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

**Part 6:  
Applications**

**iTeh STANDARD PREVIEW**  
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Published in Switzerland

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## 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.

The procedures used to develop this document and those intended for its further maintenance are described in the ISO/IEC Directives, Part 1. In particular the different approval criteria needed for the different types of document should be noted. This document was drafted in accordance with the editorial rules of the ISO/IEC Directives, Part 2 (see [www.iso.org/directives](http://www.iso.org/directives)).

Attention is drawn to the possibility that some of the elements of this document may be the subject of patent rights. ISO and IEC shall not be held responsible for identifying any or all such patent rights. Details of any patent rights identified during the development of the document will be in the Introduction and/or on the ISO list of patent declarations received (see [www.iso.org/patents](http://www.iso.org/patents)).

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For an explanation on the meaning of ISO specific terms and expressions related to conformity assessment, as well as information about ISO's adherence to the WTO principles in the Technical Barriers to Trade (TBT) see the following URL: [Foreword - Supplementary information](http://www.iso.org/foreword)

The committee responsible for this document is ISO/IEC JTC 1, *Information technology*.

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 6: Applications*
- *Part 7: Interoperability guidelines*

## 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 that multidisciplinary expertise, such as sensors, communications and networking, signal processing, electronics, computing, and cyber security is 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 networks 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, 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.

ISO/IEC 29182-4 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.

This part of ISO/IEC 29182 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 ISO/IEC 29182-1 to ISO/IEC 29182-7. Users should ensure that the sensor nodes and the related sensor network are compliant with the application or deployment governing body.

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

## Part 6: Applications

### 1 Scope

This part of the ISO/IEC 29182 series, describes and provides

- a compilation of sensor network applications for which International Standardized Profiles (ISPs) are needed,
- guidelines for the structured description of sensor network applications, and
- examples for structured sensor network applications.

This part of ISO/IEC 29182 does not cover ISPs for which drafting rules are described in ISO/IEC TR 10000. Due to the generic character of ISO/IEC 29182 fully developed ISPs will not be included in this International Standard.

### 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 29182-1, *Information technology — Sensor networks: Sensor Network Reference Architecture (SNRA) — Part 1: General overview and requirements*

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

ISO/IEC 29182-3, *Information technology — Sensor networks: Sensor Network Reference Architecture (SNRA) — Part 3: Reference architecture views*

ISO/IEC 29182-4, *Information technology — Sensor networks: Sensor Network Reference Architecture (SNRA) — Part 4: Entity models*

ISO/IEC 29182-5, *Information technology — Sensor networks: Sensor Network Reference Architecture (SNRA) — Part 5: Interface definitions*

ISO/IEC 29182-7, *Information technology — Sensor networks: Sensor Network Reference Architecture (SNRA) — Part 7: Interoperability guidelines*

ISO/IEC TR 10000-1, *Information technology — Framework and taxonomy of International Standardized Profiles — Part 1: General principles and documentation framework*

ISO/IEC TR 10000-2, *Information technology — Framework and taxonomy of International Standardized Profiles — Part 2: Principles and Taxonomy for OSI Profiles*

ISO/IEC TR 10000-3, *Information technology — Framework and taxonomy of International Standardized Profiles — Part 3: Principles and Taxonomy for Open System Environment Profiles*

### 3 Terms and definitions

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

### 4 Symbols and abbreviated terms

ISP International Standardized Profile

### 5 An overview of sensor network applications

Sensor network market segments and applications are vast and diverse covering both horizontal and vertical markets. The sensor network potential market segments and their current and future applications that employ wired/wireless sensor networks are listed in the following table.

**Table 1 — Examples of sensor network market segments and applications**

Market segments	Sensor network applications
Logistics and supply chain management	<ul style="list-style-type: none"> <li>— Cold chain monitoring</li> <li>— Monitoring of hazardous goods and chemicals</li> <li>— Theft prevention in distribution systems for high value goods</li> <li>— Container monitoring in global supply chains</li> <li>— Monitoring of electronically sealed freight containers</li> <li>— Decentralized control of material flow systems</li> </ul>
Energy & utility distribution industry	<ul style="list-style-type: none"> <li>— Smart grid systems</li> <li>— Automated meter reading</li> </ul>
Automation, monitoring, and control of industrial production processes	<ul style="list-style-type: none"> <li>— Automation of manufacturing processes</li> <li>— Quality control of production processes</li> <li>— Machine condition monitoring</li> <li>— Inventory tracking and surveillance</li> <li>— Personnel tracking at production sites</li> <li>— Control of manufacturing robots</li> </ul>
Health care and medical applications at home and in hospitals	<ul style="list-style-type: none"> <li>— Monitoring of vital physiological parameters</li> <li>— Position and posture monitoring</li> <li>— Hospital personnel and patient tracking</li> </ul>
Care for elderly and/or disabled people	<ul style="list-style-type: none"> <li>— Monitoring of activity patterns for early detection and prevention of hazardous conditions</li> <li>— Fall prevention and detection</li> <li>— Body position and posture monitoring</li> <li>— Remote monitoring and adaptation of habitat conditions (temperature, humidity, etc.)</li> <li>— Remote monitoring of water consumption</li> <li>— Remote monitoring of emotions</li> <li>— Automation of medication management</li> <li>— Nutrition monitoring</li> <li>— Early warning systems for the prevention and detection of emerging chronic conditions like Alzheimer and Parkinson</li> </ul>



Table 1 (continued)

Market segments	Sensor network applications
Critical infrastructure protection and public safety	<ul style="list-style-type: none"> <li>— Monitoring of structural integrity for bridges, tunnels, and gymnasiums</li> <li>— Early warning systems for detection of emerging forest fires</li> <li>— Landslide monitoring and early warning systems</li> <li>— Video surveillance, for example, at airports</li> <li>— Monitoring of personnel and environmental conditions in mines</li> <li>— Localization and monitoring of fire fighters and other emergency responders</li> </ul>
Automation and control of commercial buildings and smart homes	<ul style="list-style-type: none"> <li>— Building energy conservation systems</li> <li>— Remote monitoring of habitat for an enhanced feel of security</li> <li>— Monitoring and control of temperature, humidity, heating, light, etc.</li> </ul>
Automation and control of agricultural processes	<ul style="list-style-type: none"> <li>— Precision agriculture</li> <li>— Crop disease management</li> <li>— Nutrient management</li> </ul>
Intelligent transportation and traffic	<ul style="list-style-type: none"> <li>— Parking management systems</li> <li>— Harbour freight intelligent management systems</li> <li>— Advanced travellers information system</li> <li>— Advanced public transportation systems</li> <li>— Commercial vehicle operation systems</li> <li>— Advanced vehicle and highway information and management systems</li> </ul>
Environmental monitoring, forecasting, and protection	<ul style="list-style-type: none"> <li>— Monitoring of permafrost soil for early detection of problems</li> <li>— Detection of water pollution in nature reserves</li> <li>— Temperature monitoring of coral reefs</li> <li>— Sea floor monitoring and mapping</li> <li>— Detection of gas leakage in the chemical industry</li> <li>— Weather observation and reporting</li> <li>— Monitoring of ambient parameters in forest soils</li> <li>— Remote ecological sensor networks for endangered species</li> <li>— Environmental pollution monitoring, seismic sensing, and flood monitoring</li> </ul>
Facility management	<ul style="list-style-type: none"> <li>— Monitoring and control of offices and large buildings</li> <li>— Monitoring and control of industrial sites</li> <li>— Smoke, gas, and fire detection</li> <li>— Security systems for art work, windows, and doors</li> </ul>
Asset management	<ul style="list-style-type: none"> <li>— Management of mobile assets in hospitals</li> <li>— Blood bag monitoring and status tracking</li> </ul>

Table 1 (continued)

Market segments	Sensor network applications
Defence and military applications	<ul style="list-style-type: none"> <li>— Battlefield monitoring</li> <li>— Military vehicle operations and maintenance</li> <li>— Monitoring of troop movements</li> <li>— Locating snipers</li> </ul>
Homeland security	<ul style="list-style-type: none"> <li>— Container security in global supply chains</li> <li>— Monitoring of infrastructure like transport and energy systems</li> <li>— Chemical, biological, radiological, and nuclear threat detection</li> <li>— Border control and virtual fences used as anti-intrusion systems</li> </ul>

Some of these applications have already been described in larger detail in ISO/IEC JTC1 SGSN N149, SGSN Technical Document Version 3.

## 6 Guidelines for the description of sensor network applications

### 6.1 Introduction

ISO/IEC 29182-1/2/3/4/5 provide an overall reference architecture for sensor networks. This reference architecture allows the deduction of questions, which have to be answered during the design of a sensor network application. The following sub-clauses describe which information is needed.

### 6.2 General information

For a structured description of sensor network applications the following information is needed:

#### — Purpose:

The purpose of the application has to be described in a first level of detail from the user's point of view ("What is the main problem which is addressed by the sensor network-based solution?").

#### — General requirements:

General requirements relevant to the application shall be addressed. A broad variety of general requirements is presented in ISO/IEC 29182-1 ("Which requirements have to be met by the solution from a general perspective?").

#### — Main characteristics:

Main characteristics relevant to the application shall be addressed. The main characteristics of a sensor network are presented in ISO/IEC 29182-1 ("How can the sensor network be characterized from a general point of view?").

#### — Information exchange between sensor network and application server:

The information exchanged shall be described ("What kind of information is transferred between sensor network and backend application?").

### 6.3 Architecture

For a structured description of sensor network applications the following information is needed:

#### — General description:

A figure describing the sensor network application is required. A top level description of relevant data shall be given ("What does the system look like from large distance?").

— **Physical entities:**

The physical entities of the sensor network should be named and described briefly. A detailed list of physical entities can be found in ISO/IEC 29182-4 (“What are the main hardware elements which are working together?”).

— **Operation process:**

The process of sensor network operation should be described following Figure 8 in ISO/IEC 29182-3. Each one of the steps named in the figure has to be commented (“How do the different physical entities work together in order to fulfil the purpose?”).

— **Necessary functions:**

The software modules which are needed for the application should be named and explained briefly. A list of potential functional entities is presented in ISO/IEC 29182-4. They have to be assigned to the different physical entities named above (“Which physical entity has to provide which application function?”).

— **Communication network architecture:**

The network topology of the sensor network should be explained. Basic topologies are described in ISO/IEC 29182-1 (“Who is talking with whom and when?”).

— **Relevant interfaces:**

The interfaces should be listed for which standards are needed. Possible interfaces are described in ISO/IEC 29182-5 (“Where are base standards needed?”).

## 7 Example: Management of mobile assets in hospitals

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### 7.1 Introduction

In the following sub-clauses the design questions mentioned above are answered for the management of mobile assets in hospitals. There are a number of technical solutions for this application problem. The following solution is using a simple sensor network where asset location is determined based on signal strength measurements and multi-lateration. There are other means of locating mobile assets which are not addressed here.

### 7.2 General information

#### 7.2.1 Purpose

Hospitals use a large number of expensive mobile assets. In order to manage those assets their positions have to be known. The purpose of a sensor network-based application is to determine the position of a given asset within the hospital.

#### 7.2.2 General requirements

The following table shows the main requirements of the needed sensor network:

**Table 2 — Main requirements of the needed sensor network**

Requirement	Description
Connectivity to other networks	The sensor network has to be integrated into the already existing IT landscape. Depending on the complexity of the area which has to be monitored one or more gateways are needed.