital twin may require different capabilities (e.g., synchronization, real-time support) according to the specific domain of the application.

3.1.3 intelligent transport system (ITS) [b-ITU-T Y.4407]: ITS is defined as systems utilizing the combination of computers, communications, positioning, and automation technologies to improve the safety, management and efficiency of terrestrial transport systems.

3.1.4 Internet of things (IoT) [b-ITU-T Y.4000]: A global infrastructure for the information society, enabling advanced services by interconnecting (physical and virtual) things based on existing and evolving interoperable information and communication technologies.

3.1.5 sensor [ITU-T Y.4105]: An electronic device that senses a physical condition or chemical compound and delivers an electronic signal proportional to the observed characteristic.

3.2 Terms defined in this Recommendation

None.

4 Abbreviations and acronyms

This Recommendation uses the following abbreviations and acronyms:

ADAS	Advanced Driver-Assistance Systems
AI	Artificial Intelligence
C-V2X	Cellular V2X
DT	Digital Twin
DTA	Dynamic Traffic Assignment
DT-ITS	Digital Twin for Intelligent Transport System
eMBB	Enhanced Mobile Broadband
GNSS	Global Navigation Satellite System
HIL	Hardware-in-the-Loop
IoT	Internet of Things
ITS	Intelligent Transport System
LBS	Location-Based Service
MIL	Model-in-the-Loop
mMTC	Massive Machine-Type Communications
NB-IoT	Narrowband Internet of Things
OD	Origin-Destination
QoS	Quality of Service
SIL	Software-in-the-loop
URLLC	Ultra Reliable Low Latency Communications
V2X	Vehicle-to-Everything
VIL	Vehicle-in-the-Loop

5 Conventions

The following conventions are used in this Recommendation:

- The keywords "is required to" indicate a requirement which must be strictly followed and from which no deviation is permitted, if conformance to this Recommendation is to be claimed.
- The keywords "is recommended" indicate a requirement which is recommended but which is not absolutely required. Thus, this requirement need not be present to claim conformance.

- The keywords "can optionally" and "may" indicate an optional requirement which is permissible, without implying any sense of being recommended. These terms are not intended to imply that the vendor's implementation must provide the option and the feature can be optionally enabled by the network operator/service provider. Rather, it means the vendor may optionally provide the feature and still claim conformance with the specification.

6 Introduction of digital twin for intelligent transport system

Intelligent transport system (ITS) utilizes a combination of advanced technologies to improve the safety, efficiency, management, and usability of a transport system.

Digital twin for intelligent transport system (DT-ITS) as shown in Figure 1 is the digital representation of transportation infrastructure (road, bridge, tunnel, traffic lights, etc.), traffic participant (vehicle, non-vehicle, pedestrian, etc.), traffic behaviour (departure, destination, path, etc.) and the surrounding environment (urban functional area, buildings, river, forest, weather condition, etc.), which can be constructed by data interaction, data processing, modelling and simulation, and data visualization.

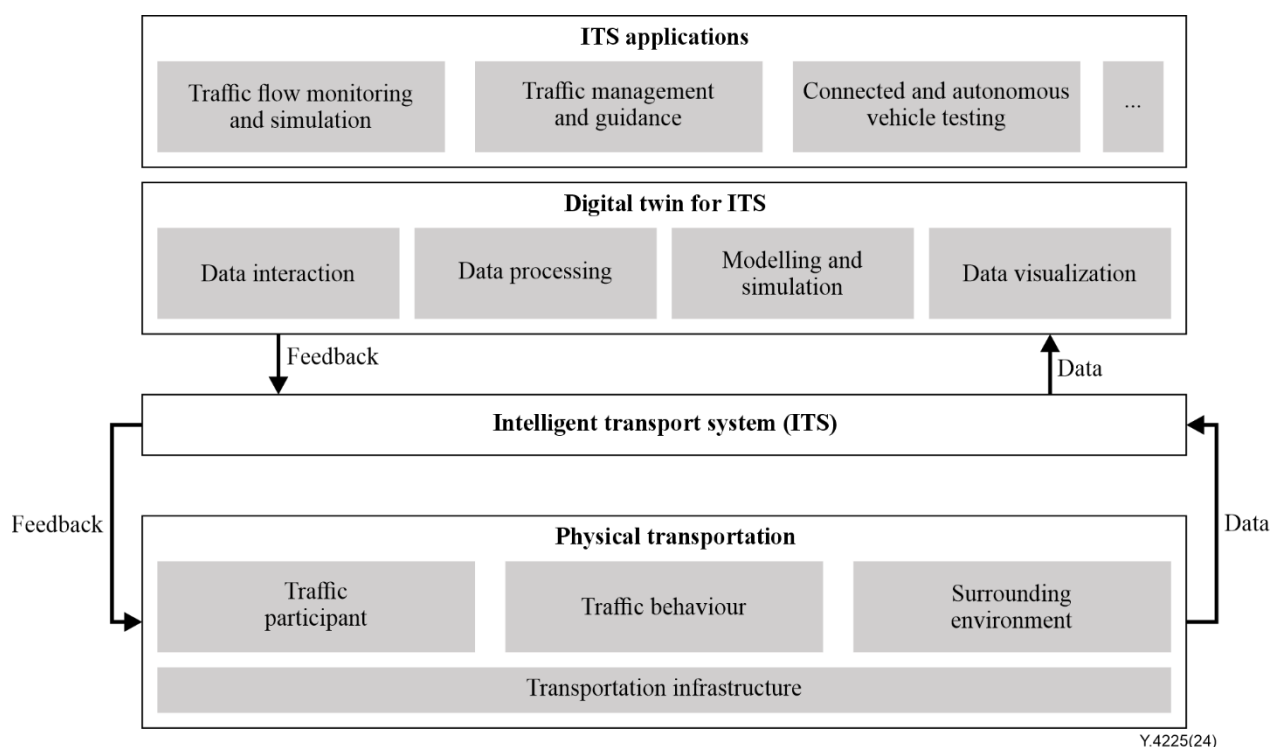


Figure 1 – Concept of digital twin for intelligent transport system

To achieve the digital representation of the physical transportation world accurately and timely, a variety of advanced ICT technologies such as big data, artificial intelligence (AI), and 3D modelling, should be utilized in DT-ITS. Correspondingly, the Internet of things (IoT), intelligent sensor, cellular vehicle-to-everything (V2X) (C-V2X), and IMT-2020 may be integrated in intelligent transport systems to obtain accurate and real-time traffic data.

In DT-ITS, the status of the transportation entities is monitored, and tremendous traffic related data can be obtained. Based on the processing of these historical, real-time and statistical traffic related data by data processing, the awareness of physical transportation is significantly enhanced, problems of the transportation system can be discovered in advance, various traffic situations can be simulated, different long term, medium term and short term strategies can be decided, and various ITS applications can be provided by modelling and simulation as well as by data visualization.