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Working Group on Sensor Networks

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Information technology — Sensor Networks: Sensor Network Reference Architecture (SNRA) — Part 7: Interoperability Guidelines

1 Scope

This international standard provides the general overview and requirements for interoperability between heterogeneous sensor networks and covers the following clauses.

- Description of interoperability for heterogeneous sensor networks
- Requirements of interoperability for heterogeneous sensor networks

2 Normative references

The following referenced documents are indispensable for the application of this document. 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, *Information technology – Sensor Network: Sensor Network Reference Architecture (SNRA) – Part 2: Vocabulary/Terminology*

ITU-T Recommendation F.744, *Service description and requirements for ubiquitous sensor network middleware (2009)*

3 Terms and definitions

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

Heterogeneous sensor networks

Sensor networks or sensor nodes that is not interworking with each other due to a difference of application, network protocols or radio signals, etc.

Application service

Application service is the layer that provides sensor network services for users directly.

Note : The entity of application service can be, for example, web server for sensor network service.

Application service data profile

Application service data profile is a collection of data used for application service.

4 Description of interoperability for heterogeneous sensor networks

There are many kinds of heterogeneous sensor networks which are not able to have interoperability with each other due to differences of application profile, network protocol, radio signal, etc as shown in table 1. Non of interoperability among the heterogeneous sensor networks causes overinvestment and reusability problems when the sensor network applications or services are extended.

For example, it will cost overinvestment when upgrading overall system such as application service, middleware, gateway and sensor network area due to non of interoperability between existing and extending system. This implies that interoperability is very critical issue for preventing overinvestment through securing reusability of existing facilities. Therefore it is required to support Interoperability among the heterogeneous sensor.

Table 1 – Heterogeneous sensor networks

Layer	Heterogeneous sensor network
Network Protocol	ZigBee, 6LoWPAN, etc
PHY/MAC	IEEE 802.15.4, WIBEEM, Wibree, B-CDMA, etc

There are two points of view to have interoperability among the heterogeneous sensor networks:

- **View of sensor network** considers standardizing overall protocols such as application profile, network, PHY/MAC for node to node communication in sensor networks
- **View of application service** considers standardizing key information for application service which application service unit must use

As the view of sensor network, it has to be standardized for device profile, network protocol, Radio Signal, etc. However, it's not simple manner for these technologies to be standardized due to of complexity, scalability, and cost-effectiveness.

In contrast, the view of application service provides efficient and effective manner for establishing interoperability because they only care about key information used for application service. On the other hand, it implies that they do not have to care interoperability of device profile, network protocol, and radio signal. Thus it's simple manner to get the interoperability through standardizing the key information which has to be used for the application service.

5 Requirements of interoperability for heterogeneous sensor networks

Sensor network application service has specific characteristics with different service requirements and functional requirements from each other[ITU-T F.744]. Therefore the key information for the application service can be categorized by classifying functional and process model for application service. Finally analyze the application service data profile which supports interoperability by the view of application service.

5.1 Classification of functional and process model of application service

The function of USN application services can be summarized below in order to define the key information[ITU-T F.744]:

- Finding appropriate sensor networks to obtain sensed data
- Requesting raw sensed data and/or processed data
- Processing received sensed data
- Activating actuators
- Monitoring sensor network status
- Controlling sensor networks
- Authenticating sensor networks
- Providing appropriate services to users

These functions above are commonly required by many types of USN application services.

The process of application service can be distinguished into three processes from the functional model defined above as shown in table 2.

Table 2 – Process model

Process	Functions
sensed data	Requesting raw sensed data and/or processed data
	Processing received sensed data
event data	Activating actuators
management data	Finding appropriate sensor networks to obtain sensed data
	Monitoring sensor network status
	Controlling sensor networks
	Authenticating sensor networks
	Providing appropriate services to users

In other words the key information of application service is the data of sensor, event and management. Therefore the interoperability among the heterogeneous sensor networks can be established by standardizing these application service data profile. Concerning complexity, scalability and cost-effectiveness, it would be beneficial to support interoperability by standardizing application service data profile

5.2 Requirements of application service data profile description

The following are the description of application service data profile.

- **Sensor data**
 - Define sensor properties, such as sensor data types, value ranges and measurement units
- **Event data**
 - Define data used for the generation rules of event, such as application-dependant context-aware and events based on the raw sensed data
- **Management data**
 - Define management data as following the rules of application-dependant management for sensor nodes, such as QoS, sensor node connectivity, software upgrade, network topology

The following are requirements for the application service data profile.

5.2.1 Sensor data

There are many kinds of applications that use sensors, for example, temperature, humidity, vibration, acceleration, etc. And each of them has different requirements for sensor data type, resolutions, value ranges and measurement units.

Therefore designing flexible sensor data profile for different applications should carefully select sensor data type, resolutions, value ranges and measurement units.

- Sensed data validation regarding associated measurement units, data types and value ranges
- Application-dependant sensed data filtering
- Sensed data aggregation and integration based on an application policy

5.2.2 Event data

Event is one of sensor network application service function that responses against to the result of context-aware, alerting data validation regarding associated limitation.

- Context-aware rules, alerting data validation regarding associated limitation
- Control actuators

5.2.3 Management data

There are many kinds of sensor networks and sensor nodes which have different protocol-dependant management rules.

Therefore management data standard should consider flexibility and scalability to manage network and device.

- Management of QoS by priority order
- Connectivity management of sensor nodes
- Software upgrade of sensor nodes
- Query scheduling for multiple applications and sensor networks
- Query routing to designated sensor nodes

Bibliography

ISO/IEC JTC1 SGSN N149, *SGSN Technical Document Version 3*

Holger Karl and Andreas Willig, *Protocols and Architectures for Wireless Sensor Network*, WILEY, 2005