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Information technology — Smart city digital platform reference architecture — Data and service

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Foreword

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This document was prepared by Joint Technical Committee ISO/IEC JTC 1, *Information technology*.

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Introduction

Smart city digital platforms (SCDPs) aim to form a pragmatic development of information technology foundations that enable the integration of urban services. SCDPs are part of the digital transformation in urban infrastructure and services that is being driven by the deployment of the internet of things (IoT), artificial intelligence (AI), cloud computing, big data and digital twin solutions, and other digital technologies.

An SCDP is a space where different applications can share fundamental common resources and functions. It provides an interface to integrate a city's digital and physical infrastructure. It also provides integrated capability to coordinate data, services and applications across operational domains for multiple stakeholders in smart cities.

An SCDP is intended to help to break down the traditional system silos of a city by bringing connections between them. It looks beyond sectoral silos to reimagine existing systems, enable new processes and interactions, and migrate towards new forms of service delivery. The digital capabilities provided by SCDPs aim at connecting things, connecting data and connecting innovation. These capabilities are key criteria for enabling cities to build partnerships to ensure their economies, environment and services are fit for the future.

Information technology — Smart city digital platform reference architecture — Data and service

1 Scope

This document specifies the reference architecture of smart city digital platforms (SCDPs), with a focus on supporting access to data and services for applications in smart cities.

2 Normative references

There are no normative references in this document.

3 Terms and definitions

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

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

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

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

3.1
asset
anything that has value to a stakeholder

[SOURCE: ISO 22739:2020, 3.1]

3.2
data
representation of facts of objective reality in a formalized manner

EXAMPLE Data can be signs and symbols, and can be in analogue form, digital form or both.

Note 1 to entry: Data can be used for communication, interpretation or processing by human beings or automatic means.

[SOURCE: IEC CDV 60050-831, 2.2]

3.3
information
structured, contextualized and processed data that are endowed with meaning

Note 1 to entry: Information is meaningful and useful to human beings, or machines or both.

3.4
interoperability
property permitting diverse systems or components to work together for a specified purpose

[SOURCE: IEC 80001-1:2010, 2.11]

3.5
metadata
data about data or data elements, possibly including their data descriptions, and data about data ownership, access paths, access rights and data volatility

Note 1 to entry: The term "metadata" in this document mainly aims to aid the identification, discovery, assessment and management of the data collected by SCDP.

[SOURCE: ISO/IEC 20546:2019, 3.1.24, modified — Note 1 to entry is added.]

3.6
platform
combination of an operating system and hardware that makes up the operating environment in which a program runs

[SOURCE: ISO/IEC/IEEE 26513:2017, 3.30]

3.7
smart city digital platform
SCDP
combination of software and hardware that makes up the operating environment to support smart city common services and applications

Note 1 to entry: The operating environment enables data from a variety of sources to be processed and common services to be provided.

Note 2 to entry: Common services are aimed at improving the interoperability of cross-domain systems, for example data exchange, catalogue service, subscription and distribution, etc.

4 Overview

A SCDP connects smart city information and communication technology (ICT) infrastructure, such as device, network and Internet, and smart city applications, such as e-government and public service, city operation, decision-making and industry service, as shown in Figure 1. The SCDP is characterized by the combined exploitation of software components with heterogeneous physical devices and protocols, furnishing smart city applications with ready-to-use software services and enhancing the system performance in various system environments. This ultimately provides optimized and integrated city services to the end users, such as governments, individuals, organizations and companies. One example of SCDP data service reusability for different applications is provided in Annex A.

SCDPs implement capabilities of the data and services supporting layer described in ISO/IEC 30145-3 (see Annex B). Guided by the design principles in Clause 5, the functions of an SCDP can be categorized into four groups:

1) technical support,

2) resource management,

3) capability exposure, and

4) interface.

This is shown in Figure 1.

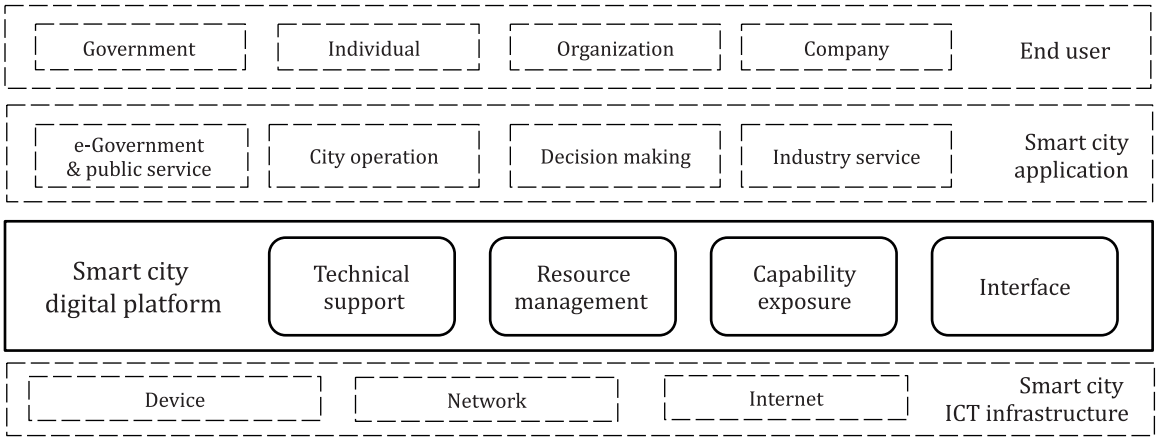


Figure 1 — Functions of a smart city digital platform

Technical support: aims at providing reliable and scalable technical and system tools to help improve data integration and service aggregation and to build horizontal foundations to eliminate information silos.

Resource management: aims at guaranteeing migration of resources, transparency of processes, quality of data and services, operation efficiency and service evolution.

Capability exposure: aims at enabling reuse and openness, integrating business value with data and services and providing ready-to-use functional blocks for smart city applications.

Interface: aims at providing a unified approach to access interfaces to reduce process complexity for external access and enable flexible interactions.

5 Design principles

The design principles of SCDPs are as follows:

Holistic: looking beyond information silos to reimagine existing systems, create new processes and interactions, and migrate towards new forms of service delivery, in order to avoid information silos and to generate interoperable, standards-based, replicable and scalable solutions for cities.

Modularity: utilize advantages of service-oriented architecture and microservice architecture, provide loosely-coupled service modules which support the constant evolution of robust and powerful services and flexible adaptation to various new business requirements;

Transparency: data and services should be able to exchange, process and deposit with standard format and trackable flow. This improves the interoperability and transparency of the platform in order to improve operational efficiency and value creation for cities;

Reusability: data, services and applications need to be utilized based on shared capabilities and functionality, in order to fulfil rapid response requirements for new businesses and avoid repetitive development investment;

Security: data, services and applications need to be secure by design.

Table 1 shows the linkage between design principles and the SCDP function groups.

Table 1 — Function group mapping with design principal

	Holistic	Modularity	Transparency	Reusability	Security
Technical supporting	X	X	X	X	X
Resource management	X	X	X	X	X
Capability exposure		X	X	X	X
Interface			X	X	X

6 Reference architecture

The reference architecture from the functional viewpoint of SCDPs with a focus on supporting external access of data and services is shown in Figure 2.

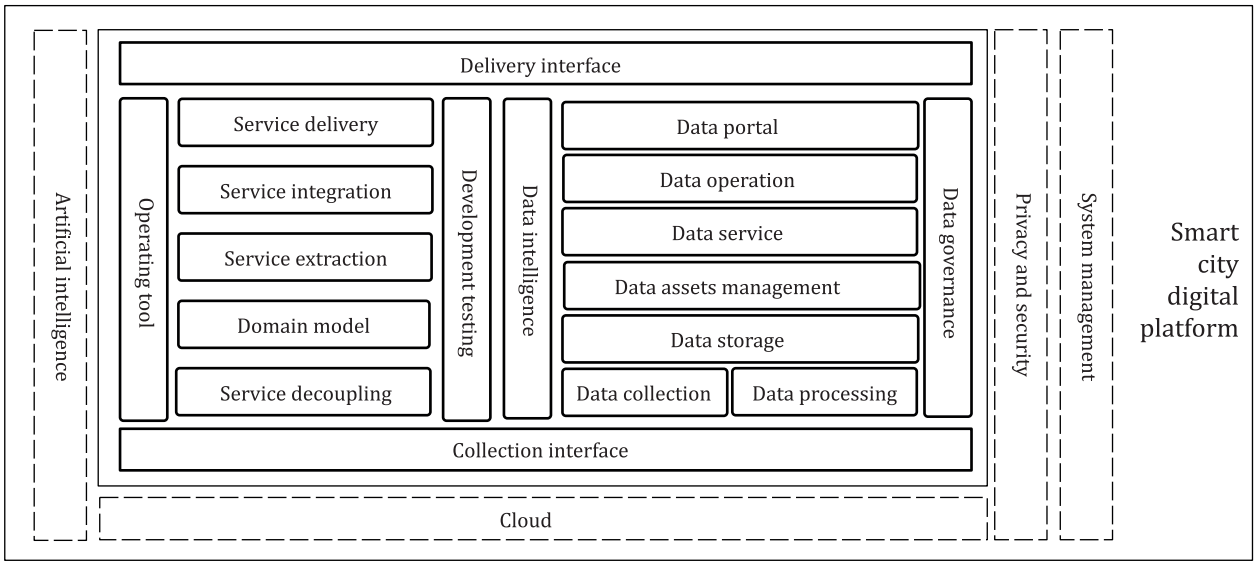
The technical support function group as described in Clause 4 and Figure 1 includes functions of data collection, data processing, data storage, operating tools and development testing.

The resource management function group as described in Clause 4 and Figure 1 includes functions of data assets management, data governance, data intelligence, service decoupling, domain model and service extraction.

The capability exposure function group as described in Clause 4 and Figure 1 includes functions of data service, data operation, data portal, service integration and service delivery.

The interface function group as described in Clause 4 and Figure 1 includes functions of collection interface and delivery interface.

NOTE Functions shown in dotted line blocks including artificial intelligence, cloud, privacy and security and system management in Figure 2 are not included in this document.



NOTE Within Figure 2, a special focus is placed on supporting external access of data and services.

Figure 2 — Reference architecture from the functional viewpoint of smart city digital platforms (SCDPs)

Data collection is a process for the collection of qualitative and quantitative data via digital tools or software from various sources.

Data processing is the manipulation of data to produce meaningful information and insight.

Data storage is the collection and retention of digital information in a storage medium.

Data asset management refers to the software components which establish a systematic approach to organizing and retrieving the assets.

Data governance is a process focused on managing the quality, consistency, usability, security and availability of data.

Data intelligence is the process of using artificial intelligence (AI) and machine learning tools to analyse and transform massive data sets into intelligent data insights, which can then be used to improve services.

Data service refers to software services that encapsulate operations on key data entities of relevance to stakeholders.

Data operation is a process to create business value from data with a systematic data management methodology.

Data portal is a system or platform which supports users in accessing collections of data.

Service decoupling is a process of segregating service flows into independent functional modules.

Domain model is a conceptual model of the domain that incorporates both behaviour and data.

Service extraction is a process of selecting and orchestrating necessary service modules to meet specific requirements.

Service integration is a process of integrating interdependent services from various internal and external service modules into ready-to-use services in order to meet specific requirements.

Service delivery is a process of enabling users to access and receive required services.

Operating tool is a set of foundational functions for effective running of hardware and software.

Development testing is a software development process that involves the synchronized application of a broad spectrum of defect prevention and detection strategies in order to reduce software development risks, time and costs.

Collection interface is the interface where an SCDP collects data from external hardware infrastructure and software systems.

Delivery interface is the interface where an SCDP provides services or capabilities for external systems or users.

7 Technical support

7.1 Data collection

Data collection capabilities provided by an SCDP should:

a) support the collection of structured data, semi-structured data and non-structured data;

b) support the collection of bulk data, near real-time data and real-time data;

c) support unified data collection management, such as management of data source, acquisition frequency, acquisition range, etc.;

d) support data import, data export and data exchange with external data sources, such as relational databases, file servers, etc.;

e) support various data collection methods, such as automatic collection, manual report, file upload, interface call, etc.

7.2 Data processing

Data processing capabilities provided by an SCDP should:

a) support the extraction of data in real time or at regular intervals according to customized requirements;

b) support distributed data processing, bulk data processing and real-time streaming data processing;

c) support various mainstream data processing frameworks, such as batch processing, interactive queries, data retrieval, real-time streaming, memory computing, etc.;

d) support mainstream data processing operations, such as task creation, orchestration, execution, monitoring, etc.;

e) enable extract-transform-load (ETL) capabilities, such as data extraction, cleaning, conversion and loading;

NOTE ETL is used to extract necessary data from data sources such as databases, to transform the data into the desired form, and to load them into a target system.

f) support data semantic capability by supporting data re-organization according to a city data model;

g) provide data processing visualization via a componentized toolbox or other methods;

h) enable data format conversion, enrich data by merging data from multiple sources, perform aggregation functions, i.e. create summary of data, or cleanse data with null values;

i) enable data packing and compression with a pre-defined data format before the data has been transmitted, and only transmit the packed and compressed data;

j) ensure the pre-defined data format includes special field, creation-time field, sub-package field, and the number of sub-package fields. Each sub-package field should include a property field and frame field. The frame field should include frame-length field, frame-compression field and frame-payload field.

7.3 Data storage

Data storage capabilities provided by an SCDP should:

a) enable massive data storage capabilities, such as building a distributed storage system on top of a distributed file system;

b) support a distributed relational database, which is able to manage a petabyte of data storage;

c) support a data warehouse or data lake, such as those providing structured data storage services and basic data analysis services;

d) support line storage, column storage, key-value storage, row-organized tables and column-organized tables;

e) support file storage and basic operations for file systems, such as file upload, file download, directory view, directory creation, directory deletion, file permission modification, etc.;

f) support conversion of data between different storage dimensions;