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

Part 5: Interface definitions

Technologies de l'information — Réseaux de capteurs: Architecture de référence pour réseaux de capteurs —
Partie 5: Définitions des interfaces

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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 multi-disciplinary 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.

This part of ISO/IEC 29182 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 5: Interface definitions

1 Scope

This part of ISO/IEC 29182 provides the definitions and requirements of sensor network (SN) interfaces of the entities in the Sensor Network Reference Architecture and covers the following aspects:

— interfaces between functional layers to provide service access for the modules in the upper layer to exchange messages with modules in the lower layer;

— interfaces between entities introduced in the Sensor Network Reference Architecture enabling sensor network services and applications.

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

SN	Sensor Network
SNRA	Sensor Network Reference Architecture
API	Application Programming Interface
I/F SNHL/BFL	Interface between Sensor Node Hardware Layer and Basic Functions Layer
I/F BFL/SL	Interface between Basic Functions Layer and Service Layer
I/F SL/AL	Interface between Service Layer and Application Layer
I/F CLM/AL-SL-BFL	Interface between Cross-Layer Management and Application Layer, Service Layer, and Basic Functions Layer
I/F CLM/AL	Interface between Cross-Layer Management and Application Layer
I/F CLM/SL	Interface between Cross-Layer Management and Service Layer
I/F CLM/BFL	Interface between Cross-Layer Management and Basic Functions Layer

QoS	Quality of Service
HLME-SAP	Hardware Layer Management Entity-Service Access Point
HLDE-SAP	Hardware Layer Data Entity-Service Access Point
BFME-SAP	Basic Functions Layer Management Entity-Service Access Point
BFDE-SAP	Basic Functions Layer Data Entity-Service Access Point
SLME-SAP	Service Layer Management Entity-Service Access Point
SLDE-SAP	Service Layer Data Entity-Service Access Point
ALME-SAP	Application Layer Management Entity-Service Access Point
PCI	Peripheral Component Interconnect
USB	Universal Serial Bus
TCP/IP	Transmission Control Protocol/Internet Protocol
GPRS	General Packet Radio Service
CDMA	Code Division Multiple Access
GSM	Global System for Mobile communications
TD-LTE	Time Division-Long Term Evolution
UWB	Ultra Wide Band

5 SN interfaces overview

A sensor network (SN) is a system consisting of interconnected (via wireless or wired) and spatially distributed sensor nodes to acquire, process, transfer, and provide information from the physical world and optionally react to the physical world by using an actuator or actuators.

Sensor networks have many different applications in a variety of domains such as environment monitoring, logistics management, industrial automation, intelligent highway system, and perimeter protection. From one SN application domain to another, significant differences exist in service requirements, service types, processing functions, interfaces, operational attributes and so on. These significant differences influence the structure, construction and performance of a SN.

An interface is the shared border between two interactive entities or modules, so interface definition depends on the entities or modules on both sides. An interface can be described in physical or logical form.

The purpose of developing generic and generalized definitions for SN interfaces is to promote the interoperability among modules within a sensor node, between sensor nodes, and other entities. Defining a set of standard interfaces for SN is one of the most efficient approaches to bring the interoperability to sensor networks.

To provide service and implement application in sensor network, sensor nodes and other entities have to exchange messages containing sensor data or command. The messages pass through different functional layers in each entity, and pass from one entity to another. Interfaces between different layers and interfaces between peer modules in functional layers of different entities (e.g. sensor node or senor network gateway) are used to enable sensor network applications and services. Figure 1 illustrates three classes of sensor networks architectures defined in ISO/IEC 29182-1 and gives an overview of interfaces enabling sensor network services and applications. Interfaces between functional layers in a sensor node or gateway, and interfaces between physical entities are shown in the Figure 1.

This standard describes common interfaces which need to be considered when building an SN infrastructure of SN. Specific interface standards and detailed interface implementations such as message format and exchanging mechanism are out of the scope of this standard.

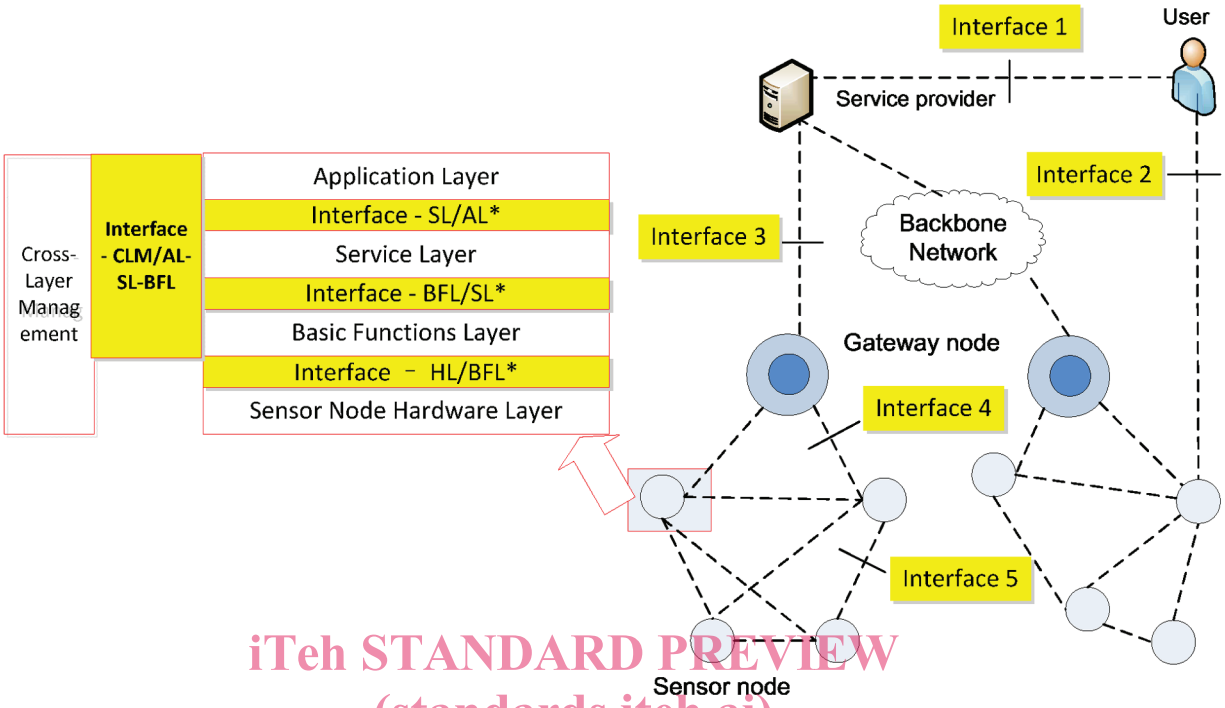

Figure 1 — Overview of interfaces enabling sensor network services and applications

6 Interfaces between different functional layers

6.1 General

From the node's architectural point of view, there are five kinds of functional layers shown in Figure 1. They are:

— Sensor Node Hardware Layer (SNHL);

— Basic Functions Layer (BFL);

— Service Layer (SL);

— Application Layer (AL);

— Cross-Layer Management(CLM)

Sensor nodes and gateways are likely to have similar layers, but modules in each layer may be largely different. For example, sensor node may integrate different sensors in its SNHL, while a gateway's hardware layer will not contain any sensors.

Communication between functional modules in layer is implemented by the interface between these layers, which provides data and management service points. A data entity SAP and management entity SAP are defined in each of interface between layers.

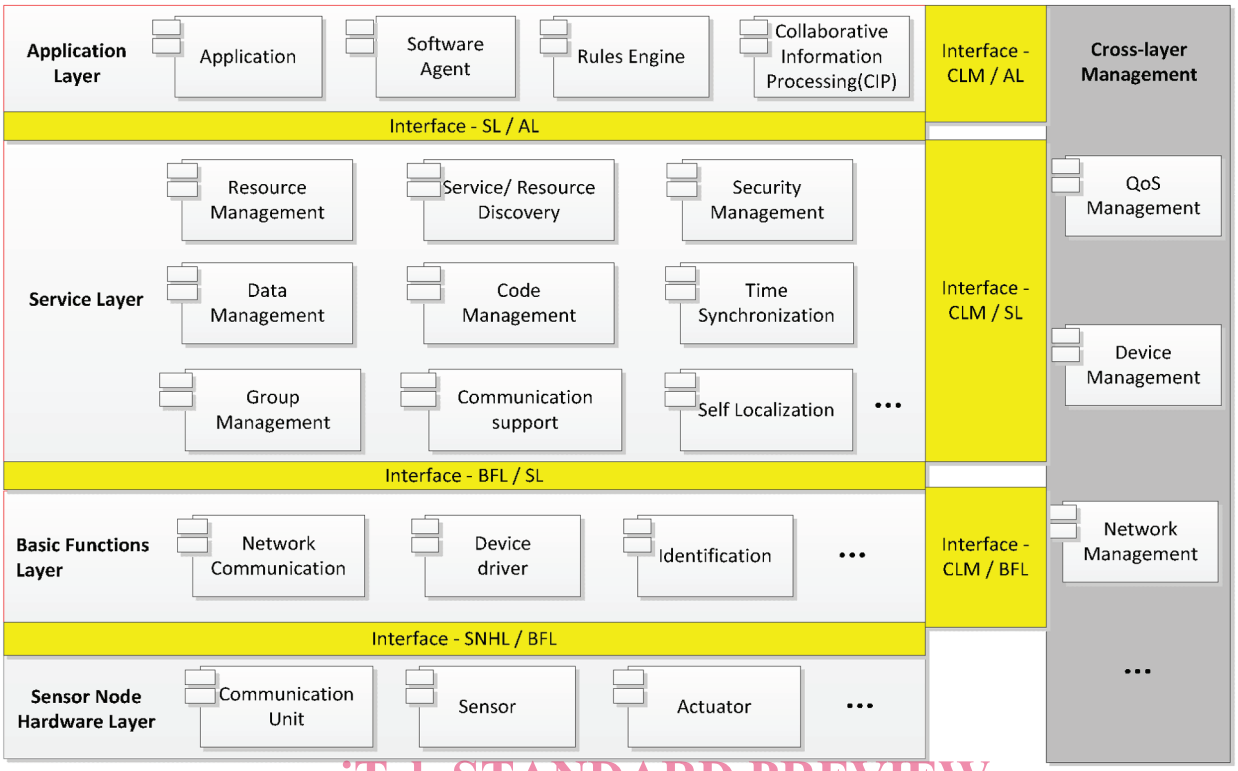

Figure 2 — Interfaces definition between functional layers enabling sensor network services and applications

Figure 2 shows the four primary interfaces between the functional layers, and the abbreviation of each interface is included separately. They are:

— Interface between sensor node hardware layer and basic functions layer (I/F SNHL / BFL);

— Interface between basic functions layer and service layer (I/F BFL / SL);

— Interface between service layer and application layer (I/F SL / AL);

— A set of interfaces between cross-layer management and application layer, service layer, and basic function layer (I/F CLM / AL-SL-BFL), namely CLM/AL, CLM/SL and CLM/BFL.

Cross-layer management can manage hardware in sensor node hardware layerthrough CLM/BFL and SNHL/BFL.

Figure 2 illustrates some function modules in each layer. It is not possible to list all of the function modules in this figure. The modules shown in Figure 2 are common and are defined in ISO/IEC 29182-4. Logically, sensor node design should follow this structure, but due to detailed application requirements differences exist. The designer can choose some of the layers and relative interfaces to build sensor network according to their application scenarios.

6.2 Interface - SNHL / BFL

I/F SNHL/BFL is an interface between the sensor node hardware layer and the basic functions layer which contains the physical (hardware) and logical (software) component in a node. Through this interface, functional models in the basic functions layer interact with the sensor node hardware layer.

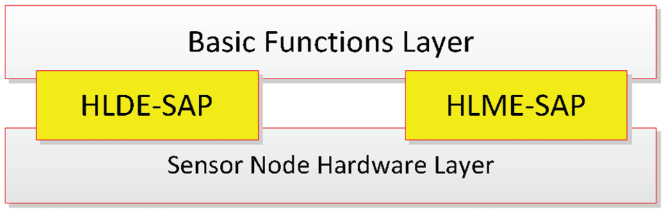

Figure 3 — Service access point provided by I/F HL/BFL

The sensor node hardware layers supplies the infrastructure including a processor, memory, communication device, power supply and other additional hardware. The interface SNHL / BFL provides interconnecting service for the basic functions layer to access and utilize sensor node hardware.

The sensor node hardware layer provides two kinds of services to basic function layer. One is hardware layer data service through the hardware layer data entity SAP (HLDE-SAP). The other is hardware layer management service through the hardware layer management entity SAP (HLME-SAP).The two SAPs are shown in Figure 3. The functional modules in the basic functions layer can use these two SAPs to support the transport of data unit in the basic functions layer between peer functional modules of layers. Modules in the basic functions layer access the data in hardware layer (such as sensor data) by HLDE-SAP, and modules in the basic functions layer manage the hardware modules in hardware layer (such as actuator) by HLME-SAP.

Due to diversity of sensors and their applications, sensor manufacturers define and implement their own physical sensor interfaces. These manufacturer-defined interfaces are rarely compatible with each other hindering interconnectivity and interoperability. Data types and data formats must also be defined in order to achieve interconnectivity and interoperability of data/information from dissimilar sensors.

This interface is described in terms of the mechanical, electrical and logical signals at the interface and the protocol for sequencing them (sometimes called signalling). The requirements to define the interface SNHL/BFL are described below:

— Information exchange mechanisms, primitives and message formats in HLDE-SAP and HLME-SAP between the sensor node hardware layer and different functional modules in the basic functions layer should be defined and developed according to the requirement of the basic functions layer.

— Characteristics of node hardware that are used for upper applications need to be described in the hardware's metadata.

— Interface standard should be developed and consolidated for the basic functions layer to access the sensor node hardware layer based on the node metadata (such as sensor type, measurement unit type), and physical hardware connection types(such as PCI, USB).

6.3 Interface - BFL /SL

I/F BFL/SL is a logical interface between the basic the functions layer and the service layer. The basic functions layer provides basic functions to service layer via I/F BFL/SL. Service layer provides services such as communication support, group management, data management, security management, self-localization, etc.

Interface BFL/SL describes data type and format which is related to modules in the basic functions layer, like type of basic function performed, type of information generated, and structure of transmitted data.

