International Telecommunication Union

ITU-T

TELECOMMUNICATION
STANDARDIZATION SECTOR
OF ITU

Y.4117

(10/2017)

SERIES Y: GLOBAL INFORMATION INFRASTRUCTURE, INTERNET PROTOCOL ASPECTS, NEXT-GENERATION NETWORKS, INTERNET OF THINGS AND SMART CITIES

Internet of things and smart cities and communities – Requirements and use cases

Requirements and capabilities of the Internet of things for support of wearable devices and related services

Recommendation ITU-T Y.4117

ITU-T Y-SERIES RECOMMENDATIONS

GLOBAL INFORMATION INFRASTRUCTURE, INTERNET PROTOCOL ASPECTS, NEXT-GENERATION NETWORKS, INTERNET OF THINGS AND SMART CITIES

GLOBAL INFORMATION INFRASTRUCTURE	
General	Y.100–Y.199
Services, applications and middleware	Y.200–Y.299
Network aspects	Y.300–Y.399
Interfaces and protocols	Y.400–Y.499
Numbering, addressing and naming	Y.500–Y.599
Operation, administration and maintenance	Y.600–Y.699
Security	Y.700–Y.799
Performances	Y.800–Y.899
INTERNET PROTOCOL ASPECTS	
General	Y.1000–Y.1099
Services and applications	Y.1100–Y.1199
Architecture, access, network capabilities and resource management	Y.1200–Y.1299
Transport	Y.1300–Y.1399
Interworking	Y.1400–Y.1499
Quality of service and network performance	Y.1500–Y.1599
Signalling	Y.1600–Y.1699
Operation, administration and maintenance	Y.1700–Y.1799
Charging	Y.1800–Y.1899
IPTV over NGN	Y.1900–Y.1999
NEXT GENERATION NETWORKS	
Frameworks and functional architecture models	Y.2000–Y.2099
Quality of Service and performance	Y.2100–Y.2199
Service aspects: Service capabilities and service architecture	Y.2200–Y.2249
Service aspects: Interoperability of services and networks in NGN	Y.2250–Y.2299
Enhancements to NGN	Y.2300–Y.2399
Network management	Y.2400–Y.2499
Network control architectures and protocols	Y.2500–Y.2599
Packet-based Networks	Y.2600–Y.2699
Security	Y.2700–Y.2799
Generalized mobility	Y.2800–Y.2899
Carrier grade open environment	Y.2900–Y.2999
FUTURE NETWORKS	Y.3000–Y.3499
CLOUD COMPUTING	Y.3500–Y.3999
INTERNET OF THINGS AND SMART CITIES AND COMMUNITIES	
General	Y.4000–Y.4049
Definitions and terminologies	Y.4050–Y.4099
Requirements and use cases	**Y.4100–Y.4249**
Infrastructure, connectivity and networks	Y.4250–Y.4399
Frameworks, architectures and protocols	Y.4400–Y.4549
Services, applications, computation and data processing	Y.4550–Y.4699
Management, control and performance	Y.4700–Y.4799
Identification and security	Y.4800–Y.4899
Evaluation and assessment	Y.4900–Y.4999

For further details, please refer to the list of ITU-T Recommendations.

Recommendation ITU-T Y.4117

Requirements and capabilities of the Internet of things for support of wearable devices and related services

Summary

Recommendation ITU-T Y.4117 describes characteristics, specific requirements and capabilities of the Internet of things (IoT) for support of wearable devices and related services.

From an IoT requirement perspective, wearable device-related services (WDS) are classified in this Recommendation into four main classes: wearable device-related multimedia services (WDMS), wearable device-related health management services (WDHS), wearable device-related sport services (WDSS) and wearable device-related assistant services (WDAS). Wearable devices (WDs) can be categorized according to their usage (WDS class).

Specific requirements and capabilities of the IoT to support the different WDs and WDS are provided. Furthermore, information concerning relevant use cases for WDs and WDS is provided in an appendix.

History

Edition	Recommendation	Approval	Study Group	Unique ID*
1.0	ITU-T Y.4117	2017-10-29	20	11.1002/1000/13386

Keywords

Capabilities, characteristics, Internet of things (IoT), requirements, use cases, wearable devices, wearable device-related services.

* 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.

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Table of Contents

Recommendation ITU-T Y.4117

Requirements and capabilities of the Internet of things for support of wearable devices and related services

1 Scope

This Recommendation investigates characteristics of wearable devices (WDs) and wearable device-related services (WDS), and provides specific requirements and capabilities of the Internet of things (IoT) in order to support them.

The common requirements of the IoT [ITU-T Y.4100] are high-level requirements applicable to WDs and WDS. This Recommendation builds on the common requirements of the IoT and provides specific requirements and capabilities for support of WDs and WDS. These specific capabilities complement the capabilities of the IoT described in [ITU-T Y.4401].

The scope of this Recommendation includes:

– description of characteristics of WDs and WDS;

– specific requirements of the IoT for support of WDs and WDS;

– specific capabilities of the IoT for support of WDs and WDS.

Information concerning use cases for WDs and WDS is provided in Appendix I.

This Recommendation does not address requirements and capabilities of wearable devices themselves.

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 Y.4000] Recommendation ITU-T Y.4000/Y.2060 (2012), *Overview of the Internet of things.*

[ITU-T Y.4100] Recommendation ITU-T Y.4100/Y.2066 (2014), *Common requirements of the Internet of things.*

[ITU-T Y.4401] Recommendation ITU-T Y.4401/Y.2068 (2015), *Functional framework and capabilities of the Internet of things.*

[ITU-R P.525] Recommendation ITU-R P.525 (2016), *Calculation of free-space attenuation,* incorporated to the Radio Regulations by reference.

[IEC 60601-1-2] IEC 60601-1-2:2014, *Medical electrical equipment - Part 1-2: General requirements for basic safety and essential performance – Collateral Standard: Electromagnetic disturbances – Requirements and tests*.

3 Definitions

3.1 Terms defined elsewhere

This Recommendation uses the following terms defined elsewhere:

3.1.1 device [ITU-T Y.4000]: With regard to the Internet of things, this is a piece of equipment with the mandatory capabilities of communication and the optional capabilities of sensing, actuation, data capture, data storage and data processing.

3.1.2 gateway [b-ITU-T Y.4101]: A unit in the Internet of things which interconnects the devices with the communication networks. It performs the necessary translation between the protocols used in the communication networks and those used by devices.

3.1.3 Internet of things [ITU-T Y.4000]: A global infrastructure for the information society, enabling advanced services by interconnecting (physical and virtual) things based on existing and evolving, interoperable information and communication technologies.

NOTE 1 – Through the exploitation of identification, data capture, processing and communication capabilities, the IoT makes full use of things to offer services to all kinds of applications, whilst ensuring that security and privacy requirements are fulfilled.

NOTE 2 – In a broad perspective, the IoT can be perceived as a vision with technological and societal implications.

3.1.4 service [b-ITU-T Y.2091]: A set of functions and facilities offered to a user by a provider.

3.2 Terms defined within this Recommendation

This Recommendation defines the following terms:

3.2.1 wearable device (WD): A category of devices that are incorporated into items of clothing or accessories, which can comfortably be worn or carried by the user.

NOTE 1 – This Recommendation treats wearable devices as devices of the IoT (as defined in [ITU-T Y.4000]), considering that the communication between wearable devices and network may not require any human intervention.

NOTE 2 – Wearable devices often have a variety of sensing abilities, but limited power capacity, constraining communication and data processing abilities.

NOTE 3 – Wearable devices include devices usable by persons with disabilities.

3.2.2 wearable device-related assistant services (WDAS): A class of wearable device-related services specifically providing the user with services to improve personal efficiency.

3.2.3 wearable device-related health management services (WDHS): A class of wearable device-related services specifically providing the user with services for personal health management.

3.2.4 wearable device-related multimedia services (WDMS): A class of wearable device-related services specifically providing the user with multimedia content, virtual reality and social communication services.

3.2.5 wearable device-related services (WDS): With regard to the Internet of things (IoT), services built on the IoT and its capabilities that store, process and deliver data generated by wearable devices aiming to improve the life of the user.

NOTE 1 – Examples of WDS objectives include, but are not limited to, monitoring of the physiological conditions, expansion of perception and improvement of the work efficiency of the user.

NOTE 2 – Examples of data generated by wearable devices include user's physiological data, user's activity data and environmental data.

3.2.6 wearable device-related sports services (WDSS): A class of wearable device-related services specifically providing the user with services for sporting activity recording, analysis and planning.

4 Abbreviations and acronyms

This Recommendation uses the following abbreviations and acronyms:

2G second Generation

3G third Generation

4G fourth Generation

API Application Programming Interface

IoT Internet of Things

EIRP Equivalent Isotropically Radiated Power

NFC Near Field Communications

NIR Non-Ionizing Radiation

PHR Personal Health Record

WD Wearable device

WDAS Wearable Device-related Assistant Services

WDHS Wearable Device-related Health management Services

WDMS Wearable Device-related Multimedia Services

WDS Wearable Device-related Services

WDSS Wearable Device-related Sports Services

5 Conventions

In this Recommendation:

– The keywords "is required to" indicate a requirement which must be strictly followed and from which no deviation is permitted if conformance to this Recommendation is to be claimed.

– The keywords "is recommended" indicate a requirement which is recommended but which is not absolutely required. Thus, this requirement need not be present to claim conformance.

– The keywords "can optionally" and "may" indicate an optional requirement which is permissible, without implying any sense of being recommended. These terms are not intended to imply that the vendor's implementation must provide the option and the feature can be optionally enabled by the network operator/service provider. Rather, it means the vendor may optionally provide the feature and still claim conformance with the specification.

6 Introduction to wearable devices and related services

Figure 1 provides an overview of WDs and WDS in the IoT.

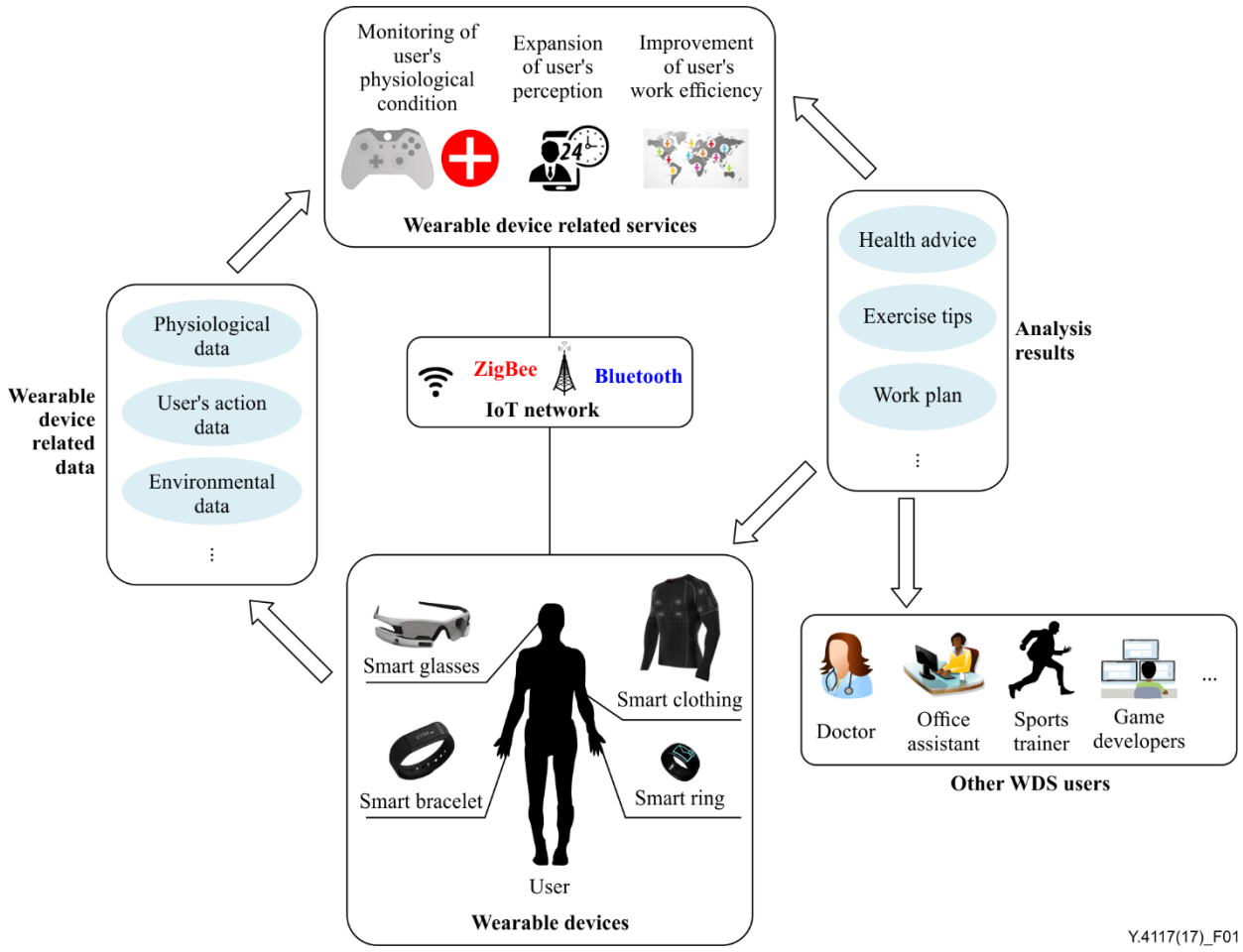

Figure 1 – Overview of wearable devices and wearable device-related services in the IoT

The fast development of semiconductor technology and mobile Internet has paved the way for the evolution of WDs. A WD can be seen as a kind of device [ITU-T Y.4000], such as a smart watch or virtual reality headset, with diverse sensing abilities that can be easily worn or carried by the user, as shown in Figure 1. By using information and communication technologies, WDS process the data generated by wearable devices including user physiological data, user action data, as well as environmental data. Objectives of these services include monitoring of the physiological conditions, expansion of perception and improvement of work efficiency of the user. In order to achieve these objectives, as an example, WDS provide analysis results, like health advice, exercise tips and work plans, to WDs and other WDS users, such as doctors and sport trainers. WDS interact with WDs via the IoT network as shown in Figure 1.

The common requirements of the IoT [ITU-T Y.4100] are high-level requirements applicable to all IoT devices and related services. However, the special characteristics of WDs and WDS, as well as the requirements and capabilities of the IoT especially aiming for efficient support of WDs and WDS, need to be investigated.

7 Characteristics of wearable devices and wearable device-related services

In this clause, the common characteristics of WDs and WDS are described taking into consideration the use cases described in Appendix I.

WDS are classified in this Recommendation into four main classes, as defined in clause 3: WDMS, WDHS, WDSS and WDAS. Different classes of WDS present specific characteristics. According to the categorization of WDS, the specific characteristics corresponding to the different classes of WDS are also described in this clause.

7.1 Common characteristics of wearable devices and wearable device-related services

Some characteristics independent of the particular class of WDS can be abstracted as common characteristics.

– Wearability: Unlike other devices that are agnostic to or rarely interact with users, WDs are carried by users and interact with them all the time. Convenience and comfort are the top considerations. The design of WDs needs to be small enough for convenience and portability.

– Personal data protection: WDs and related services collect, transmit, and store lots of personal data. The confidentiality of data is fundamental for WDS, while data sharing is essential for the mutual interaction of users within a community.

– Limited communication ability: Due to limitations of size, mass and power supply, WDs are not usually equipped with wide-bandwidth network access abilities. Most of them only support narrow-bandwidth connectivity technologies, e.g., Bluetooth and near field communications (NFC).

– Limited storage space: According to use cases, WDs have limited storage space.

– Limited power supply: Due to size and comfort requirements, WDs are only equipped with a small battery or even use solar or biological energy, which supply limited power.

– Intelligence: As WDs can be carried by different users and work in different environments, they need adequate intelligence to adjust themselves to different usages.

7.2 Characteristics of different classes of wearable device-related services and related wearable devices

Clauses 7.2.1 to 7.2.4 describe characteristics of the different classes of WDS as defined in clause 3.

7.2.1 Characteristics of wearable device-related multimedia services and related wearable devices

The characteristics of WDMS and related WDs follow.

– Real-time processing: Normally, the bulk raw multimedia data collected by WDs in WDMS are required to be processed in real time. Such real-time processing includes pre-processing, compression, coding and transmission of the multimedia streams.

– High power consumption: In WDMS, the power consumption of the WDs is relatively higher than in other classes of WDS, due to the massive quantities of data to be transmitted and real-time processing requirements.

7.2.2 Characteristics of wearable device-related sport services and related wearable devices

The characteristics of WDSS and related WDs follow.

– Best effort delivery: Sports data can be temporarily stored and transmitted when network access is available. It is not necessary for WDs in WDSS to ensure real-time interaction with remote services.

– Backend predominant analysis: Constrained by the size and fitness required by wearability in sports, the WDs in WDSS lack processing capability. Data analysis is generally realized in remote servers.

– Diverse operational environment: The surrounding conditions may vary dramatically in WDSS. WDs are supposed to operate normally in different sporting activity situations.

7.2.3 Characteristics of wearable device-related health services and related wearable devices

The characteristics of WDHS and related WDs follow.

– Always on and reliable: WDs in WDHS are always on and reliable, as health support is critical and intolerant of mistakes. Once an emergency takes place, warning messages or alerts must be generated and delivered in time.
– High precision: Health monitoring needs high precision of physiological signals in WDHS. Such high precision needs to be maintained during the data processing and analysis phases.
– Strict time delay tolerance: WDs in WDHS have strict time delay tolerance all the time, which is particularly crucial to ensure the timeliness of sensing data transmission in an emergency.

7.2.4 Characteristics of wearable device-related assistant services and related wearable devices

The characteristics of WDAS and related WDs follow.

– Individualization: For WDs in WDAS, the services are customized to the individual accessing the services and independently from the WDs. The customization may concern the human/WDAS interface, access history, personal address book, to do list, etc.
– Location awareness: Many services provided by WDAS are location based, such as navigation, patrol recording and location-based accommodation reservation. WDAS also pushes notifications according to WD positions.

8 Specific requirements of the IoT for support of wearable devices and wearable device-related services

This clause describes the specific requirements of the IoT for the support of WDs and WDS that complement the common requirements of the IoT described in [ITU-T Y.4100].

Clauses 8.1 and 8.2 provide common requirements of the IoT for WDs and WDS, respectively, and specific requirements of the IoT for different classes of WDS and related WDs.

NOTE – The requirements are numbered for Recommendation management purposes. Each requirement is assigned two letters (CR, SR) to distinguish between common and specific requirements; a third letter (where it applies) indicates the specific WDS class (M, S, H and A) to which the requirement applies, and a number to enumerate all the requirements within the specific group identified by the two or three letters. In clauses 8.1 and 8.2, requirement identifications appear between square brackets "[ ]" and are inserted at the end of each paragraph describing the corresponding requirement(s).

8.1 Common requirements of the IoT for wearable devices and wearable device-related services

The common requirements of the IoT for support of WDs and WDS are independent of any specific WDS class.

NOTE 1 – The common requirements of the IoT identified in [ITU-T Y.4100] are a prerequisite for the support by the IoT of WDs and WDS, including those concerning security and confidentiality.

The common requirements of the IoT for support of wearable devices and related services are as follows:

– The IoT is required to support WDS communications for WDs with size and shape constraints. [CR1]

  NOTE 2 – Antennas and battery parameters are constrained by size or shape.

– The IoT is recommended to support intelligent capabilities in order to provide good experience and accurate services to users according to their individual preferences, including historical data. [CR2]
– The IoT is recommended to offer open and secure application programming interfaces (APIs), and associated management, for WDs and WDS. [CR3]

NOTE 3 – As an example, this allows different actors of the ecosystem to access relevant data in a convenient and secure way.

– The IoT is recommended to support energy saving management capabilities and low power communication protocols that can reduce WDS energy consumption. [CR4]

NOTE 4 – This can extend the lifetime of power-constrained WDs.

– The IoT is recommended to support WDs that comply with national or regional regulations regarding non-ionizing radiation (NIR). [CR5]

– The IoT is required to support data sharing among different WDS and WDs. [CR6]

NOTE 5 – Services and devices may need to use data from other devices or services. For example, two different WDHS may need to share information related to a patient who is a user of both services, e.g., in order to facilitate doctor's diagnosis.

8.2 Specific requirements of the IoT for different classes of wearable device-related services and related wearable devices

8.2.1 Specific requirements of the IoT for wearable device-related multimedia services and related wearable devices

The following are specific requirements of the IoT for support of WDMS.

– The IoT is required to support high and reliable communication bandwidth for multimedia data transmission, like movies, voice and real-time online gaming. [SRM1]

– The IoT is required to support real-time data processing, e.g., for support of video and music playing and online gaming. [SRM2]

8.2.2 Specific requirements of the IoT for wearable device-related sport services and related wearable devices

The following are specific requirements of the IoT for support of WDSS.

– The IoT is required to support environment adaptability in order to cope with the different conditions of sporting activities, such as swimming and climbing. [SRS1]

– The IoT is required to support remote processing capability in order to cope with sporting activity data analysis, storage, management, sharing and feedback, given the limited processing ability in WDs. [SRS2]

– The IoT is required to support delay tolerant communications. [SRS3]

NOTE – For example, WDs in a sports scenario may cache the gathered data and transfer them when the network is available or according to a predefined schedule.

8.2.3 Specific requirements of the IoT for wearable device-related health management services and related wearable devices

The following are specific requirements of the IoT for support of WDHS.

– The IoT is required to support alarm mechanisms and warning messages according to WDHS requirements. [SRH1]

NOTE 1 – Alarm mechanisms and warning messages are essential for close surveillance on abnormal states of patients or old people.

– The IoT is required to provide accuracy both in sensing and analysis aspects according to WDHS requirements. [SRH2]

NOTE 2 – For example, WDs should capture the precise status of patients and WDHS should also provide the correct analysis of captured data.

– The IoT is required to provide reliable data communication in all possible communication environments (e.g., environments with healthcare devices, smart phones and WDHS). [SRH3]

NOTE 3 – This is the precondition to use WDHS and related WDs for taking care of patients or old people.

– The IoT is required to support WDHS communications for WDs compliant in terms of power constraints to an environment where medical electric equipment is present. [SRH4]

NOTE 4 – Depending on the minimal possible distance to medical electric equipment (d), the maximum value of equivalent isotropically radiated power (EIRP) shall not exceed $(E * d)^2/30$ [ITU-R P.525], where the limit of the electric field E is specified in Table 9 of [IEC 60601-1-2].

8.2.4 Specific requirements of the IoT for wearable device-related assistant services and related wearable devices

The following are specific requirements of the IoT for support of WDAS.

– The IoT is recommended to support network-assisted positioning. [SRA1]

NOTE 1 – Network-assisted positioning provides a WD with its network location when the WD does not have locating capability.

– The IoT is required to support voice communication and instant messaging communication capabilities. [SRA2]

9 Specific capabilities of the IoT for support of wearable devices and wearable device-related services

This clause describes the specific capabilities of the IoT for the support of WDs and WDS which complement the capabilities of the IoT described in [ITU-T Y.4401].

NOTE 1 – The capabilities of the IoT described in [ITU-T Y.4401] include support for security and privacy protection.

The capabilities specified in this clause are deduced from characteristics and requirements mentioned in clauses 7 and 8. Some capabilities are deduced from corresponding characteristics and requirements, others are deduced by the analysis of multiple characteristics and requirements.

NOTE 2 – The capabilities are numbered for Recommendation management purposes. Each capability is assigned two letters (CC, SC) to distinguish between common and specific capabilities; a third letter (where it applies) indicates the specific WDS class (M, S, H and A) to which the capability applies, and a number to enumerate all the capabilities within the specific group identified by the two or three letters. In clauses 9.1 and 9.2, the capability numbers appear between square brackets "[ ]" and are inserted at the end of each paragraph describing the corresponding capability(ies).

9.1 Common capabilities of the IoT for wearable devices and wearable device-related services

The common capabilities of the IoT for support of wearable devices and wearable device-related services are independent of any specific WDS classes. The capabilities follow.

– Wearable communications capability: Wearable communications capability provides communication technology support for WDs with size and shape limitations of antennas and battery. [CC1]

– Intelligent capability: Intelligent capability provides data processing, analysis and self-learning ability. [CC2]

– API management capability: API management capability provides standard APIs enabling access to data or services in a convenient and secure way. [CC3]

– Effective energy management capability: Effective energy management capability provides the appropriate energy-saving scheme for data collection, transmission and processing. [CC4]

– Radio frequency emission-constrained capability: Radio frequency emission-constrained capability enables communication with WDs that have constraints in terms of radiofrequency emissions. [CC5]

– Data-sharing capability: Data-sharing capability enables data to be shared among different WDs and WDS according to the WD user data sharing control. [CC6]

9.2 Specific capabilities of the IoT for different classes of wearable device-related services and related wearable devices

9.2.1 Specific capabilities of the IoT for wearable device-related multimedia services and related wearable devices

The capabilities of WDMS and related WDs follow.

– Real-time processing capability: Real-time processing capability realizes timely and efficient aggregation, processing and analysis of the multimedia data from WDs according to the specific WDMS requirements. This can ensure the quality of experience for users. [SCM1]

– Enhanced communication capability: Enhanced communication capability can offer high bandwidth and reliable communication mechanisms. It enables collected and analysed data transmission with low latency and packet loss, providing an adequate guarantee for the quality of experience of users. [SCM2]

9.2.2 Specific capabilities of the IoT for wearable device-related sport services and related wearable devices

The capabilities of WDSS and related WDs follow.

– Delay tolerant communication capability: Delay tolerant communication capability can enable WDs to transmit data to WDSS according to network availability. [SCS1]

– Remote processing capability: Remote processing capability enables data aggregation, sampling, modelling, analysis and feedback. With this capability, the computing load and energy consumption of WDs can be significantly reduced. [SCS2]

– Environmental adaptation capability: Environmental adaptation capability enables WDs to operate normally and reliably under diverse environmental conditions. [SCS3]

NOTE – For instance, water resistance capability is needed for WDs operating underwater.

9.2.3 Specific capabilities of the IoT for wearable device-related health management services and related wearable devices

The capabilities of WDHS and related WDs follow.

– Sensing accuracy and stability: Sensing accuracy and stability provides the capability of data sensing, collection, transmission and processing with accuracy and stability. [SCH1]

– Alarm capability: Alarm capability enables detection of abnormal health parameters and offers timely warning or alarm messages. [SCH2]

9.2.4 Specific capabilities of the IoT for wearable device-related assistant services and related wearable devices

The capabilities of WDAS and related WDs follow.

– Network-assisted locating capability: Network-assisted locating capability enables users to acquire their location information by the network. [SCA1]

– Voice and instant messaging communication capability: Voice and instant messaging communication capability can enable users to communicate with WDAS or others WDAS users via voice and instant messaging. [SCA2]

Appendix I

Use cases for wearable devices and wearable device-related services

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

I.1 Gateway for wearable device-related services

With the growing number of WDs and WDS, issues related to communication, security, cost, power consumption and device management become more and more critical. Most WDs cannot store and analyse data locally because of their limited power and computing resources, and only support short-range communication protocols like Wi-Fi [b-IEEE 802.11] or Bluetooth [b-IEEE 802.15.1]. Reliable and secure gateway capabilities are needed to process collected data from WDs.

Figure I.1 shows a use case of a gateway for WDS.

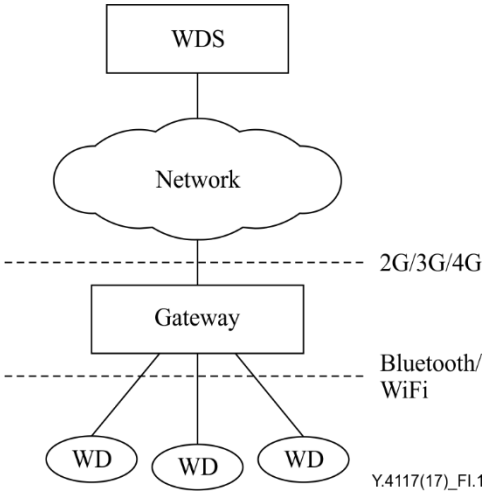

Figure I.1 – Gateway for wearable device-related services

Use case description

a) Before using the service, the user needs to configure the gateway and WDs.

b) WDs can automatically connect to the network through the gateway or synchronize their data with the network according to WDS settings. All data generated by the WDs can then be sent to WDS through the gateway.

In this use case, the gateway is capable of:

– interconnecting networks with different technologies;

– collecting, processing storing and relaying huge quantities of data from the WDs;

– acting as a computation centre for power-hungry processes on behalf of the WDs;

– acting as a firewall for security and confidentiality protection.

I.2 Wearable device-related multimedia services for broadcasting of car-racing games

According to statistics, more than half of the data generated by the Internet is multimedia entertainment content. Audiences always want to get this content in a simple or creative way. WDs with multimedia functionality will greatly impact the multimedia industry.

Figure I.2 shows a use case of WDMS for broadcasting of car-racing games.

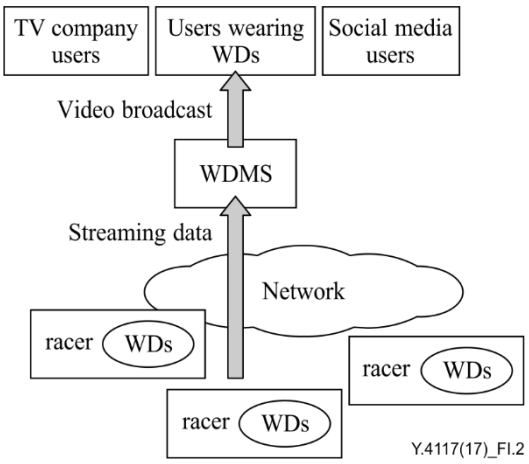

Figure I.2 – Wearable device-related multimedia services for broadcasting car racing games

Use case description

a) Racers are equipped with helmets with camera and Wi-Fi, and the helmets maintain connection to the network throughout the whole game.

b) All streaming data recorded by helmets are received and processed by WDMS, then broadcast to different multimedia users.

c) Users can see the live broadcast on TV or on social media. In addition, users wearing WDs like smart glasses can see the scenes in the same way as the racers, no matter where they are.

I.3 Wearable device-related sport services for running exercise

A WD can be used for sporting activity recording, e.g., accumulated number of steps, travelled distance and motion trail. With the availability of some extra information (e.g., sex, height, age of the runner), WDSS can suggest exercise plans based on the analysis of exercise records.

Figure I.3 shows a use case for a running exercise with WDSS.

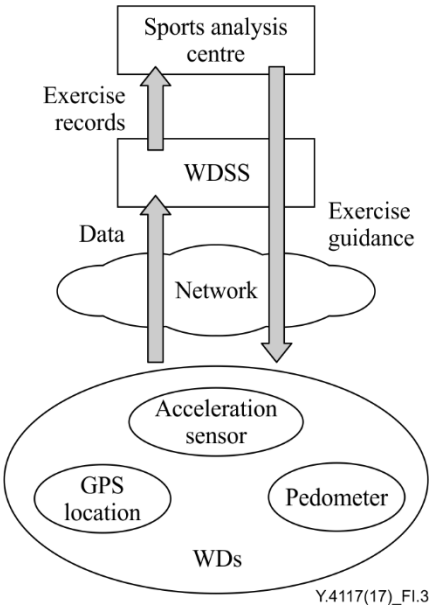

Figure I.3 – Wearable device-related sport services for running exercise

Use case description

a) A runner uses different WDs to collect running data, such as accumulated number of steps, travelled distance and motion trail. The collected running data are stored locally on the WDs.

b) A gateway collects all the running data and sends them to WDSS, and WDSS generate and store the running history data of the runner. As WDs may not always have network connectivity to the gateway, the collected data stored in the WDs may need the runner to enable their transmission.

c) With the permission of the runner, WDSS share the running history data with the sports analysis centre, normally a professional exercise agent like a gym or sporting club.

d) Exercise guidance, such as running trails, calorie consumption and total steps, developed by the sport analysis centre, is sent back to the runner.

I.4 Wearable device-related health management services for generation of personal health record related information

WDs used in the health management domain can include sensors to measure a broad range of physiological parameters, including heart rate, blood pressure and oxygen levels, sleep and mood conditions, and potentially even complex measures such as stress or blood sugar levels. WDHS put together all the data related to an individual for the generation of a personal health record (PHR) – i.e., a complete and accurate record of an individual's health state and medical history – for health management and medical consulting. For WDHS, the promise of keeping patients out of hospital and providing timely health advice and feedback is a major responsibility.

Figure I.4 shows a use case of WDHS for generation of PHR-related information.

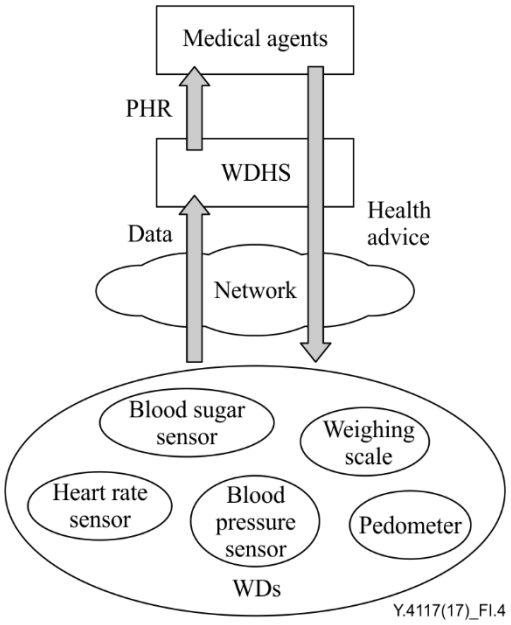

Figure I.4 – Wearable device-related health management services for personal health record-related information generation

Use case description

a) The WDHS user uses different WDs to collect different physiological data, e.g., body mass and blood pressure measurements in the morning, activity-tracking data and burning calorie during the daytime and sleep patterns at night.

b) User data are sent to WDHS, which generate and store a PHR of the user.

WDHS share the PHR with medical agents, like hospitals or recovery centres, with the user's permission, and forward health advice back to the WDHS user.

I.5 Wearable device-related assistant services for assistance of policemen on duty

WDs can be easily worn or carried by users for professional use, e.g., in law enforcement. Through the interconnection with the police system, WDAS may greatly increase the work efficiency of the police. Figure I.5 shows a use case of WDAS assisting policemen on duty.

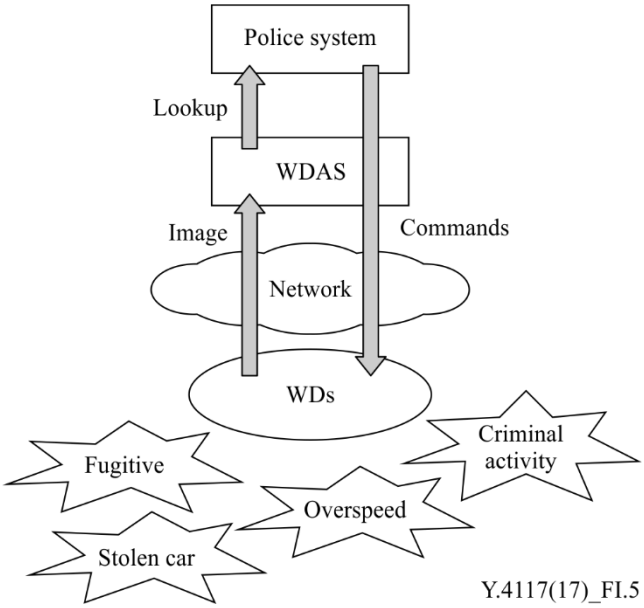

Figure I.5 – Wearable device-related assistant services to a policemen on duty

Use case description

a) Policemen on duty wear smart glasses or other appropriate WDs, and all suspected activities are recorded by WDs, e.g.,
   - checking for speeds above limit with an integrated speed measuring system;
   - suspected people or car tracking with an integrated camera.

b) Data collected by the WDs of policemen are sent to WDAS. WDAS classify the data and look up it in the police system.

c) WDAS forward specific commands back to the policemen, and assist them to take appropriate action, e.g.,
   - generation of a traffic plan so that policemen can arrive at the identified site as soon as possible;
   - real-time communication for police team work;
   - real-time reporting to police headquarters.

Bibliography

[b-ITU-T Y.2091] Recommendation ITU-T Y.2091 (2011), *Terms and definitions for next generation networks*.

[b-ITU-T Y.4101] Recommendation ITU-T Y.4101 (2017), *Common requirements and capabilities of a gateway for Internet of things applications*.

[b-IEEE 802.11] IEEE Std 802.11-2016, *IEEE Standard for Information technology – Telecommunications and information exchange between systems Local and metropolitan area networks – Specific requirements – Part 11: Wireless LAN Medium Access Control (MAC) and Physical Layer (PHY) Specifications*.

[b-IEEE 802.15.1] ANSI/IEEE Std 802.15.1-2005, *IEEE Standard for information technology – Local and metropolitan area networks – Specific requirements – Part 15.1a: Wireless medium access control (MAC) and physical layer (PHY) specifications for wireless personal area networks (WPAN)*.

[b-GLOBALCOM] IEEE Global Communications Conference (2016), *A Real Time and Non-Contact Multiparameter Wearable Device for Health Monitoring*.

[b-ICNIRP-guidelines] International Commission on Non Ionizing Radiation Protection (1998), *Guidelines for limiting exposure to time-varying electric, magnetic and electromagnetic fields (up to 300 GHz)*.

[b-IEEE Access] IEEE Access (2016), *Context-Aware Scheduling in Personal Data Collection From Multiple Wearable Devices*.

[b-JSAC] IEEE Journal on Selected Areas in Communications (2016), *Assessing System-Level Energy Efficiency of mmWave-Based Wearable Networks*.

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Printed in Switzerland
Geneva, 2017