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# Information technology— Internet of Things Reference Architecture (IoT RA)

# WD stage

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# Foreword

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The committee responsible for this document is ISO/IEC JTC 1/WG 10.

# Introduction

Internet of Things (IoT) has broad use in the industry and society today, and it will be further studied and developed for many years to come. Various applications and services have been adopting and adapting are IoT technology to provide innovative solutions for users, which weren't possible a few years ago. There are a number of possible applications such as smart city, smart grid, smart home/building, smart factory, digital agriculture, manufacturing, intelligent transportation and traffic, logistics and asset/inventory management, retail transactions, e-Health, public safety, e-Learning, environment monitoring. Thus, IoT is an enabling technology that consists of many supporting technologies, for example, different type of communication networking technology, information technology, sensing and control technologies, software technology, device/hardware technology, and so on.

In designing and developing IoT systems, three key technologies should be considered: (1) system technology; (2) communications technology; and (3) information technology. In a different perspective, IoT systems are composed of physical objects and virtual objects where both objects together mean "things" in "Internet of Things." The physical and virtual objects together collect, process, extract, and exchange data. They also can decide, and/or act/react to environments autonomously or upon user's request. The data and information generated by IoT systems are likely sensitive in nature; yet, data and information exchange is an essential and imperative process of IoT systems which enable to provide various applications and services. Therefore, data/information security and user privacy is the other major technology area of importance for IoT systems. Security and privacy in IoT systems are dictated by international and national legislations, and IoT systems should comply with the local security/privacy laws and regulations. Additionally, reliability, dependability, and data validation and associated requirements are the other areas that the developers of IoT Systems should consider.

ISO/IEC 30141 identifies and specifies IoT systems' Conceptual Model (CM), Reference Model (RM), and Reference Architecture (RA). The RA is described by different architectural views, namely, systems view, communications view, information view, functional view, and usage view. These views generically represent the IoT systems. These RA views provide various types of architectural elements (e.g., subsystem platforms, functional entities) as well as base building blocks to develop application-specific (or target) architectures.

In this IoT RA International Standard (IS), the reference model is given to describe an abstract framework for understanding significant relationships among the entities of some environment, and for the development of consistent standards or specifications supporting that environment. Thus, the IoT RA is described from the aforementioned three main technology views in this international standard (IS):

- IoT RA Systems View: Describes the IoT Systems from system perspective
- IoT RA Communications View: Describes the IoT Systems from communication technology perspective

— IoT RA Information View: Describes the IoT Systems from information technology perspective

In addition to the above three architecture views, the following two architecture views are described in this IS:

— IoT RA Functional View

— IoT RA Usage View

— The architecture entities defined in the Systems View, Communications Views, Information View, Functional View and Usage View are related across these five IoT reference architecture views. Describing the IoT RA using these five different views will benefit not only the IoT standard developers but also the IoT Systems developers. For example, developing IoT Security Architecture or implementing IoT security, the developers can do their work in accordance to the three technology views (e.g., systems, communications, and information) describing physical security, communication security, and information security while the effectiveness of security features in architecture can be evaluated by Functional and Usage Views.

The objectives of this ISO/IEC 30141 of standard are:

— provide guidance to facilitate the design and development of IoT Systems,

— promote open and common guiding architecture leading to seamless interoperability of IoT Systems.

IoT covers a wide range of applications, for example, applications in smart city, in smart energy, in smart mobility, in smart home, in smart building, in smart factory, in smart health, in smart logistic etc. Each application area has its own , which leads to different requirements on IoT system architecture. In order to develop a generic IoT reference architecture which is applicable for all application areas, it is necessary to investigate its common concepts and relationships at abstract level. Such investigation helps to establish a solid grounding for further development of the reference architecture.

# Information technology —Internet of Things Reference Architecture (IoT RA)

## 1 Scope

This International Standard specifies IoT Conceptual Model, Reference Model, and Reference Architecture from different architectural views, common entities, and high-level interfaces connecting the entities.

## 2 Normative references

The following documents, in whole or in part, are normatively referenced in this document and are indispensable for its application. For dated references, only the edition cited applies. For undated references, the latest edition of the referenced document (including any amendments) applies.

ISO #####-#:20##, *General title — Part #: Title of part*

## 3 Terms and definitions

**Editors´ Note**: ISO/IEC JTC 1/WG 10 agreed to transfer the clause 3, Terms and definitions in ISO/IEC 30141 to ISO/IEC NP 20924 in the Shanghai meeting. WG 10 instructs the Project Editors of ISO/IEC NP 20924 to review the disposition of comments on clause 3 in ISO/IEC 30141 (WG10_N0315) and forward the result to the Project Editors of ISO/IEC 30141 after separating out the definitions for ISO/IEC 30141 and ISO/IEC NP 20924 no later than 2016-02-21. The updated revised WD with clause 3 will be published to the experts for comments and contributions after 2016-02-21.
**Editor's Note:** Continue to call for the new comments and contributions especially for the updated contents of clause 4-8.
**Editor's Note:** Terms and definitions has been processed by ISO/IEC NP20924. Following terms are considered as RA specific. Comments shall also indicate placement of the definition. If the definition is considered to be "general", it will be moved to 20924.

**3.1**
**actuator**
a component which conveys digital information to effect a change of some property of a physical entity[IoT-A]++

**3.2**
**component**
a modular, deployable, and replaceable part of a system that encapsulates implementations [ISO/TS 19104:2008 ++]

Note 1 to entry: a component may expose or use interfaces (local or on a network) to interact with other entities. A Component which exposes or uses network interfaces is called an Endpoint.

Note 2 to entry: see also “functional component”: that specialization of the component concept is consistent with this definition except that it is not deployable, as it is a part of a logical architecture and not part of an implementation architecture.

**3.3**
**conceptual model**
common structure and definitions for describing the concepts and relationships within an IoT system

[SOURCE: ISO/IEC 20006-1:2014(en), 4.8]

**3.4**
**digital entity**
any computational or data element of an IT-based system, and it may exist as a service based in a data centre or cloud, or a network element or a gateway.

**3.5**
**digital user**
a non-human user of the IoT system and it includes automation services that act on behalf of human users.

**3.6**
**domain**
class of entities of similar group and common characteristic

[SOURCE: ISO 14813-5:2010(en), B.1.49]

**3.7**
**endpoint**
a component that exposes or uses network interfaces [ISO/IEC 24791-1:2010 ++].

**3.8**
**entity**
item inside or outside an information and communication technology system such as a person, an organization, a device, a subsystem, or a group of such items that has recognizably distinct existence

[SOURCE: ISO/IEC 24760-1:2011, 3.1.1]

**3.9**
**functional component**
functional building block needed to engage in an activity realized by an implementation

[SOURCE: ISO/IEC 17789:2014]

**3.10**
**human user**
an IoT user.

### 3.11
### IoT Gateway
a forwarding device enabling the connections between the sensing or actuating subsystem in the real environment and other subsystems or networks.

### 3.12
### identifier
information that unambiguously distinguishes one entity from another one in a given identity context.

### 3.13
### identity
characteristics determining who or what a person or thing is.

### 3.14
### identity context
the environment where anananentity can use a set of attributes for identification and other purposes.

### 3.15
### interface
shared boundary between two functional components, defined by various characteristics pertaining to the functions, physical interconnections, signal exchanges, and other characteristics, as appropriate

[SOURCE: ISO/IEC 13066-1:2011(en), 2.15]

### 3.16
### interface device
a hardware component or system of components that allows a human being to interact with a computer, a telephone system, or other electronic information system

[SOURCE: http://whatis.techtarget.com/definition/interface-device-IDF]

### 3.17
### IoT Device
a component that can be a single or a combination of the following elements:

- Sensors, which provide information about the Physical Entity

- Tags, which are used to identify Physical Entities

- Actuators, which can modify the physical state of a Physical Entity [IOT-A,RERUM].

Note 1 to entry: A IoT device can be either attached to or embedded inside a Physical Entity, or monitor a Physical Entity in its vicinity. [Short OED]

Note 2 to entry: Several IoT specifications have used the term Device for this concept. However, the term Device in the English dictionary has a much broader context, which is why this RA introduces IoT as a more specific concept.

 

**3.18**
**IoT domain**
set of **entities** which in an **IoT** context have similar **characteristics** and share the same rules

**3.19**
**IoT User**
an entity that is interested in interacting with a physical or virtual entity. [IoT-A].

**3.20**
**network**
an entity that connects endpoints, sources to destinations, and may itself act as a value added element in the IoT system or services.

**3.21**
**network interface**
set of operations accessible on a network, that characterizes the behaviour of an endpoint.

**3.22**
**physical entity**
a thing that is discrete, identifiable, and observable, and having material existence in real world

**3.23**
**reference architecture**
description of common features, common vocabulary, guidelines, interrelations and interactions among the entities, and a template for an IoT architecture

**3.24**
**sensor**
a component that senses or measures certain characteristics of the real world and transfers them into a digital representation. [IoT-A]

**3.25**
**virtual entity**
a discrete software, firmware, or data, e.g., computing device/system or virtual data storage, that performs a task or tasks. It is a digital representation of a physical entity