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Internet of Things (IoT) – Functional architecture for resource identifier interoperability

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INTERNET OF THINGS (IoT) – FUNCTIONAL ARCHITECTURE FOR RESOURCE IDENTIFIER INTEROPERABILITY

FOREWORD

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The text of this International Standard is based on the following documents:

Draft	Report on voting
JTC1-SC41/458/FDIS	JTC1-SC41/471/RVD

Full information on the voting for its approval can be found in the report on voting indicated in the above table.

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The language used for the development of this International Standard is English.

This document was drafted in accordance with ISO/IEC Directives, Part 2, and developed in accordance with ISO/IEC Directives, Part 1, and the ISO/IEC Directives, JTC 1 Supplement available at www.iec.ch/members_experts/refdocs and www.iso.org/directives.

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INTRODUCTION

Internet of Things (IoT) is defined as an infrastructure of interconnected entities, people, systems and information resources together with services which processes and reacts to information from the physical world and virtual world. IoT has attracted significant social attention globally and is expanding in various fields such as smart homes, healthcare, smart cities, logistics, smart cars, etc. In particular, IoT platforms are essential because they connect various devices (e.g. sensors, access points, and data networks) and provide services to the user. Heterogeneous IoT platforms refer to IoT platforms developed based on different standards such as various data models, policies, vendors, interfaces, and specifications. Therefore, interoperability, such as requesting services and sharing resources among heterogeneous IoT platforms, is important, and it is essential for a real IoT system.

IoT platform has many challenges to interoperability, such as support for diverse protocols, discovery service, well-defined semantic management, and processing of data formats in heterogeneous IoT platforms. However, current diverse IoT platforms and related standards make it difficult to achieve interoperability and collaboration between heterogeneous IoT platforms. Especially regarding resource interoperability issues, each IoT platform has been developed using a specific and unique resource identifier, including a different type of resource-request format, so it is difficult to identify resources among heterogeneous IoT platforms. Furthermore, the existing approaches mainly focus on integrating and managing each IoT platform's ontology and a method of duplicating resources for the target IoT platforms. It makes it a burden for the developer to construct specific ontologies for the diverse IoT platforms.

This document provides a functional architecture for resource identifier (ID) interoperability, which converts the format of a resource identifier among heterogeneous IoT platforms. This document concentrates on converting resource paths (e.g. uniform resource identifier (URI)) used in a specific IoT platform to the target IoT platform. In addition, this document provides an IoT resource name system (RNS) architecture based on the comparative analysis of heterogeneous IoT platforms and a smart city scenario, including resource registration, resource deletion, sharing mapping tables, and resource path conversion. To ensure the user can use heterogeneous IoT resources, IoT RNS analyses and converts identifier into desired resource-request formats, including reconfiguring resource requests between heterogeneous IoT platforms as appropriate for the user-requested resources.

This document has the ISO/IEC 30141 [1][1] IoT reference architecture as a reference to consider interoperability among heterogeneous components and systems. In addition, this document has IEC 61406-2 [2] as a reference to specify minimum requirements for a globally unique identification of resources which constitutes a link to its related digital information. Furthermore, the IoT RNS in this document can be modularized in middleware as edge computing in the IoT system. Therefore, this document has as a reference ISO/IEC TR 30164 [3], which describes the general concepts, terms, characteristics, use cases, and techniques (e.g. data management, coordination, processing, network functionality, heterogeneous computing, security, hardware and software optimization) of edge computing for IoT system applications.

[1] Numbers in square brackets refer to the Bibliography.

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INTERNET OF THINGS (IoT) – FUNCTIONAL ARCHITECTURE FOR RESOURCE IDENTIFIER INTEROPERABILITY

1 Scope

This document specifies functional requirements and architecture about the following items for resource interoperability among heterogeneous IoT platforms through the conversion of resource identifiers (IDs) and paths (e.g. uniform resource identifier (URI)):

– requirements for interoperability of resource IDs in the heterogeneous IoT platforms;
– functional architecture for converting IDs and paths of resources on heterogeneous IoT platforms; and,
– functional architecture for mapping and managing resource IDs among heterogeneous IoT platforms.

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:

- IEC Electropedia: available at https://www.electropedia.org/
- ISO Online browsing platform: available at https://www.iso.org/obp

3.1
identifier
information that unambiguously distinguishes one entity from other entities in a given identity context

Note 1 to entry: It refers to a name used to identify and distinguish an object.

Note 2 to entry: In the IoT system, it is used to identify resources such as devices and services and related policies can be different for each platform.

[SOURCE: ISO/IEC 20924:2024, 3.1.19 [4], modified – The Notes to entry have been added.]

3.2
identity context
environment where an entity can be sufficiently identified by a certain set of its attributes and values

[SOURCE: ISO/IEC 20924:2024, 3.1.20]

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3.3
Internet of Things
IoT
infrastructure of interconnected entities, people, systems and information resources together with services which processes and reacts to information from the physical world and virtual world

Note 1 to entry: In this document, IoT is described as a hyper-connection among smart things, services, and humans that provides useful and seamless services with minimum human involvement.

[SOURCE: ISO/IEC 20924:2024, 3.2.8 modified – Note 1 to entry has been added.]

3.4
IoT platform
software that connects various devices, including sensors, access points, and data networks

Note 1 to entry: An IoT platform is the role of middleware that can connect to networked devices and provide a hosted infrastructure to cost-effectively and securely manage and path data.

Note 2 to entry: It is important that scalable and provide interoperability that handles connectivity to large numbers of devices and easily interacts with them.

Note 3 to entry: It provides user security such as authentication and access control, and a service that collects, visualizes, and analyses data from sensors.

3.5
IoT resource name system
IoT RNS
module that converts resource requests into the respective format of each IoT platform

Note 1 to entry: The IoT RNS can be implemented as local IoT RNS or root IoT RNS.

Note 2 to entry: The local IoT RNS is modularized on each IoT platform to store metadata of registered devices and services. It also converts the resource paths of heterogeneous IoT platforms.

Note 3 to entry: All resource metadata are stored in the root resource table of the root IoT RNS and sent to each local IoT RNS if the root resource table is updated.

3.6
near field communication
NFC
wireless technology that enables communication between devices over a short distance

[SOURCE: ISO 20252:2019, 3.55]

3.7
next generation service interface for linked data
NGSI-LD
information model and API for publishing, querying and subscribing to context-aware information management in IoT systems

3.8
object identifier
OID
ordered list of primary integer values from the root of the international object identifier tree to a node, which unambiguously identifies that node

[SOURCE: ISO/IEC 9834-1:2012, 3.5.11]

3.9
resource
application service used between devices based on various IoT platforms

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3.10
radio frequency identification
RFID
wireless use of electromagnetic fields to transfer data, for the purposes of automatically identifying and tracking tags attached to objects

[SOURCE: ISO/IEC 18038:2020, 3.25]

3.11
discovery service
service to find resources, entities, or services based on a specification of the desired target

[SOURCE: ISO/IEC 20924:2024, 3.1.14, modified – Note 1 to entry has been deleted.]

3.12
uniform resource identifier
URI
compact sequence of characters that identifies an abstract or physical resource

Note 1 to entry: It is a conceptual term that refers to a unified identifier for Internet application information resources.

Note 2 to entry: It includes a URN indicating an identifier using the name and a URL indicating a resource path.

[SOURCE: ISO/IEC 12785-1:2009, 3.23, modified – Note 1 to entry has been replaced and Note 2 to entry has been added.]

4 Abbreviated terms

ADN	application dedicated node
ASN	application service node
CSE	common service entity
ID	identifier
IN	infrastructure node
IoT	Internet of Things
MN	middle node
OID	object identifier
RNS	resource name system
URI	uniform resource identifier
URL	uniform resource locator
URN	uniform resource name

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