Technology Reports

Wellness Support Platform Using Mobile Terminals

Metabolic syndrome has received much attention in recent years prompting the launch of a new health screening and intervention program in Japan to reduce the number of people suffering from both metabolic syndrome and pre-metabolic syndrome. The Wellness Support platform has been developed to enable vital data such as weight, blood pressure and step-count that affect the health of the user to be collected and provided to a healthcare provider or health adviser. This platform can simplify the management of vital data for the user while reducing the cost of data collection for health-related service providers and expanding the opportunities for acquiring customers.

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1. Introduction

A new health screening and intervention program oriented to metabolic syndrome[*1] was launched in April 2008 by the Japanese government. In this program, publically insured persons and nonworking dependents from 40 to 74 years old (hereinafter referred to as "insured persons") will be targeted for health checkups, and those deemed to be in need of health advice will receive active support or motivational support for up to six months. Considering that obtaining a person's vital data (weight, percentage of body fat, step-count, etc.) on a daily basis can be immensely useful in providing health advice, NTT DOCOMO has developed the Wellness Support platform. This platform interlinks the mobile terminal with health devices so that a person's vital data can be easily provided on a daily basis to an organization or company developing health-related services such as a health adviser. Wellness Support can also promote self-enlightenment in insured persons through a "visualization effect" achieved by enabling measurement results to be conveniently checked on a mobile terminal.

In this article, we outline the Wellness Support launched in June 2009 and describe health devices and functions for providing healthcare services.

2. Service Overview and System Configuration

2.1 Service Overview

The service concept is shown in **Figure 1**. The insured person to receive health advice, that is, the user, must first configure the wellness-appli, which is the i-appli for using this service, on his / her mobile terminal.

Then, after taking measurements with a health device, the user sends measurement results to the Wellness Support server that collects vital data via the wellness-appli on the mobile terminal. A health-related service provider

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*1 **Metabolic syndrome**: A state characterized by visceral fat obesity combined with at least two of the conditions of hypertension, hyperglycemia, and hyperlipidemia.

(hereinafter referred to as "SP") can now obtain that user's vital data from that server and provide the user with health-related services based on that company's know-how.

2.2 System Configuration

System configuration is shown in **Figure 2**.

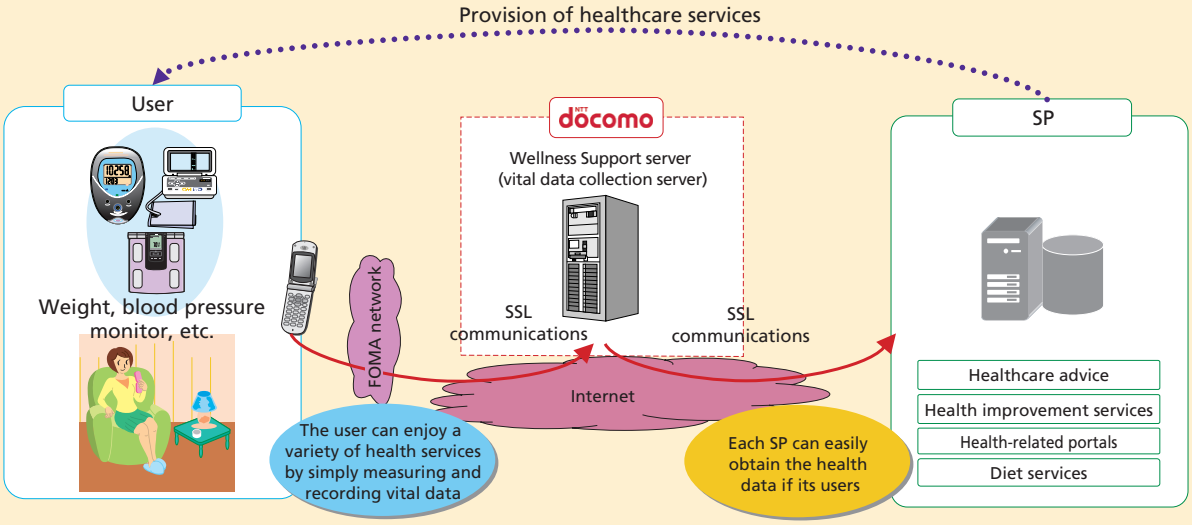
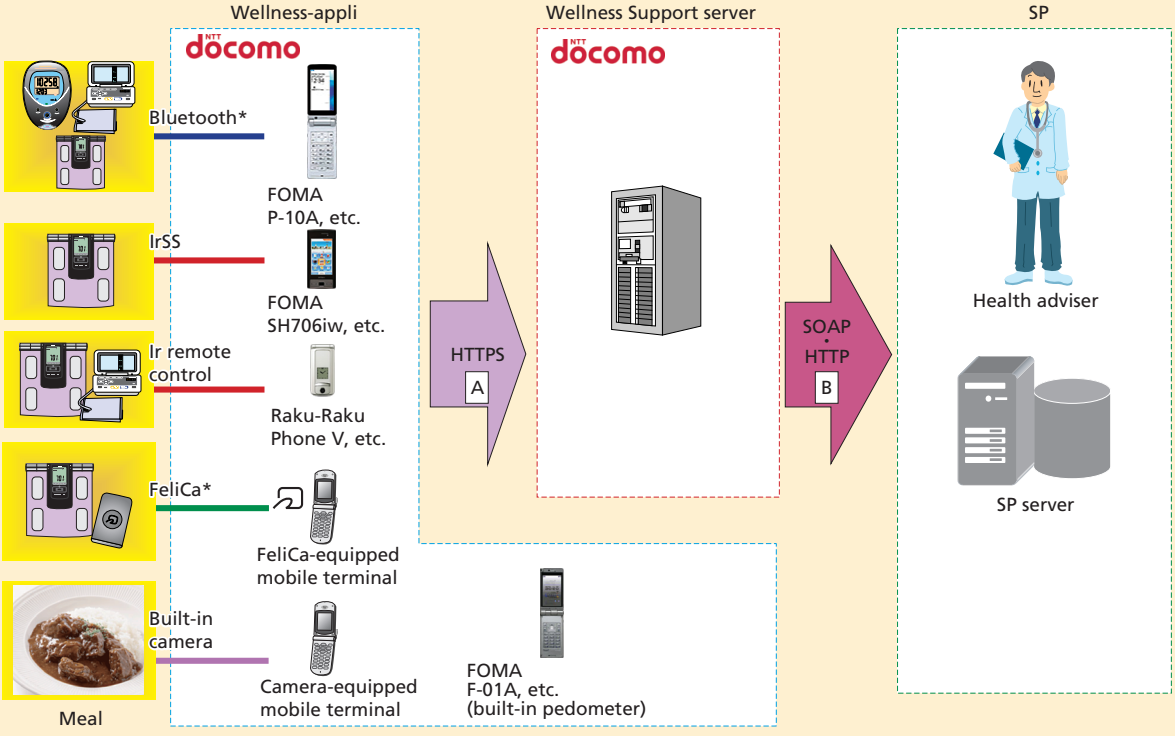


Figure 1 Service concept



* The Bluetooth and FeliCa systems shown above are at the prototype development stage (as of July 2009)

Figure 2 System configuration

1) Wellness-appli

The wellness-appli has three main functions as shown in **Figure 3** and described below.

- Data receiving through multiple interfaces

  Although health devices have different physical interfaces and communication protocols according to the manufacturer, the wellness-appli accommodates multiple physical interfaces for a variety of health devices in order to receive and analyze measurement data obtained from them.

- Data transmission to server

  The wellness-appli can transmit data received from health devices to the Wellness Support server using HTTPS encrypted communications.

- Data display by graphs and tables

  The wellness-appli features a graph-and-table display function enabling the user to visually check how personal vital data changes over time on a mobile terminal.

2) Wellness Support Server

This server features the following four functions.

- Data receiving/conversion

  The Wellness Support server receives data from the mobile terminal over HTTPS protocol via interface "A" shown in Fig.2. At this time, the format of the received data depends on the health device or manufacturer. The server absorbs these differences in format and performs a data conversion to a common format (such as Institute of Electrical and Electronics Engineers (IEEE) 11073[*2]) appropriate for SPs. To perform this conversion processing, the server stores information and data formats on different types of health devices and maps received data to this common format.

- Temporary data storage

  The server stores received vital data in the following three formats

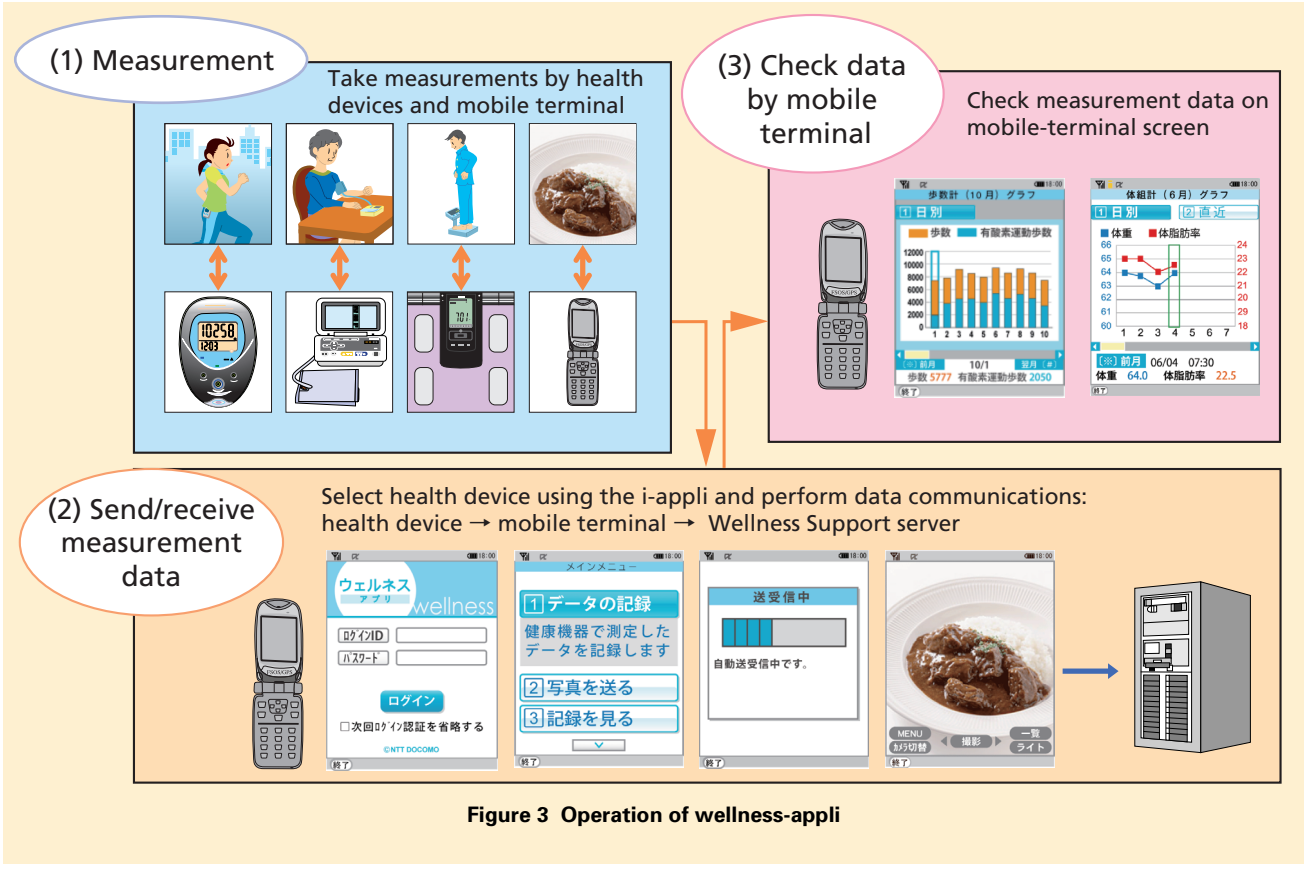


Figure 3 Operation of wellness-appli

*2 **IEEE 11073**: An international standard defining communication specifications between health-management instruments and systems. Support for the data formats of multiple health devices is under study. At present, the standard is targeting Bluetooth (see *5) and USB interfaces with plans to expand to ZigBee®, IrDA and serial communications.
ZigBee® is a registered trademark of ZigBee Alliance.

up until the data is obtained by the SP.

(a) Raw data format: The server saves data such as that for photos in the same file format as received from the i-appli.

(b) Extensible Markup Language (XML)[*3] format: The server converts received data into common XML format before saving.

(c) DB format: The server takes data from an XML file and places it into a DB conducive to searching and retrieval.

- Data provision to SP

An SP can obtain vital data from the Wellness Support server over Simple Object Access Protocol (SOAP)[*4] or HTTP/POST protocol via interface "B" shown in Fig.2. At this time, the SP can select a file in raw data format preceding conversion, in XML format following conversion, or in DB format for data searching depending on the system and scale of the SP.

- Diverse information management

The server manages various types of information including health-device information requiring format conversion, user information and SP information. User information consists only of correspondence information relating the user-application ID (including the user-application password) issued by this system and the SP login ID managed by the SP. The Wellness Support server manages no information identifying the individual user thereby separating received vital data from user-identifying information and enabling vital data to be searched for and retrieved on the basis of the SP login ID managed by the SP itself.

2.3 Interfaces between Health Devices and Mobile Terminals (i-appli)

To enable the wellness-appli to interact with a variety of health devices, support is being given to the following five types of interfaces (some of which are now in prototype development).

1) Bluetooth®[*5] Interface (Prototype Development)

The Bluetooth interface is being implemented in health devices and mobile terminals in prototype form. The Bluetooth profile adopted here is the Serial Port Profile (SPP) and the communication protocol is a proprietary one belonging to Omron Healthcare Co., Ltd., a manufacturer of health devices.

In general, Bluetooth signals are non-directional, which means that communication can almost always be achieved within a room. On the negative side, a pairing[*6] operation that includes input of a passkey[*7] must be performed beforehand, and during a communication, operations must be performed on a screen native to the mobile terminal, all of which can make terminal operations complicated for the user.

2) IrSS™[*8] Interface

This interface provides a high-speed, large-capacity system using infrared radiation to enable communication between the HBF363IT body composition monitor from Omron Healthcare and FOMA SH706iw. Here, vital data is embedded in a media format that can be received by the mobile terminal and transferred via data communications.

Since infrared communications is generally directional, the user must align the mobile terminal with the infrared emitter on the health device to receive data after taking measurements.

3) Ir Remote Control Interface

As one type of infrared communications, this interface adopts a protocol for communicating between the Raku-Raku Phone V (FOMA F884iES) and the BC-501 body composition monitor or BP-300 blood pressure monitor from TANITA Corporation. With this interface, the behavior of the TANITA KY-001 relay key for data transfer is reproduced on the mobile terminal.

In comparison with IrSS, the bit rate of this interface is inferior, but its ability to perform bidirectional communications is a strong point. Thus, in addition to data receiving, this interface enables the user to perform a variety of operations such as turning on the power supply of the health device and

*3 **XML**: A markup language proposed by the World Wide Web Consortium (W3C) for describing the meaning and structure of documents and data. It can be extended by user-defined tags.

*4 **SOAP**: A protocol for calling up data and services on other computers via a network.

*5 **Bluetooth®**: A registered trademark of Bluetooth SIG Inc. in the United States.

*6 **Pairing**: In Bluetooth, operations performed between two Bluetooth devices to establish connectivity. Once completed, subsequent connections become semiautomatic.

*7 **Passkey**: An authentication key or PIN. During the pairing process between two Bluetooth devices, a passkey is input at each device to perform mutual authentication.

inputting personal information such as height and age directly from a mobile terminal. This negates the need for bending over or stooping to operate the body composition monitor. Since this interface is based on infrared communications, the mobile terminal must be aligned with the infrared emitter on the health device when receiving data similar to the IrSS interface.

4) FeliCa®*9: (Prototype Development)

The FeliCa interface is also being implemented in health devices and mobile terminals in prototype form. It adopts the FeliCa communications system used for achieving Osaifu-Keitai (wallet phones). The wellness-appli makes use of three-way communications*10 to communicate with a dedicated reader/writer connected to an RS232C connector on a health device such as a body composition monitor. The reader/writer converts measurement data of the health device in question to a format oriented to mobile terminals and transmits the data to the wellness-appli on the mobile terminal.

With this interface, user operation is very simple. When taking measurements with a health device, the only thing the user has to do is to place the mobile terminal over the reader/writer.

On the other hand, only 150 bytes of data can be transmitted due to limitations in three-way communications, and as a result, all measurement data may not be transmitted depending on the health device.

5) Built-in Interfaces

- Built-in pedometer

Starting with the Raku-Raku Phone, there are an increasing number of mobile terminals that are coming equipped with a built-in pedometer. The pedometer data from such a mobile terminal can be used via an Application Program Interface (API) of the i-appli. Data can be obtained in a relatively short time in this way. In addition, an automatic startup function (native function) can be used to start up a timer and automatically obtain information from the built-in pedometer and forward it to the Wellness Support server. In this way, everyday information on the user's walking habits can be uploaded regularly to the server without the user having to worry about wellness-appli operations.

- Built-in camera

To enable a daily record of meals to be obtained through the use of a camera, the wellness-appli incorporates a function for sending photos to the Wellness Support server. Comments (text data) can also be attached to photos and transmitted at this time. The wellness-appli can maintain a record of photos sent to the server.

Since the amount of data in a photo is quite large compared to measurement data from a health device, the wellness-appli sets control and timing in the transmission of photos so that photo data can be correctly transferred to the server while minimizing the effects of transmission time on the user.

2.4 Server/SP Interfaces and Provided Functions

We can expect SPs making use of this service to be of diverse scale ranging from small- and medium-size SPs to those with large-scale operations. With this in mind and with the aim of simplifying connections, two types of interfaces are being implemented: the SOAP interface consisting of general Web-service technology and the HTTP/POST interface*11 using the POST method of HTTP. The data format used here for sending data to an SP is XML considering the flexibility it offers with regards to changes in data structure.

1) SOAP Interface

This interface, which adopts the SOAP protocol commonly used in the Web services field, has been installed on the Wellness Support server as one of two server/SP interfaces. The manner in which a SOAP message needs to be described to request the server to perform processing is obtained by reading the Web Services Description Language (WDSL) on the server.

The WDSL so obtained becomes a model for SOAP messages via SOAP-supporting middleware. Parameters can then be set in this model to send request

*8 **IrSS™**: A trademark of the Infrared Data Association® and a standard for using infrared radiation to communicate. Short for IrSimpleShot, it is a unidirectional communications function conforming to IrSimple 1.0.

*9 **FeliCa®**: A registered trademark of Sony Corp.

*10 **Three-way communications**: A mechanism for issuing instructions to the mobile terminal controller from the FeliCa reader/writer. It enables the wellness-appli startup and data transmission to be executed simultaneously.

messages to the server. The use of middleware in this way can make the creation of messages extremely simple.

2) HTTP/POST Interface

This interface has also been installed on the Wellness Support server. Used by many small and medium-size SPs and existing Web services, it is easy to use and has high affinity with existing systems. With this interface, parameters are input into a previously determined format and sent to the server using the HTTP POST method to request processing. Although the SP-side system must create an interface section, the HTTP/POST interface can cope flexibly with the system environment.

3) Provided Functions

The functions performed by the above server/SP interfaces can be broadly divided into the following two types.

- Search for and retrieve data sent from mobile terminals

The server/SP interface is outlined in **Figure 4**. Data sent from mobile terminals can be searched for and retrieved by setting conditions such as time and date of data transfer, user associated with that data, etc.

Data are provided to an SP in XML format. This enables the SP to prepare XSLT stylesheets[*12] that make it easy to transform documents received in XML into a form more appropriate to the data in question. At the same time, an increase in the types of health devices supported by the system can be easily handled by simply adding XSLT stylesheets or modifying existing ones.

As for photo data, the Wellness Support server saves photos without performing any conversion processing such as BASE64[*13] enabling the SP side to obtain photos taken by the user without having to worry about conversion processing.

- User operation functions

Users can be added or removed and passwords changed from the SP side. With functions like these, SPs can expedite the provision of services to users.

4) Security

The interfaces introduced above ensure security through the use of SSL communications, password hashing, time-limited authentication IDs, and other measures.

2.5 Future Issues

From here on, we plan to address the following issues with an eye to enhancing the Wellness Support system.

1) Unification of i-appli Operations

At present, the physical interface and communication protocol of a health device depends on the manufacturer and device model. In Bluetooth communications, for example, not only is it necessary to perform a passkey-input operation before communicating with the health device for the first time, the target device must also be selected on a native screen of the mobile terminal

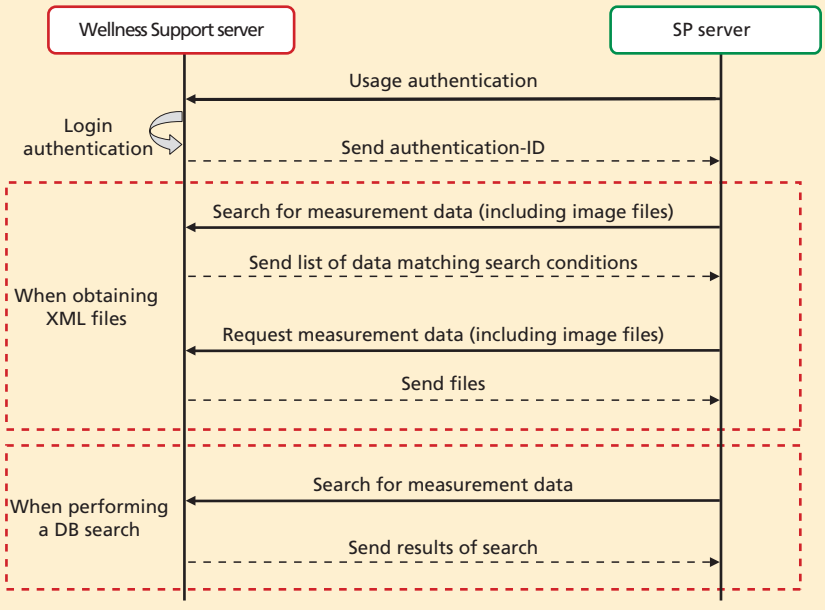


Figure 4 Server/SP interface

*11 **HTTP/POST interface**: A proprietary interface of the Wellness Support server created by using the HTTP POST method. While the SOAP interface is based on XML, this interface is based on JavaScript Object Notation (JSON) that makes it even easier to describe requests. JSON is a data description language based on JavaScript in which data are separated by commas and grouped by square brackets.

*12 **XSLT stylesheet**: A mechanism for describing the conversion of an XML document into a document in another format.

*13 **BASE64**: A system for converting binary data into a combination of characters from among a total of 64 alphanumeric characters and symbols to support binary data in a media environment such as e-mail that allows only alphanumeric characters to be used.

when taking data measurements. Such requirements that are necessary for Bluetooth but unnecessary in other interfaces can create confusion for the user when using a health device. In addition, supporting multiple interfaces can lead to higher development costs and operating expenses.

NTT DOCOMO is pursuing an ideal user interface and promoting protocol unification by interfacing with the health-device manufacturing industry and participating in standardization activities.

2) Shift of Vital-data Analysis Processing to the Server

At present, data obtained from a health device are transferred to the Wellness Support server after being analyzed by the wellness-appli. As a result, the introduction of new health devices or new models for existing ones requires that programs for analyzing the data of these new or upgraded devices be added to the wellness-appli even if such new or upgraded devices result in minimal additions to the content to be sent to the server. This means that the user may have to be asked to update wellness-applis frequently in the future as the number of health devices on the market increases.

In response to this situation, NTT DOCOMO is investigating an architecture that could accommodate new or upgraded health devices without having to update the i-appli on the user side. This could be accomplished by having the wellness-appli analyze only key items such as weight, blood pressure, and body temperature and having the server interpret and process all other data obtained from health devices.

3) Expansion of Provided Functions

A user-grouping function has been suggested as an expansion of the functions provided for SPs. As it turns out, there are cases in which users can be grouped on the SP-side by SP-provided menus or other means, and in which SPs are specifying users with such groups in mind when obtaining data from the Wellness Support server. As a future research issue, we will study a means of specifying users in units of groups.

3. Relationship with Continua Health Alliance

In February 2009, Continua Health Alliance (CHA)[*14] announced in Tokyo the release of Design Guidelines V1 and the launch of products and services in Japan (14 companies including NTT DOCOMO). At the same time, several companies are participating in the development and sale of metabolic guidance systems using Nintendo's Wii Fit®[*15] exercise game. Thus, by connecting measurement data from health devices to the network, many mechanisms for providing a variety of health services are being proposed.

3.1 Interfaces between a Health Device and Mobile Terminal (i-appli)

As reflected in the issues described above, standardizing data connectivity between health devices and mobile terminals will make it much easier to implement the wellness-appli and should facilitate connection with many CHA-based health devices.

The physical interfaces specified by the CHA guidelines are USB and Bluetooth. The profile adopted for Bluetooth is the Health Device Profile (HDP)[*16] and the data format conforms to IEEE 11073.

3.2 Server/SP Interface

The interface between the server and SPs has not yet been specified, but it has begun to be discussed in a CHA Working Group (WG). In this WG, much importance is being given to this interface due to its role in distributing health-related information. NTT DOCOMO is actively participating in those discussions and conducting studies on extending the server/SP interfaces presented in this article to keep pace with these standardization efforts.

4. Conclusion

In this article, we described the Wellness Support launched in June 2009. Services that make use of measurement data from health devices constitute a field that will no doubt increase

*14 **CHA**: An organization promoting home health care using health and medical devices such as weight and blood pressure monitors.
*15 **Wii Fit®**: A registered trademark of Nintendo Co., Ltd.
*16 **HDP**: A profile under study by Bluetooth SIG Inc. targeting medical devices.

significantly in the years to come. They will probably become an indispensible part of our lives as the technology supporting them continues to progress.

Looking forward, NTT DOCOMO will continue to work together with health-device manufacturers, SPs, and standardization bodies with the aim of developing advanced systems that can provide user-friendly health services.