INTERNATIONAL STANDARD

# ISO/IEC 29182-4

First edition
2013-07-15

# Information technology — Sensor networks: Sensor Network Reference Architecture (SNRA) —

## Part 4: Entity models

*Technologies de l'information — Réseaux de capteurs: Architecture de référence pour réseaux de capteurs —*

*Partie 4: Modèles des entités*



Reference number
ISO/IEC 29182-4:2013(E)

## Contents

Page

# Foreword

ISO (the International Organization for Standardization) and IEC (the International Electrotechnical Commission) form the specialized system for worldwide standardization. National bodies that are members of ISO or IEC participate in the development of International Standards through technical committees established by the respective organization to deal with particular fields of technical activity. ISO and IEC technical committees collaborate in fields of mutual interest. Other international organizations, governmental and non-governmental, in liaison with ISO and IEC, also take part in the work. In the field of information technology, ISO and IEC have established a joint technical committee, ISO/IEC JTC 1.

International Standards are drafted in accordance with the rules given in the ISO/IEC Directives, Part 2.

The main task of the joint technical committee is to prepare International Standards. Draft International Standards adopted by the joint technical committee are circulated to national bodies for voting. Publication as an International Standard requires approval by at least 75 % of the national bodies casting a vote.

Attention is drawn to the possibility that some of the elements of this document may be the subject of patent rights. ISO shall not be held responsible for identifying any or all such patent rights.

ISO/IEC 29182 consists of the following parts, under the general title *Information technology — Sensor networks: Sensor Network Reference Architecture (SNRA)*:

— *Part 1: General overview and requirements*

— *Part 2: Vocabulary and terminology*

— *Part 3: Reference architecture views*

— *Part 4: Entity models*

— *Part 5: Interface definitions*

— *Part 7: Interoperability guidelines*



The following part is under preparation:

— *Part 6: Applications*

 

# Introduction

A wide range of applications has been proposed for sensor networks. In practice, however, sensor networks have been built and deployed for a relatively small number of applications. This is partly due to the lack of a business case for certain applications and partly due to technical challenges in building a non-trivial sensor network of reasonable complexity. The main reason for this impediment is the multi-disciplinary expertise – such as sensors, communications and networking, signal processing, electronics, computing, and cyber security – required to design a sensor network. Presently, the design process is so complex that one can leverage little from one sensor network design to another. It appears as if one has to start from almost scratch every time one wishes to design and deploy a sensor network. Yet, upon closer inspection, there are many commonalities in instantiations of sensor networks that realize various applications. These commonalities include similarities in the choice of network architecture and the entities/functional blocks that are used in the architecture.

The purpose of the ISO/IEC 29182 series is to

— provide guidance to facilitate the design and development of sensor networks,

— improve interoperability of sensor networks, and

— make sensor network components plug-and-play, so that it becomes fairly easy to add/remove sensor nodes to/from an existing sensor network.

The ISO/IEC 29182 series can be used by sensor network designers, software developers, system integrators, and service providers to meet customer requirements, including any applicable interoperability requirements.



The ISO/IEC 29182 series comprises seven parts. Brief descriptions of these parts are given next.

ISO/IEC 29182-1 provides a general overview and the requirements for the sensor network reference architecture.



ISO/IEC 29182-2 provides definitions for the terminology and vocabulary used in the reference architecture.

ISO/IEC 29182-3 presents the reference architecture from various viewpoints, such as business, operational, system, technical, functional, and logical views.

This part of ISO/IEC 29182 categorizes the entities comprising the reference architecture into two classes of physical and functional entities and presents models for the entities.

ISO/IEC 29182-5 provides detailed information on the interfaces among various entities in the reference architecture.

ISO/IEC 29182-6 provides detailed information on the development of International Standardized Profiles.

ISO/IEC 29182-7 provides design principles for the reference architecture that take the interoperability requirements into account.

There are no requirements for compliance in the ISO/IEC 29182 series. Users should ensure that the sensor nodes, and the related sensor network, are compliant with the application or deployment governing body.

# Information technology — Sensor networks: Sensor Network Reference Architecture (SNRA) —

# Part 4: **Entity models**

## 1 Scope

This part of ISO/IEC 29182 presents models for the entities that enable sensor network applications and services according to the Sensor Network Reference Architecture (SNRA).

## 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/IEC 29182-2, *Information technology — Sensor networks: Sensor Network Reference Architecture (SNRA) — Part 2: Vocabulary and terminology*



## 3 Terms and definitions

For the purposes of this document, the terms and definitions given in ISO/IEC 29182-2 apply.



## 4 Abbreviated terms

| | |
|---|---|
| 3G | 3rd Generation |
| 4G | 4th Generation |
| GNSS | Global Navigation Satellite System |
| GPS | Global Positioning System |
| ICT | Information and Communication Technology |
| IEEE | Institute of Electrical and Electronics Engineers |
| IP | Internet Protocol |
| IT | Information Technology |
| LBS | Location-Based Services |
| MAC | Medium Access Control |
| OSI | Open Systems Interconnection |
| PHY | Physical |
| PII | Personally Identifiable Information |

QoS Quality of Service

RF Radio Frequency

RFID Radio Frequency IDentification

SCM Source Configuration Management

SDP Service Discovery Protocol

SNRA Sensor Network Reference Architecture

TEDS Transducer Electronic Data Sheet

## 5 Overview

The purpose of this part of ISO/IEC 29182 is to provide basic information about and high-level models for various entities that comprise a sensor network. Entities can be roughly categorized into two classes, physical and functional. Physical entities are pieces of hardware and actual devices or components thereof that form the network, such as sensor nodes and gateways. For example, while a sensor node is a physical entity, so are any of the sensors in that node. A functional entity, on the other hand, represents a certain task that may be carried out on one or more types of physical entity. For example, data acquisition and collaborative information processing are both functional entities. While the former is carried out by the sensors, the latter is done "collaboratively" by sensor nodes, service providers, and users (or their machines, to be more precise). Routing and authentication are other examples of functional entities. More often than not, functional entities are pieces of code that run on physical entities.



Each entity model presented in this document is a description of the function/role of that entity. An attempt has been made to provide more detailed models for entities that are specific to sensor networks and typically not found in general-purpose communication networks. Examples of such physical entities include sensors and actuators. Similarly, more detailed models have been provided for functional entities such as data processing, self-localization, group management/clustering, collaborative information processing, and device management. A more detailed model may include an input-output relationship for what the entity does, some features of the entity that characterize its capabilities, and a taxonomy of various ways in which the entity may be implemented.

Figures 1 and 2 provide an overall view of the entities modelled in this document. Figure 1 is an amalgamation of Figure 3 in ISO/IEC 29182-1[1] and Figure 4 in ISO/IEC 29182-3[2]. It shows the physical entities that form a sensor network and how these entities are connected to each other. The blow-up part of the figure is borrowed from ISO/IEC 29182-3 and it shows the internal structure of a sensor node. It implies that actuator(s), although associated with sensor nodes, may not physically reside in sensor nodes. The rest of the figure comes from ISO/IEC 29182-1 and it depicts a more complex instantiation of a sensor network than the other cases presented in Figures 1 and 2 in ISO/IEC 29182-1. Figure 2 is the same as Figure 7 in ISO/IEC 29182-3. It has been reproduced in this document for ease of reference.

 

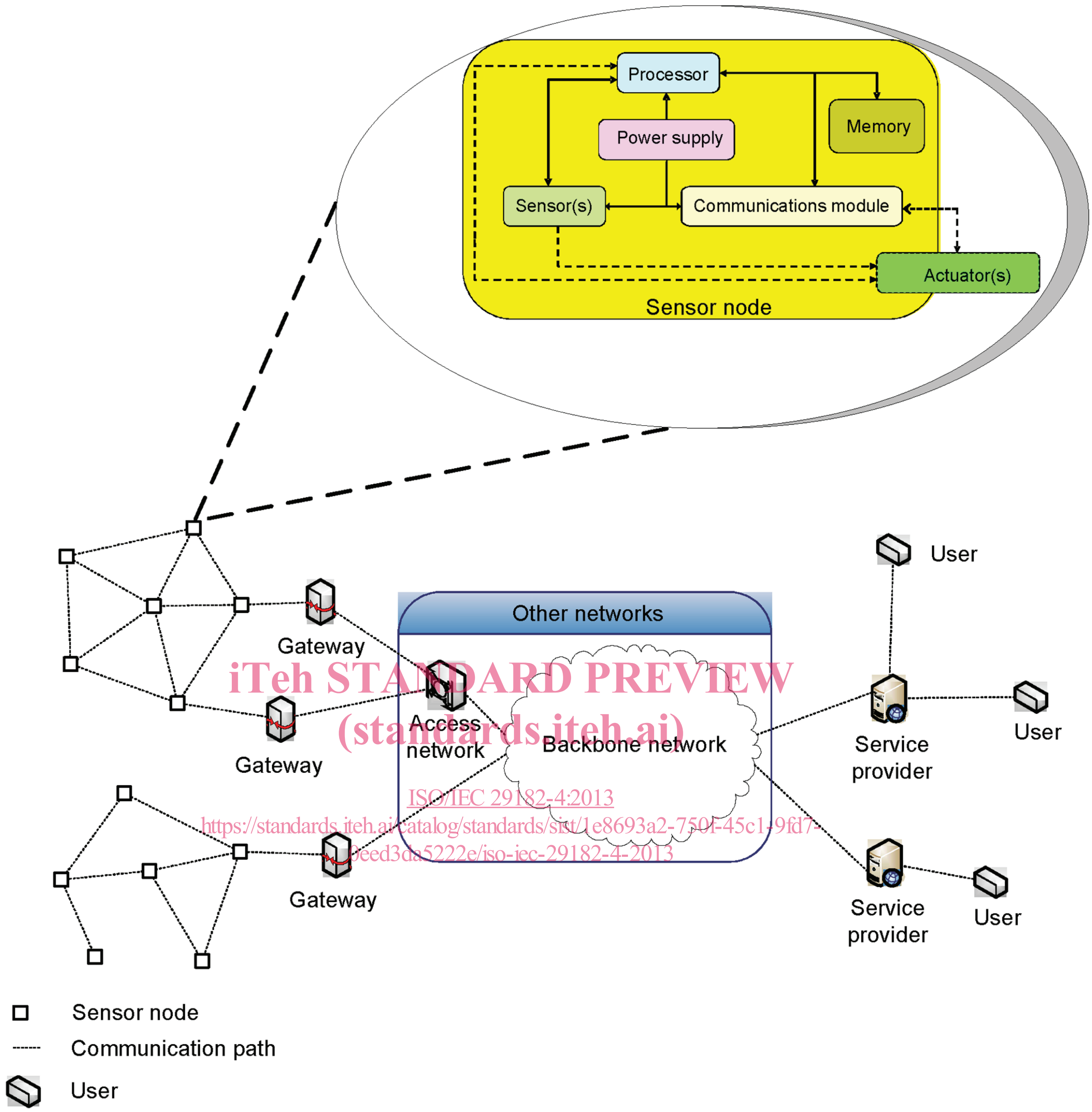




**Figure 1 — Physical entities of a sensor network**

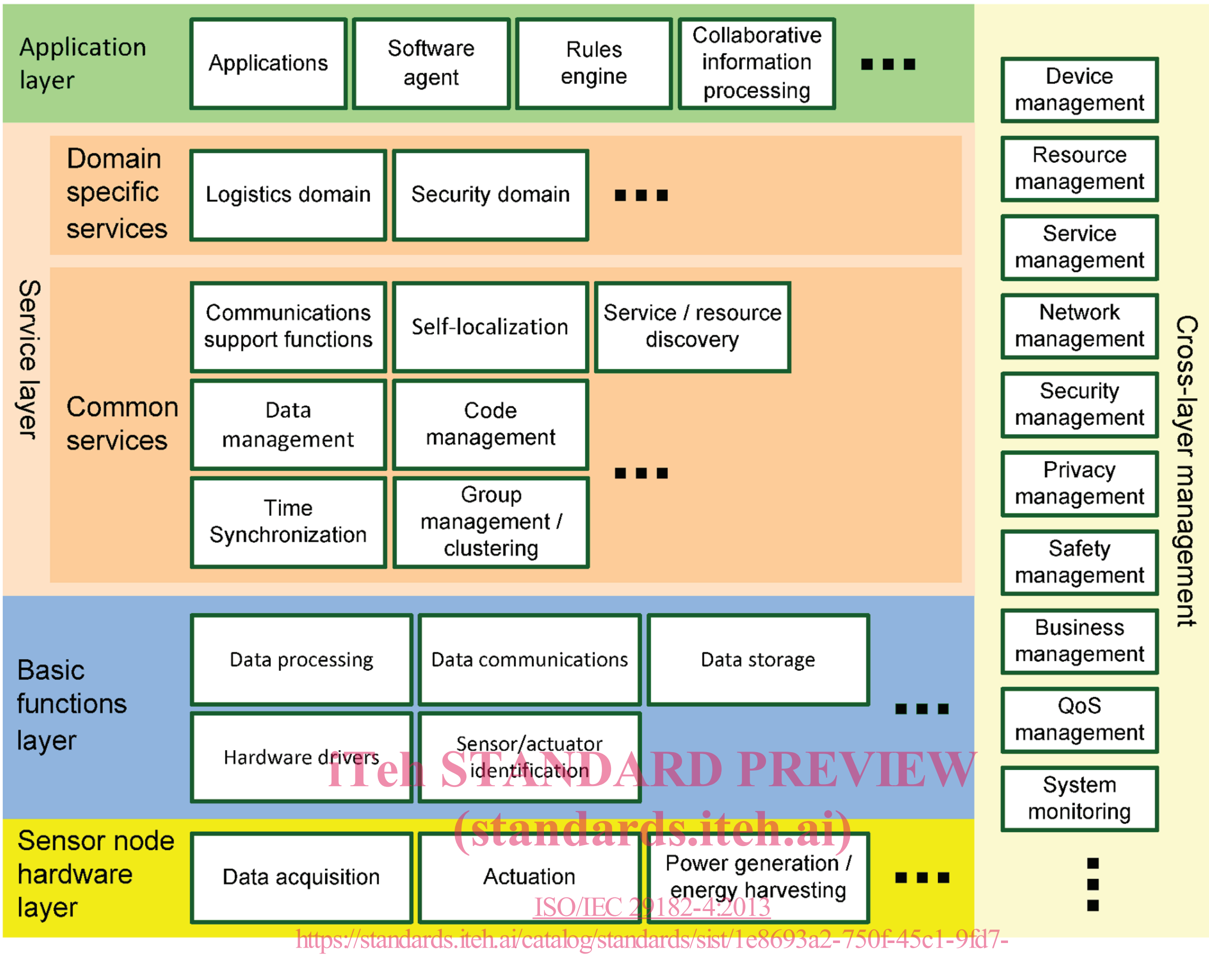




**Figure 2 — Functional entities of a sensor network**

The distinction between physical and functional entities in a sensor network and how they relate to each other can at times be confusing. Table 1 is an attempt to remedy this problem. It shows all the physical entities a functional entity could be associated with. The word "could" has been used here, because some physical entities may not be present in a given sensor network. For example, if there are no service providers in the overall architecture, which would be the case in a stand-alone sensor network, then one cannot say that there is an association between the collaborative information processing functional entity and service providers. In other words, the reader is urged to think of Table 1 as representative of certain possibilities, but not covering all possible ways of which entities might be present in the sensor network and how they might be configured.

**Table 1 — Interrelationships between physical and functional entities in a sensor network**

| Functional entities | | | Physical entities: Sensor nodes — Sensors | Sensor nodes — Actuators | Sensor nodes — Communications module | Sensor nodes — Processor | Sensor nodes — Memory | Sensor nodes — Power supply | Gateways | Other networks — Access networks | Other networks — Backbone network | Service providers | Users |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Sensor node hardware layer | | Data acquisition | • | | | | | | | | | | |
| | | Actuation | | • | | | | | | | | | |
| | | Power generation / energy harvesting | | | | | | • | | | | | |
| Basic functions layer | | Data processing | • | | | • | • | | | | | | |
| | | Data communications | | | • | | | | • | • | • | • | • |
| | | Data storage | | | | | • | | | | | • | • |
| | | Hardware drivers | • | • | | • | | | | | | | |
| | | Sensor/actuator identification | • | • | | • | | | | | | | |
| Service layer | Common services | Communications support functions | | | • | • | • | | • | • | • | • | • |
| | | Self-localization | • | | • | • | • | | | | | | |
| | | Service/resource discovery | | | • | | | | | | | • | • |
| | | Data management | | | | • | • | | | | | • | • |
| | | Code management | | | | • | • | | • | | | • | • |
| | | Time synchronization | | | • | • | | | | | | • | • |
| | | Group management / clustering | | | • | • | • | | | | | • | |
| | | Domain specific services | | | | • | | | | | | • | |
| Application layer | | Applications | | | | • | | | | | | • | |
| | | Software agent | | | | • | | | • | | | • | • |
| | | Rules engine | | | | • | | | | | | • | • |
| | | Collaborative information processing | • | | | • | • | | | | | • | • |
| Cross-layer management | | Device management | • | • | • | | | | • | | | | • |
| | | Resource management | • | • | • | • | • | | | | | • | • |
| | | Service management | | | | | | | | | | • | • |
| | | Network management | | | • | • | • | | | | | • | • |
| | | Security management | | | • | • | • | | • | | | • | • |
| | | Privacy management | | | | | | | | | | | |
| | | Safety management | | | | | | | | | | | |
| | | Business management | | | | • | • | | | | | • | • |
| | | QoS management | • | • | • | • | • | | • | | | • | • |
| | | System monitoring | • | • | • | • | • | • | | | | | |

# 6 Physical entities

## 6.1 Sensor nodes

### 6.1.1 Overview

As it was stated earlier and depicted in the upper part of Figure 1, a sensor node comprises several sub-entities whose models are presented next. Note that the actuator(s), if at all present, may not physically reside inside the sensor node.

### 6.1.2 Sensors

A sensor measures a physical attribute, such as temperature, humidity, or level of carbon monoxide in the air, and converts it into an electric voltage/current. This conversion may be direct or indirect. While in the former case the attribute is directly converted into an electric voltage/current, in the latter case the attribute is converted into a sequence of one or more intermediate attributes before finally getting converted into an electric voltage/current. For example, a thermometer may measure temperature and convert it into physical displacement of some object and then convert that displacement into an electric voltage/current. The sensor output voltage/current may be in analog or digital form. In the former case an analog to digital converter (ADC) is used to convert the analog electric voltage/current into a finite-length sequence of bits (binary digits) that constitutes a binary representation of the voltage/current.

Therefore, an appropriate model for a sensor with analog output is an input-output relationship that characterizes the conversion from the attribute being measured by the sensor into the output electric voltage/current. The relationship may occasionally be characterized through a mathematical formula or more frequently through a xy-plot. For example, Figure 3 shows the output voltage of a temperature sensor versus the input temperature. As the temperature increases, the output voltage decreases, which is an indication of a negative temperature coefficient.



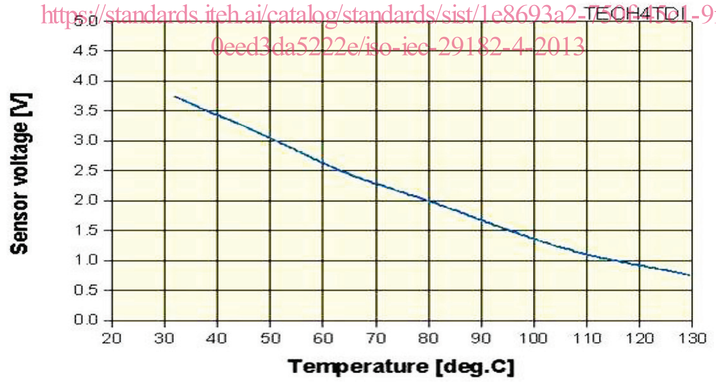


**Figure 3 — Input-output relationship of a temperature sensor**

On the other hand, an appropriate model for a sensor with digital output is a quantizer input-output plot or table. The former is a staircase xy-plot that represents the analog physical attribute on the horizontal axis and the analog value represented by the sensor binary output on the vertical axis. Figure 4 shows a quantizer input-output plot.

 