Recommendation

ITU-T H.862.7 (01/2024)

SERIES H: Audiovisual and multimedia systems

E-health multimedia systems, services and applications – Multimedia e-health data exchange services

Interoperability framework for sleep management services

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Recommendation ITU-T H.862.7

Interoperability framework for sleep management services

Summary

Recommendation ITU-T H.862.7 specifies an open, interoperable application programming interface (API) for smart sleep management devices and sleep services. In order to provide an individual with optimal sleep, data collection, analysis, and customized services on individual sleep are required. For this, interoperability between sleep management devices and services based on the Internet of things must be secured. Interoperability of services covered by Recommendation ITU-T H.862.7 includes interoperability of data and interoperability at the API level.

Sleep occupies a third of our lives, and helps to relieve the physical and mental fatigue experienced during the day. Therefore, it is possible to obtain an improvement effect that can enhance quality of life based on the understanding of sleep time and quality through sleep monitoring.

With the growth of the sleep market, various sleep monitoring products combined with information and communication technology have been launched, mainly composed of dedicated applications and sensors. The use of products composed of such dedicated software for each sensor is a major limitation in service operation. This is due to difficulties of integration with existing service data and sharing data with other services when changing the product or using it with other services.

History *

Edition	Recommendation	Approval	Study Group	Unique ID
1.0	ITU-T H.862.7	2024-01-13	16	11.1002/1000/15765

Keywords

Interoperability framework, sleep management services.

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FOREWORD

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The World Telecommunication Standardization Assembly (WTSA), which meets every four years, establishes the topics for study by the ITU-T study groups which, in turn, produce Recommendations on these topics.

The approval of ITU-T Recommendations is covered by the procedure laid down in WTSA Resolution 1.

In some areas of information technology which fall within ITU-T's purview, the necessary standards are prepared on a collaborative basis with ISO and IEC.

NOTE

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Recommendation ITU-T H.862.7

Interoperability framework for sleep management services

1   Scope

This Recommendation specifies sleep management service functions that are based on an open application programming interface (API) and a method for securing interoperability in terms of data and management.

This Recommendation includes:

–   an open API for sleep management services;

–   function APIs;

–   management APIs;

–   interoperability between sleeping devices and services.

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.

None.

3   Definitions

3.1   Terms defined elsewhere

This Recommendation uses the following terms defined elsewhere:

3.1.1   interoperability [b-ITU-T Y.101]: The ability of two or more systems or applications to exchange information and to mutually use the information that has been exchanged.

3.1.2   open interface [b-ITU-T Y.4201]: A public standard for connecting hardware to hardware and software to software. Open interfaces are designed and documented for safe and easy use by third party developers and freely available to all.

3.2   Terms defined in this Recommendation

None.

4   Abbreviations and acronyms

This Recommendation uses the following abbreviations and acronyms:

API   Application Programming Interface

ECG   Electrocardiogram

EEG   Electroencephalogram

FHIR   Fast Healthcare Interoperability Resources

IoT   Internet of Things

5   Conventions

None.

6   Background

Humans spend about one-third of their lives sleeping. The duration or quality of sleep greatly affects quality of life and health. Various types of device have been invented and used to improve the quality of sleep for a better life. Recently, devices have evolved from the passive form to monitor and improve sleep quality by directly intervention. In order to provide optimized sleep, customized services are required through individual sleep data collection and analysis. The sleep management service in this Recommendation follows the requirements of [b-ITU-T H.862.0].

This Recommendation provides an open interoperability API for smart sleep management devices and services.

7   Interoperability between sleep management devices and services

7.1   Sleep management services

A sleep management service requires various components such as an Internet of things (IoT) sleep management device (the core element), network infrastructure and a service platform.

Various technologies are used in a sleep management service for communication between a device, data relay unit, personal service terminal unit and service platform.

A sleep management service includes IoT protocols, security and personal information protection, data analysis and management, a service coordinator and service management.

When the perspective is expanded to various services and devices for sleep management, interoperability becomes an important consideration in service development and operation. The components of a sleep management service are shown in Figure 1.
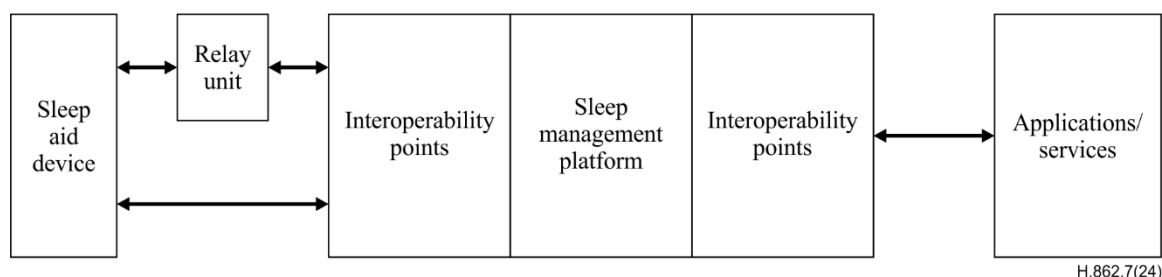

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Figure 1 – Components of a sleep management service

Although there are many standards applicable to IoT and lifelog interoperability, the following problems exist in accommodating various requirements of sleep management services.

–   While IoT standards are simple to apply to the functions of sleep management devices, such application increases their production cost.

–   The Health Level 7 fast healthcare interoperability resource [b-HL7 FHIR R5a] is used for lifelog interoperability, but this standard only deals with data interoperability, so it is inappropriate to apply to services.

7.2 Interoperability points

Interoperability points include devices, relays, platforms and application services. Sleep management devices are connected to the service platform through relays or by themselves. A service platform is connected to application programs or services.

7.3 Interoperability targets

In the sleep management service, interoperability targets include service data, service contents, and service functions.

7.3.1 Service data

Service data are those for sleep monitoring. Sleep monitoring data are expressed as measurement values measured by sleep aid devices or as values for combined sleep duration and quality. It is not easy to integrate sleep measurement values in terms of services because there are various sensors. In addition, it is difficult to accurately express sleep monitoring state because sensors have different accuracies. Various methods are used to express duration and quality of sleep in various services. Figure 2 is a diagram for data conversion for sleep management services.
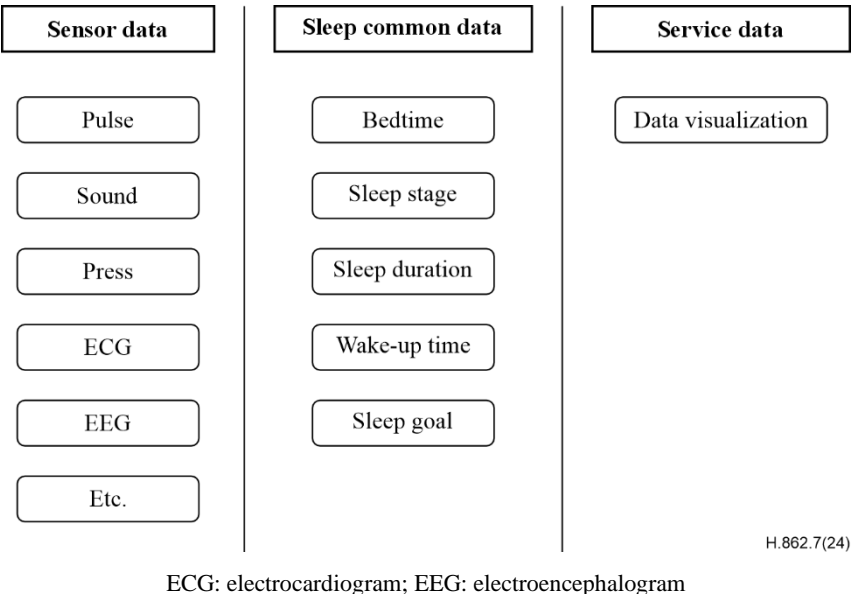
Sensor data	Sleep common data	Service data
Pulse	Bedtime	Data visualization
Sound	Sleep stage	
Press	Sleep duration	
ECG	Wake-up time	
EEG	Sleep goal	
Etc.		

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ECG: electrocardiogram; EEG: electroencephalogram

Figure 2 – Data conversion for sleep management services [b-ITU-T H.862.1]

7.3.2 Service content

Service content includes sounds, images, etc. to provide a sleep service. Service content js provided in the form of advice, white noise and visualization images to help sleep. These contents should be standardized so that they are used for various services with interoperability.

7.3.2.1 Providing personalized sleep content

Sleep content is provided to users according to their disease or habit. In order to provide customized services to users, it is necessary to record and analyse their sleep diseases and habits. Figure 3 shows the basic process for providing personalized sleep content.
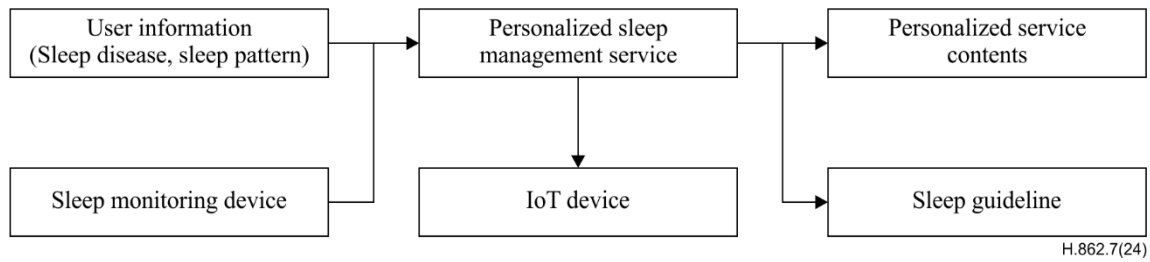
Figure 3 – Process of providing customized content

Service content data are composed of web standard documents, image and video standards, and IoT standard device control forms rather than user interface-dependent functions to provide contents of various expression types. Content is listed by type in Table 1.

Table 1 – Content by type

Content type	Content composition	Example
Visual data	Visual contents composed of text, images, videos, etc.	Images or video clips and text on the books
Auditory data	Audio files that are heard through the auditory sense	Sound for the sleep induction (white noise)
Environmental data	IoT devices that help for sleeping	Sleep surroundings (lighting control, humidity and temperature control)

7.3.3 Service functions

Sleep service functions are classified as those for information provision, recording and improvement.

7.3.3.1 Sleep information provision

Sleep information provision is a function that provides content helpful for sleep. Sleep information provision is divided into two types: one that provides information related to sleep at random; and one that identifies sleep problems and provides customized information to the user. Personalized information is helpful for both records and disorders of sleep.

7.3.3.2 Sleep record

A sleep record is classified as one by a user or one containing information obtained from an IoT device. Such records are important functional elements for checking the quantity and quality of the sleep of users and providing customized services to them. In order for sleep records to be interoperable, they must be expressed based on a common data model that is expressed in various services. As shown in Figure 2, it is expressed in the form of sleep common data in [b-ITU-T H.862.1].

7.3.3.3 Sleep improvement

Sleep improvement is the provision of digital services to assist sleep. Sleep improvement is a form of content provision, and involves detection of status in real time with an IoT device. In order to secure interoperability in sleep improvement, an IoT standard-based device connection method for service provision is utilized.

7.3.4 Service devices

Sleep management services employ devices to monitor, induce and improve sleep, as listed in Table 2. These devices are required to follow standard interfaces and protocols to ensure interoperability.

Table 2 – Type of devices

Device type	Description
Sleep monitoring	Devices to measure and record your sleep
Sleep induction	A device that helps you fall asleep using lights, sounds, etc.
Sleep improvement	Personalized device to improve sleep disorders

7.4 End-to-end security

Security is essential to processing sensitive health information. This Recommendation has been developed to support the development of secure systems.

Security that is excessive or insufficient can be both costly and risky. Security is dynamic and becomes more demanding over time. Therefore, security must be considered comprehensively.

Security standards considered in sleep management services are listed in Table 3, which includes advanced security and privacy requirements, such as identity management and prevention of source denial. Confidentiality means that only those who have the right to know have access to the data. Integrity ensures that the data is not tampered with or modified in any way to compromise the reliability of the data. Availability means timely access to information. Identity management enables the association of health information with the correct individuals by managing user identities across services. Nonrepudiation of origin is achieved using digital signatures, which guarantee that the sender of information cannot deny having sent it.

Table 3 – An overview of security standards used in sleep management services

Standards development organizations	Security standards	Security requirements
IETF	[b-IEFC RFC 5246]	Network protocol, confidentiality, integrity and authentication
HL7	[b-HL7 FHIRR5b]	Auditing
W3C	[b-W3C XML]	Data encryption
Bluetooth Special Interest Group	[b-Bluetooth HDP]	Confidentiality, integrity and authentication

8 Interoperability framework

Interoperability in management services is required to be considered from the perspective of data, content and devices of sleep. The interoperability framework for sleep management services is shown in Figure 4.
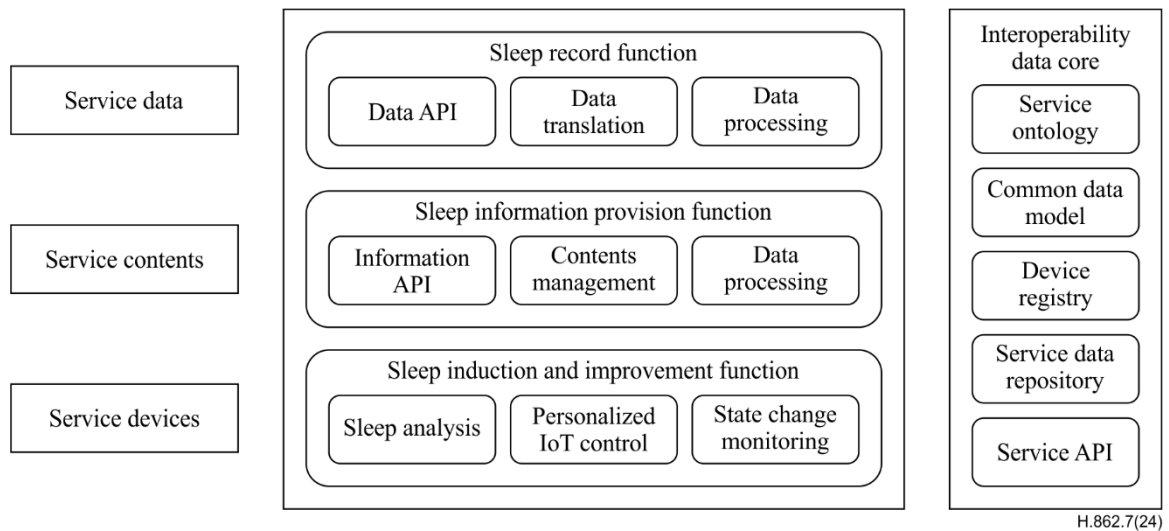
Figure 4 – Interoperability framework for sleep management services

8.1 Service function

This function records sleep provided by the sleep management service, provides information, and induces and improves sleep.

8.1.1 Sleep record function

This function records and processes sleep data, consisting of data API, data translation and data processing.

8.1.2 Sleep information provision function

This function provides sleep-related information. consisting of information API, component management and data process.

8.1.3 Sleep induction and improvement function

This function analyses sleep data and provides functions to induce and improve sleep, consisting of sleep analysis, personalized IoT control and state change monitoring.

8.2 Interoperability data core

This function refers to the basic elements to provide interoperability in sleep management services, including the items in clauses 8.2.1 and 8.2.5.

8.2.1 Service ontology

In order to provide semantic interoperability of services, an ontology-based semantic interoperability framework is utilized.

8.2.2 Common data model

Data collected from various sensors must be stored and provided in the form of a common data model to ensure interoperability. The common data model converts various types of information into an abstracted form of common data and may be provided as visualized information to a user.

8.2.3 Device registry

In order to provide services with the data of various manufacturers, for each device, metadata is stored and a method for identification is provided.

8.2.4 Service data repository

The sleep management service stores data collected from devices and data necessary for the service in order to measure and manage the sleep of the user.

8.2.5 Service application programming interface

APIs that should be provided include those for management of users, data and services, as well as APIs for functional interoperability. These APIs are provided in open form. In particular, the API that collects and transmits the sleep state from the sensor exchanges data in association with other service providers through a standardized open interface, such as those described in [b-HL7 FHIR R5b].

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