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Audiovisual services

Requirements and functional architecture for the open ubiquitous sensor network service platform

Recommendation ITU-T F.747.4

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Recommendation ITU-T F.747.4

Requirements and functional architecture for the open ubiquitous sensor network service platform

Summary

Recommendation ITU-T F.747.4 defines the requirements and functional architecture for the open ubiquitous sensor network (USN) service platform.

History

Edition	Recommendation	Approval	Study Group	Unique ID*
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Keywords

Open USN service, semantic data, USN middleware, USN resource.

* To access the Recommendation, type the URL http://handle.itu.int/ in the address field of your web browser, followed by the Recommendation's unique ID. For example, http://handle.itu.int/11.1002/1000/11830-en.

FOREWORD

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Introduction

There is a large number of middleware available for sensor networks and different kinds of ubiquitous sensor network (USN) middleware that may be deployed. Furthermore, USN services may utilize widely distributed sensors or sensor networks through different USN middleware. In a widely distributed environment, USN applications need to know of the various USN middleware, sensors and sensor networks used. For example, if an application wants to get the current temperature in Geneva, the application should have information specifying which USN middleware and which sensors or sensor networks can provide the data requested and how they can provide the data.

The open USN service platform aims to provide unified access to USN resources and sensed data/semantic data through heterogeneous USN middleware, thereby enabling USN applications to take full advantage of the USN capabilities. It allows providers, users and application developers to provide USN resources, use USN services, or develop USN applications without needing to have specific knowledge about the USN middleware and sensors, or how to access specific sensor networks. The main purpose of the open USN service platform defined in this Recommendation is to provide:

– easy access to and use of the global USN resources and sensed data/semantic data;

– easy connection of USN resources; and

– easy development and distribution of various applications.

Recommendation ITU-T F.747.4

Requirements and functional architecture for the open ubiquitous sensor network service platform

1 Scope

The objective of this Recommendation is to define the open ubiquitous sensor network (USN) service platform and provide requirements and functional architecture for the open USN service platform.

The scope of this Recommendation includes:

– concept of the open USN service platform;

– requirements for the open USN service platform;

– functional architecture of the open USN service platform;

– functional entities of the open USN service platform.

2 References

The following ITU-T Recommendations and other references contain provisions which, through reference in this text, constitute provisions of this Recommendation. At the time of publication, the editions indicated were valid. All Recommendations and other references are subject to revision; users of this Recommendation are therefore encouraged to investigate the possibility of applying the most recent edition of the Recommendations and other references listed below. A list of the currently valid ITU-T Recommendations is regularly published. The reference to a document within this Recommendation does not give it, as a stand-alone document, the status of a Recommendation.

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

[ITU-T Y.2201] Recommendation ITU-T Y.2201 (2009), *Requirements and capabilities for ITU-T NGN*.

[ITU-T Y.2221] Recommendation ITU-T Y.2221 (2010), *Requirements for support of ubiquitous sensor network (USN) applications and services in the NGN environment*.

3 Definitions

3.1 Terms defined elsewhere

This Recommendation uses the following terms defined elsewhere:

3.1.1 context awareness [ITU-T Y.2201]: A capability to determine or influence a next action in telecommunication or process by referring to the status of relevant entities, which form a coherent environment as a context.

3.1.2 sensor [ITU-T Y.2221]: An electronic device that senses a physical condition or chemical compound and delivers an electronic signal proportional to the observed characteristic.

3.1.3 sensor network [ITU-T Y.2221]: A network comprised of interconnected sensor nodes exchanging sensed data by wired or wireless communication.

3.1.4 sensor node [ITU-T Y.2221]: A device consisting of sensor(s) and optional actuator(s) with capabilities of sensed data processing and networking.

3.1.5 sensed data [ITU-T F.744]: Data sensed by a sensor that is attached to a specific sensor node.

NOTE – The sensed data are collected from USN resources via USN middleware and stored in a sensed data repository.

3.1.6 ubiquitous sensor network (USN) [ITU-T Y.2221]: A conceptual network built over existing physical networks which makes use of sensed data and provides knowledge services to anyone, anywhere and at anytime, and where the information is generated by using context awareness.

3.1.7 USN middleware [ITU-T Y.2221]: A set of logical functions to support USN applications and services.

3.2 Terms defined in this Recommendation

This Recommendation defines the following terms:

3.2.1 metadata: Description of USN resources which include types of operations supported, attributes for those operations, etc.

3.2.2 open USN service: USN service which provides unified access to USN resources and sensed data/semantic data through heterogeneous USN middleware.

3.2.3 semantic data: Data translated into resource description framework (RDF) [b-RDF] form from metadata of USN resources and sensed data, and data processed by the Semantic inference functional entity (FE) from data represented in RDF form. These data are stored in a Semantic data repository.

3.2.4 USN resource: An entity that provides a USN service including sensor, actuator, sensor node, sensor network and gateway.

4 Abbreviations and acronyms

This Recommendation uses the following abbreviations and acronyms:

API	Application Programming Interface
FE	Functional Entity
LOD	Linked Open Data
RDF	Resource Description Framework
REST	Representational State Transfer
SPARQL	SPARQL Protocol and RDF Query Language
URI	Uniform Resource Identifier
USN	Ubiquitous Sensor Network

5 Conventions

None.

6 Open USN service description and characteristics

USN services require USN applications to have knowledge of USN middleware and sensors or sensor networks in order to access USN resources. For example, heterogeneous USN middleware is not easily accessed by applications since each USN middleware may have proprietary application programming interfaces (APIs) which may hinder access to various USN resources attached to the USN middleware.

Even when applications have access to multiple USN middleware entities, the applications must search, collect, analyse and process the sensed data themselves.

These limitations can be overcome by providing a unified access method for USN resources and sensed data/semantic data via heterogeneous USN middleware.

Figure 6-1 shows the traditional USN service framework and the open USN service framework.

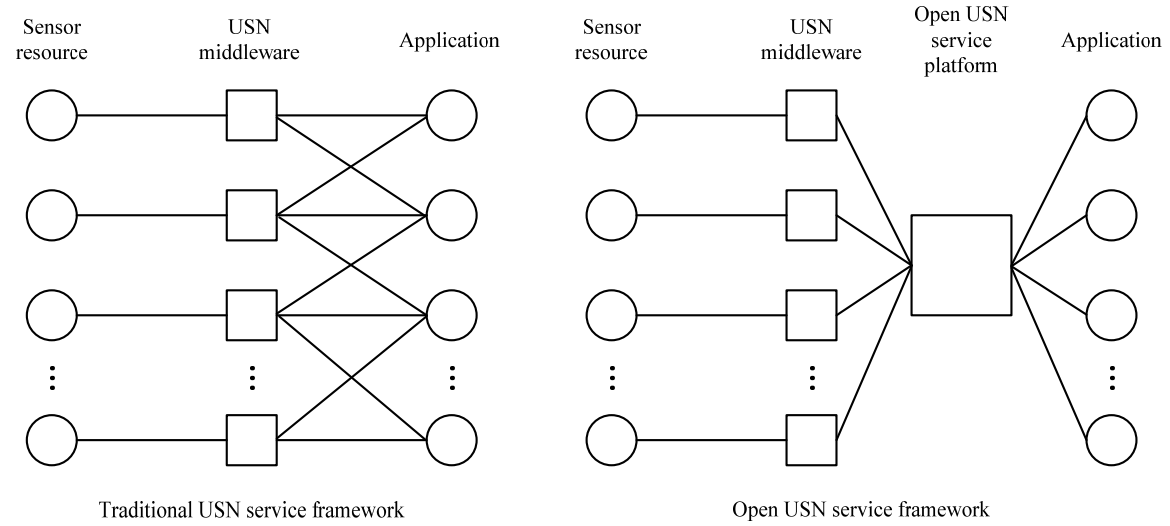

Figure 6-1 – Traditional USN service framework and open USN service framework

In the traditional USN service framework, each application needs to know how to access heterogeneous USN middleware and which USN resources should be accessed. In the open USN service framework, each application does not need to know how to access heterogeneous USN middleware nor which USN resources should be accessed.

Figure 6-2 shows heterogeneous USN middleware access provided by the open USN service platform.

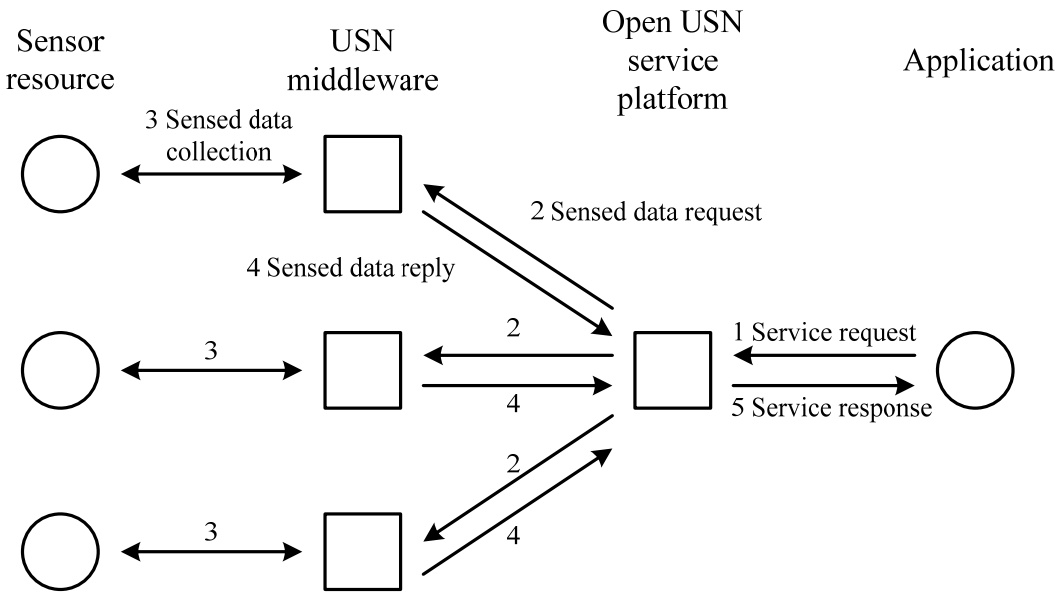

Figure 6-2 – Heterogeneous USN middleware access through the open USN service platform

In the open USN service framework, a USN application only needs to send requests to the open USN service platform; the remaining processing is done by the platform itself. The open USN service platform converts a request from each USN application into a specific request for different USN middleware.

The ultimate goal of the open USN service platform is to provide the application with the following services:

– easy access to and use of global USN resources and sensed data/semantic data;
– easy connection of USN resources;
– easy development and distribution of various applications.

7 Requirements for the open USN service platform

The following are the requirements for the open USN service platform.

7.1 Requirements to communicate with heterogeneous USN middleware

– It is required to provide an open interface for heterogeneous USN middleware to provide the sensed data and metadata received from USN resources.
– USN resources and semantic data are required to be identified by a universal resource identifier (URI).
– URIs for USN resources are required to be dynamically assigned when the USN resources are registered to the open USN service platform.
– It is required to provide open interface for accessing heterogeneous USN middleware.

7.2 Requirements of the open USN service platform

– USN resource management is required according to proper management policies on authentication, authorization and access rights.
– The characteristics and status of USN resources are required to be managed.
– It is required to provide functionality of inheritance and binding of USN middleware management policy.
– It is recommended to manage a logical group of USN resources according to application service requests.
– It is recommended to provide inference functions to derive the context data by user rules.

7.3 Requirements for linking the LOD

– It is required to be accessed by external linked open data (LOD) [b-LOD] by assigning a unique URI to each USN resource and semantic data.
– It is required to access the external LOD via the web.

7.4 Requirements for applications

– It is required to provide an open protocol, such as representational state transfer (REST), for applications.
– It is required to provide an open interface to services and applications for the combination of existing applications.

7.5 Requirements for USN resources and sensed data/semantic data

– Metadata of USN resources and semantic data are required to be represented in RDF [b-RDF] format.

– It is required to provide functions to store, query, modify and delete data in RDF form in the repository.
– It is required to provide functions to search USN resources and sensed data/semantic data by analysing the intention of service requests from an application.
– It is required to support a standard query language such as SPARQL Protocol and RDF Query Language (SPARQL) [b-SPARQL].
– It is recommended to manage access for USN resources and sensed data/semantic data according to proper access rights.

8 Functional architecture of the open USN service framework

8.1 Functional architecture

Figure 8-1 shows the functional architecture of the open USN service framework.

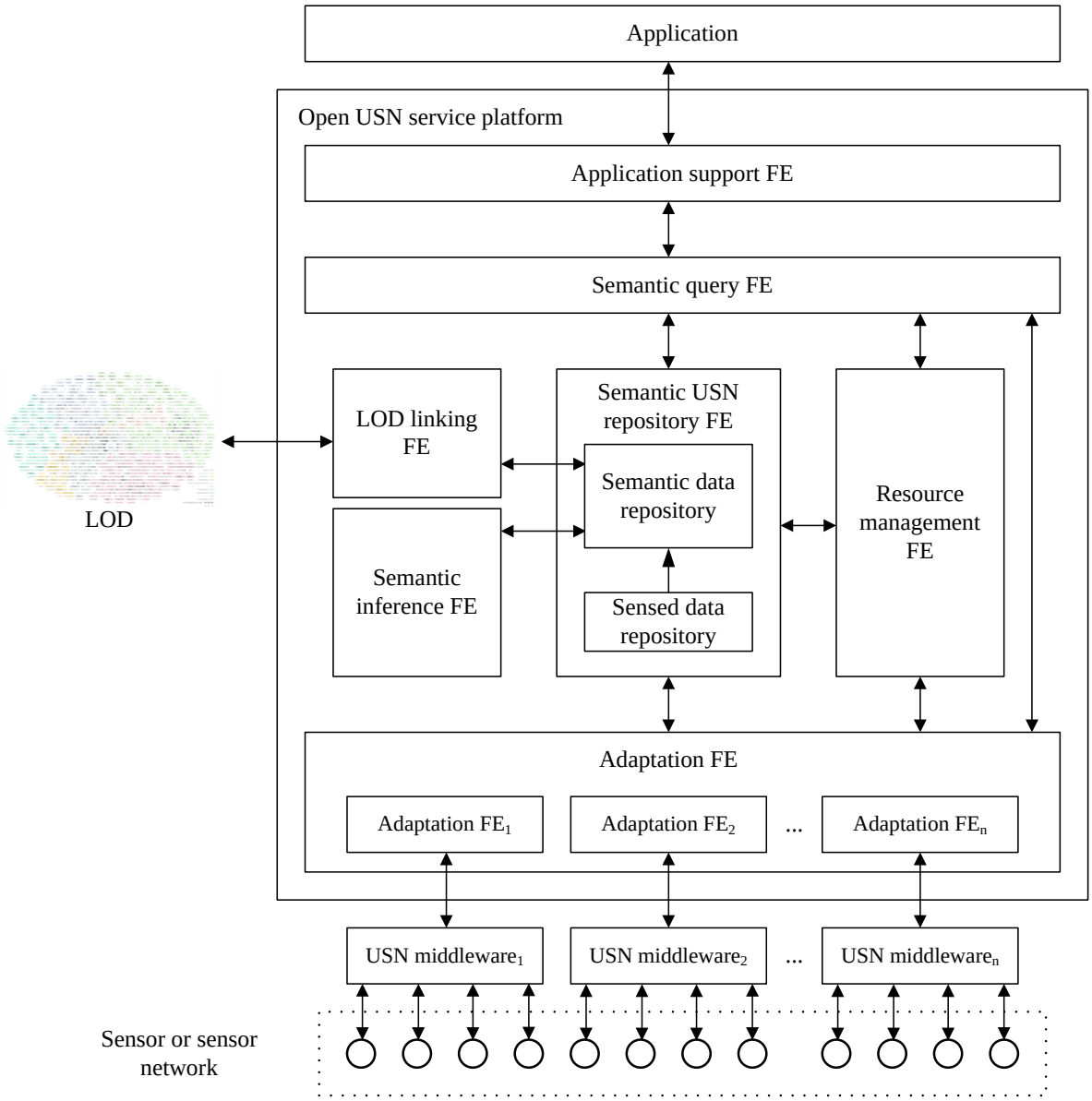

Figure 8-1 – Functional architecture of the open USN service framework

The functional architecture of the open USN service framework consists of the open USN service platform and heterogeneous USN middleware. The open USN service platform consists of seven functional entities (FEs): Application support FE, LOD linking FE, Semantic inference FE, Resource management FE, Semantic USN repository FE, Semantic query FE and Adaptation FE.

The heterogeneous USN middleware entities are integrated into the open USN service platform through the Adaptation FEs; furthermore, the metadata of USN resources and semantic data are shared with the other services through LOD linking FE.

8.2 Functional entities

8.2.1 Application support FE

The Application support FE provides the functions which enable USN applications to obtain open USN services and/or the sensed data/semantic data from the open USN service platform.

The Application support FE also supports the functions that allow the establishment or maintenance of connections or disconnections according to the type of data request, and access control to handle access rights for user authentication and the use of services.

8.2.2 LOD linking FE

The LOD linking FE provides the functions that enable users to access the metadata of USN resources and semantic data in the open USN service platform via the web. It allows linking external LOD with the metadata of USN resources and semantic data in the open USN service platform.

The LOD linking FE also supports the interface for querying the metadata of USN resources and semantic data from the LOD, and the functions which allow the application and management of policies that include criteria about selection and publication of data for the LOD.

8.2.3 Semantic inference FE (optional)

The Semantic inference FE provides the inference functions based on the information described in the ontology schema and user rules by using the data stored in the Semantic USN repository FE.

Through the inference functions, the original sensed data in the sensed data repository are processed into semantic data, such as context data, and stored in the semantic data repository. The semantic data repository is updated with the inferred data either periodically or on-demand. Furthermore, it provides the functions to compose different kinds of patterns and levels for inference.

8.2.4 Resource management FE

The Resource management FE provides the functions that issue and manage the URIs of USN resources and semantic data. It also provides the functions that manage the mapping relations with the address of the USN resource. Further, the Resource management FE supports the functions that enable USN resources to be automatically registered in the open USN service platform when a USN resource is connected to a network such as the Internet, and enables applications to obtain and utilize information about USN resources.

The Resource management FE provides the functions that enable USN resources to actively register their status and connection information. By using this information, the open USN service platform will support network connection and mobility of USN resources.

Therefore, the Resource management FE can support plug and play functions which enable the open USN service platform to dynamically use USN resources which can automatically connect to the open USN service platform and register their own status and property information.

The Resource management FE provides the functions needed to search URIs of USN resources for performing queries that can provide necessary information for requests from applications.

In some cases, the Resource management FE can provide the functions necessary to configure and manage a logical group on USN resources for satisfying application service requests.

The Resource management FE may perform the functions to create a resource group according to application service requests and to manage lists of USN resources that belong to the resource group. Also, it supports the functions needed to create, maintain and manage information such as the resource group purpose, makers, control with rights, etc. It provides the functions necessary to manage the lifecycle of each resource group according to the duration of service.

8.2.5 Semantic USN repository FE

The Semantic USN repository FE includes the functions for converting metadata of USN resources and sensed data into RDF form. The Semantic USN repository FE includes two different repositories: Semantic data repository and Sensed data repository.

The Semantic USN repository FE stores the metadata of USN resources and semantic data in the Semantic data repository in RDF form. Also, the Semantic USN repository FE stores sensed data collected from USN middleware in the Sensed data repository.

It also provides query functions for searching, modifying and deleting stored data, as well as for inserting new data.

8.2.6 Semantic query FE

The Semantic query FE performs the functions that handle queries to USN middleware, Semantic USN repository FE and Resource management FE for providing responses to application information requests. It consists of a query analyser function, middleware query function, SPARQL query function and URI request query function.

The query analyser function creates queries by analysing the intentions of requests made by the applications, translates the results of each query process according to application message specifications, and delivers the translated data to the applications through the Application support FE. It classifies the requests from the applications into a query to the USN middleware, a query to the Semantic USN repository FE and a query to the Resource management FE. The query to the USN middleware, which requests the sensed data to the USN resources through the USN middleware, is created from metadata of USN resources according to types and attributes of operations supported. The query to the Semantic USN repository FE, which requests the metadata of USN resources and semantic data to the Semantic USN repository FE, is created by translating the queries that the applications request into SPARQL. The query to the Resource management FE, which requests the URIs of corresponding USN resources to the Resource management FE, is created for performing queries to the USN middleware or the Semantic USN repository FE that can provide the necessary information for satisfying requests from applications.

The middleware query function performs the functions to send queries to the USN middleware, and to collect the resulting data from the USN middleware through the Adaptation FE: it also manages the query status of each query to the USN middleware created from the query analyser function. The data, received temporarily or periodically from the USN middleware, are stored in the Semantic USN repository FE by the Adaptation FE. However, in some cases, such as for a real-time sensed data request, the sensed data can be directly sent to the query analyser function.

The SPARQL query function performs the functions to simultaneously handle many SPARQL queries created by the query analyser function, to produce the outcome of each query from the Semantic USN repository FE and to deliver these to the query analyser function.

The URI request query function performs the functions to send URI request queries to the Resource management FE, receive the URIs of corresponding USN resources from the Resource management FE and deliver them to the query analyser function.

8.2.7 Adaptation FE

Adaptation FE provides the functions to handle the protocols and messages for setting up connections with USN middleware and delivering queries and commands. It works as an interface between the open USN service platform and heterogeneous USN middleware for processing the corresponding protocols and messages for the respective USN middleware.

It supports the message translation function to translate the data from/to heterogeneous USN middleware according to proper message specifications to deal with in the open USN service platform and the respective USN middleware. It also provides the message routing function to deliver the translated data to corresponding FEs (Semantic USN repository FE, Resource management FE and Semantic query FE) of the open USN service platform in order to process requests.

Appendix I

Information flow in the open USN service framework

(This appendix does not form an integral part of this Recommendation.)

This appendix describes the information flow related to the operation of the open USN service framework that includes USN resource registration, sensed data/semantic data access from Semantic USN repository FE and USN resources.

I.1 USN resource registration

Figure I.1 shows the information flow describing how to register a USN resource into the open USN service platform.

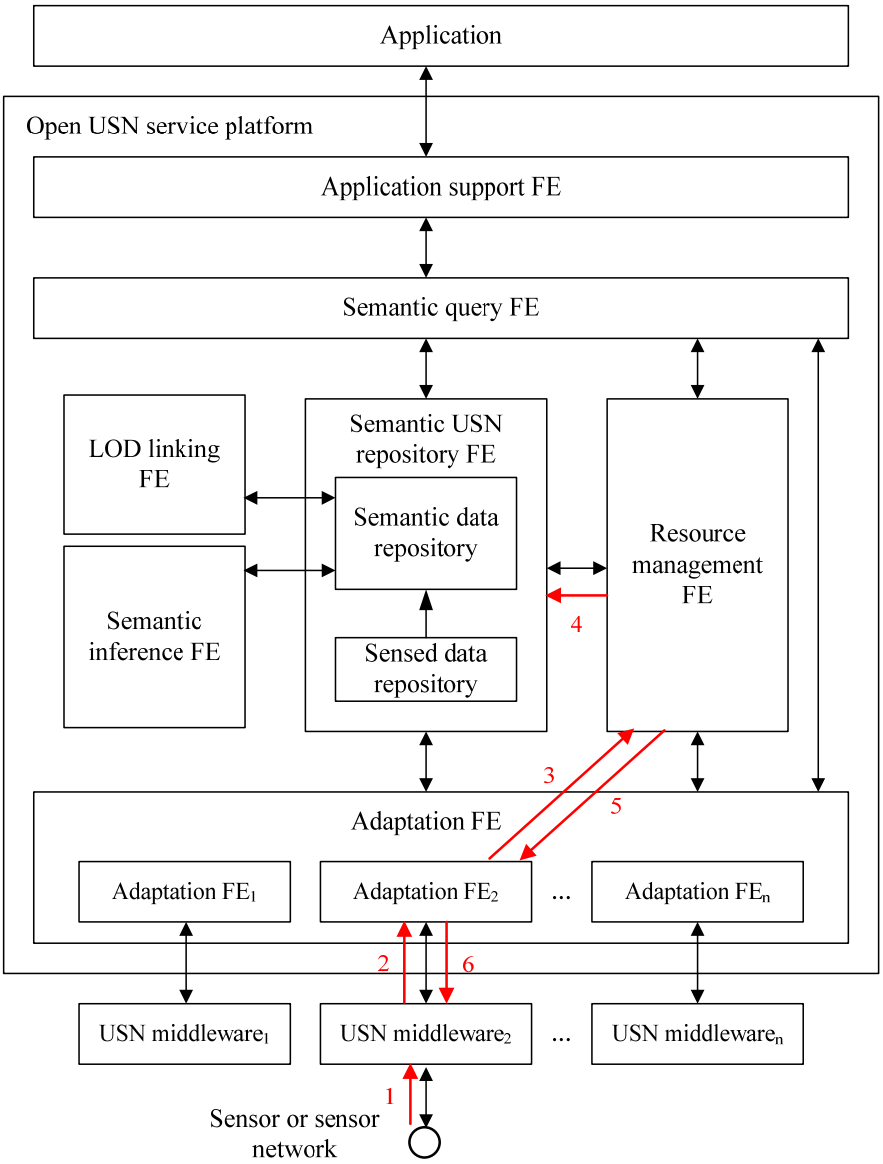

Figure I.1 – Information flow of USN resource registration

(1) The USN resource requests the USN middleware to register its information to the open USN service platform.

(2) The USN middleware sends a request to the open USN service platform through the Adaptation FE.

(3) The Adaptation FE sends the request message to the Resource management FE.

(4) The Resource management FE issues the URI of the USN resource and requests the Semantic USN repository FE to store the URI and metadata of the USN resource.

(5) The Resource management FE returns the result of the registration to the Adaptation FE.

(6) The Adaptation FE returns the result to the USN middleware.

I.2 Sensed data/semantic data access from Semantic USN repository FE

Figure I.2 shows the information flows describing how to access sensed data/semantic data stored in the Semantic USN repository FE.

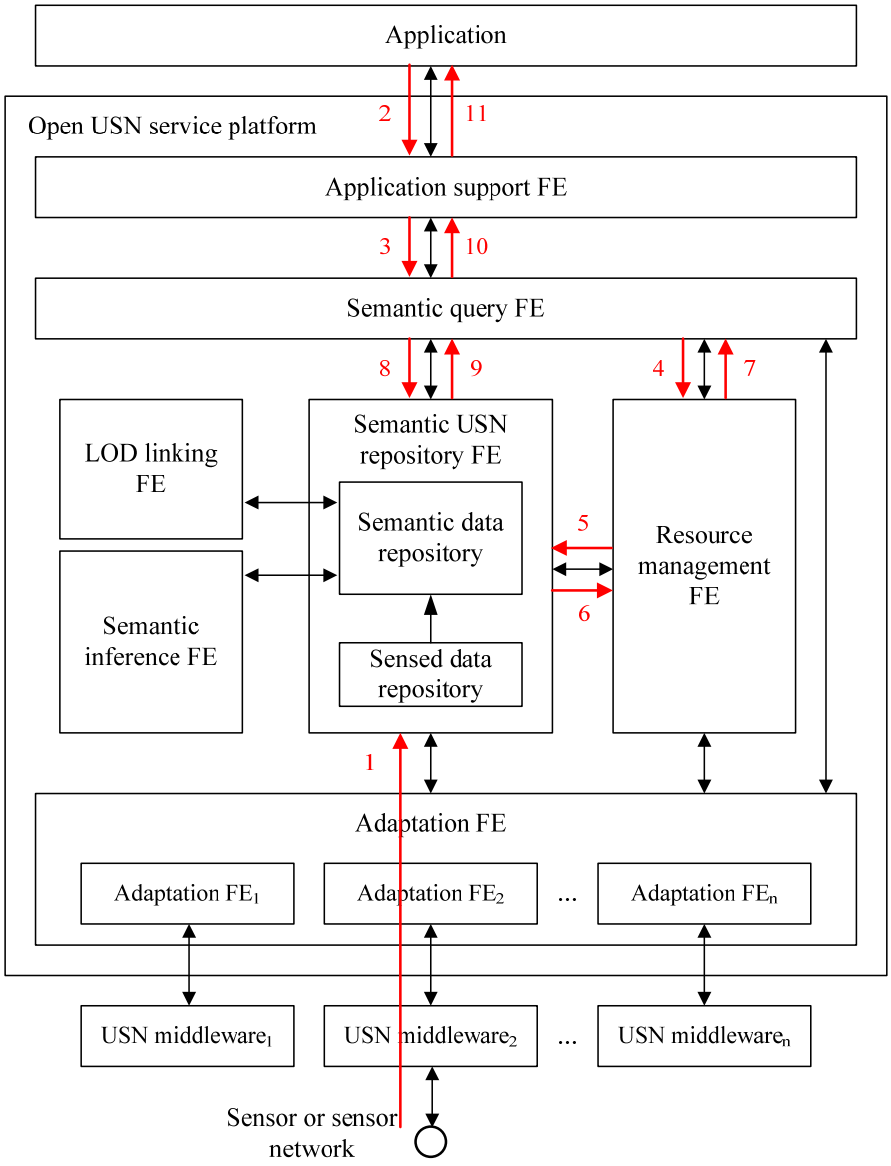

Figure I.2 – Information flow of accessing sensed data/ semantic data from Semantic USN repository FE

(1) The sensed data via the USN middleware from USN resources are periodically or continuously stored in the Semantic USN repository FE. The Semantic inference FE converts sensed data into semantic data periodically or on-demand.

(2) The Application requests the sensed data/semantic data from the open USN service platform through the Application support FE.

(3) The Application support FE sends a request message to the Semantic query FE.

(4) The Semantic query FE requests from the Resource management FE the URIs of USN resources that can be used for performing queries that will provide the necessary information to satisfy the Application request.

(5) The Resource management FE sends this request message to the Semantic USN repository FE.

(6) The Resource management FE receives the URIs of corresponding USN resources from the Semantic USN repository FE.

(7) The Resource management FE returns the URIs of corresponding USN resources to the Semantic query FE.

(8) The Semantic query FE queries the Semantic USN repository FE for the sensed data/semantic data related to the returned URIs.

(9) The Semantic query FE receives the sensed data/semantic data related to the returned URIs in the Semantic USN repository FE.

(10) The Semantic query FE sends the sensed data/semantic data to the Application support FE.

(11) The Application support FE sends the sensed data/semantic data to the Application.

I.3 Sensed data access from USN resources

Figure I.3 shows the information flows describing how to access sensed data directly from USN resources in real-time.

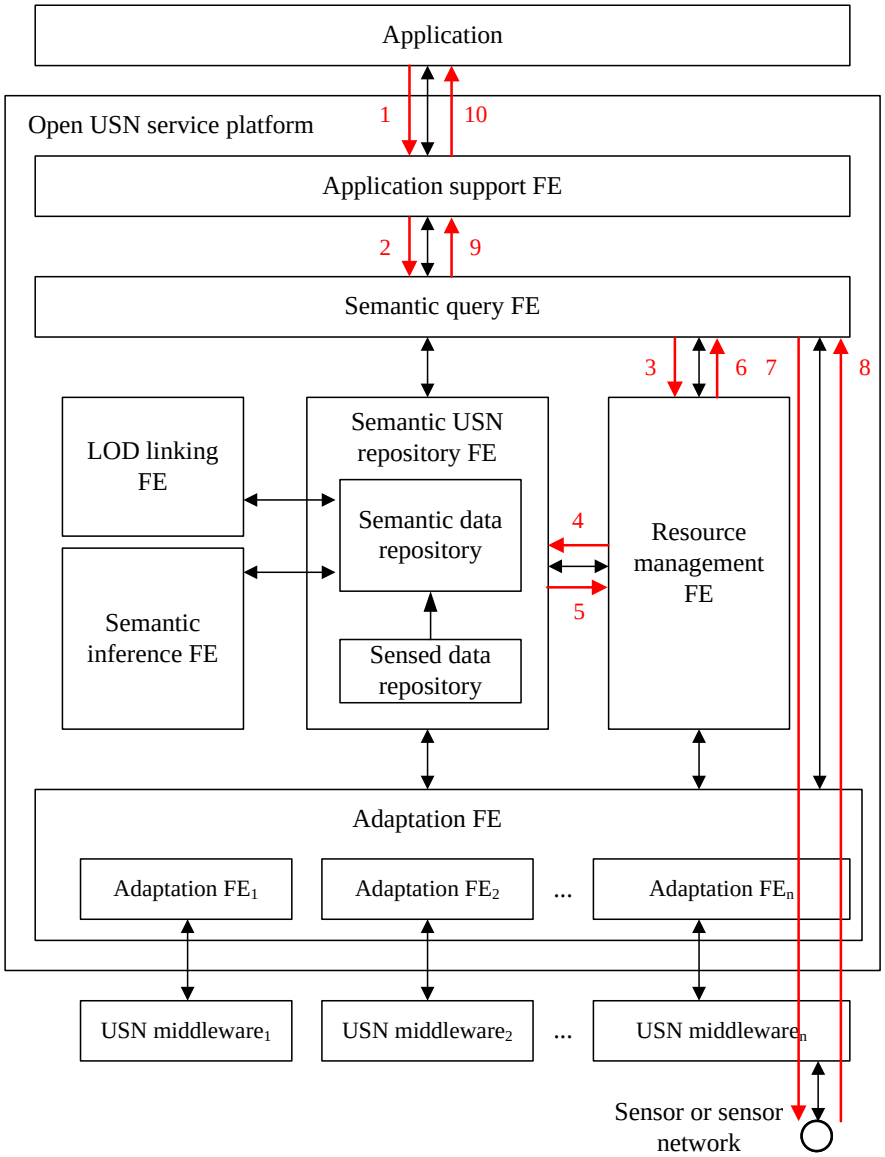

Figure I.3 – Information flow of accessing sensed data from USN resources

(1) The Application requests the sensed data from the open USN service platform through the Application support FE.

(2) The Application support FE sends a request message to the Semantic query FE.

(3) The Semantic query FE requests from the Resource management FE the URIs of USN resources that can be used for performing queries that will provide the necessary information to satisfy the request from the Application.

(4) The Resource management FE sends this request message to the Semantic USN repository FE.

(5) The Resource management FE receives the URIs of corresponding USN resources from the Semantic USN repository FE.

(6) The Resource management FE returns the URIs of corresponding USN resources to the Semantic query FE.

(7) The Semantic query FE queries via the USN middleware the sensed data of the corresponding USN resources using the returned URIs.

(8) The Semantic query FE receives the sensed data from corresponding USN resources via the USN middleware.

(9) The Semantic query FE sends the sensed data to the Application support FE.

(10) The Application support FE sends the sensed data to the Application.

Appendix II

Use cases of the open USN service platform

(This appendix does not form an integral part of this Recommendation.)

This appendix describes a use case for providing traffic information service using the open USN service platform.

II.1 Traffic information service using the open USN service platform

Most traffic information services provide information related to the driving of vehicles, such as traffic reports, road conditions and route guides (navigation) based on distance data. If various data related to the driving of vehicles are obtained in real-time, more valuable traffic information services could be provided. For example, recommended routes could be served more usefully by utilizing various data in real-time such as vehicle speed and condition data, weather data, traffic light data, personal schedule, and so on. Figure II.1 shows a use case that illustrates providing recommended routes in the traffic information service.

For this service, the open USN service platform could collect the following data:

– vehicle speed and condition (e.g., parts, tires, fuel) data from several sensors installed within the vehicle,

– weather data from weather sensors installed nationwide,

– traffic light data from sensor nodes that collect the state of traffic lights,

– personal scheduling data stored in a smart phone that can be used as a sensor node or gateway which delivers data in a smart phone to destination.

These data can be collected by the methods used to handle the respective messages and protocols through heterogeneous USN middleware, such as the open geospatial consortium (OGC) sensor web enablement (SWE) [b-SWE] or USN middleware described in [ITU-T F.744]. In the open USN service platform, the data collected from heterogeneous USN middleware are translated into proper message specifications by the message translation function of the Adaptation FE. The translated data are delivered to the corresponding FEs (Semantic USN repository FE, Resource management FE and Semantic query FE) of the open USN service platform in order to process requests by the message routing function of the Adaptation FE. The above data are stored in the Semantic USN repository FE in RDF form.

Using the Semantic inference FE, data with semantics such as the following context data are created and provided to users:

– recommended routes with good weather conditions and without traffic congestion, based on weather and speed data collected from vehicles on route to the destination;

– recommended routes to reach a meeting place in time for appointments according to personal schedule and vehicle fuel-level data based on traffic light and speed data collected from vehicles on route to the destination

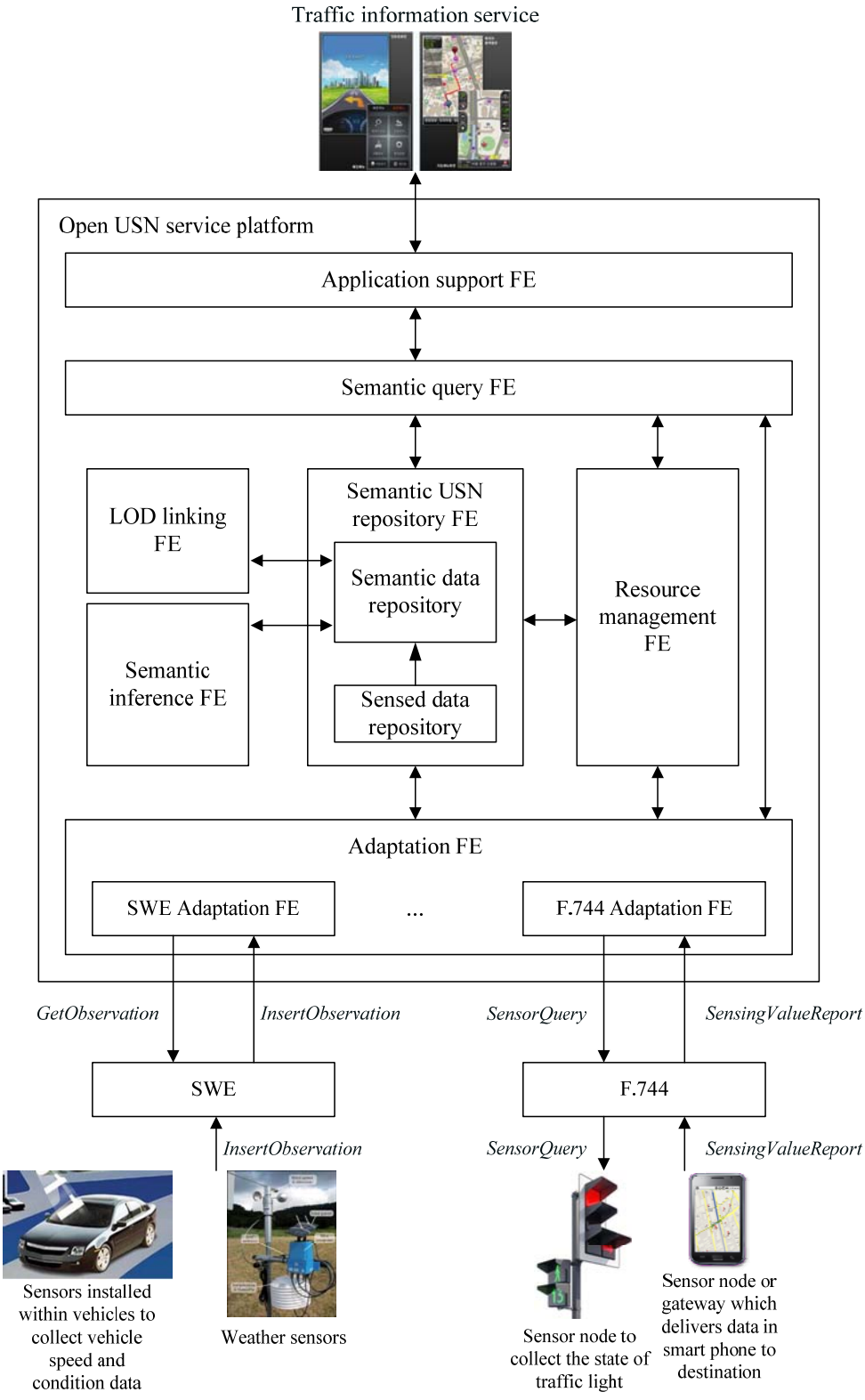

Figure II.1 – Traffic information service using the open USN service platform

Based on these data, the following scenario can be considered:

– The application requests information from the open USN service platform for finding the optimal route – with good weather conditions without traffic jams – to a destination.

– The open USN service platform collects relevant data from various sensors through various USN middleware including weather sensors and sensors installed within vehicles.

– The open USN service platform provides the information which is needed by the application to determine the optimal route to the destination.
– The application generates the recommended route to the destination based on the information provided from the open USN service platform.

Bibliography

[b-LOD] W3C Working Group Note 27 June 2013, Linked Data Glossary, *Linked Open Data (LOD)*, <http://www.w3.org/TR/ld-glossary/#linked-open-data>

[b-RDF] W3C RDF Working Group (2004-02-10), *Resource Description Framework (RDF)*, <http://www.w3.org/2001/sw/wiki/RDF>

[b-SPARQL] W3C Recommendation 15 January 2008, *SPARQL Query Language for RDF*, <http://www.w3.org/TR/rdf-sparql-query>

[b-SWE] Open Geospatial Consortium (OGC), Sensor Web Enablement Domain Working Group (DWG), *Sensor Web Enablement*, <http://www.opengeospatial.org/projects/groups/sensorwebdwg>

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