SFML: Screening Form Markup Language for Healthcare Service

Kyuchang Kang*, Seonguk Heo*, Changseok Bae*

*BigData Software Research Lab. Electronics and Telecommunication Research Institute

218 Gajeongno Yuseong-gu Daejeon Korea

{k2kang, h7530, csbae}@etri.re.kr

***Abstract*— This paper proposes a markup language to describe and deliver the contents of health screening form and a case study for data transfer. In this paper, we define elements and schema needed to generate a health screening form based on personal lifelogs including data from daily, health and medical domain. In our proposal, we allow for three categories of data. First, the daily domain includes lifestyle data represented as activity, a sleeping pattern and eating habits. Second, the health domain includes height, weight, blood pressure, glucose and so on. Third, the medical domain includes the result of medical treatment information from a medical institute. This information is structured as SFML and can be exchanged with participant of health service entities.**

***Index Terms*—Healthcare, lifelog, markup language, screening form**

I. Introduction

MAJOR challenges to modern healthcare is to find solutions to cope with aging population, rising of inpatient and ambulatory costs, lack access to facilities and personal of rural residents. Due to the aging population, chronic disease began to emerge as the central healthcare issue. Chronic disease is the major cause of disability, the principle reason why patients visit hospitals [1]. Especially, South Korea is expected to become the most aged country in the world in 2050, raising worries it could erode the economy's growth potential.

To prevent or monitor chronic diseases, we need continuous monitoring of lifestyle and connection with healthcare professionals. A health screening in everyday life can be one of solution for these objects.

Screening, in medicine, is a strategy used in population to detect a disease in individual without signs or symptoms of that disease. Unlike what generally happens in medicine, screening tests are performed on persons without any clinical sign or disease [2].

Todays, almost all the people have chance of a regular health screening supported by a company or the government every year. As preparing the checkup, people may generally fill up the health screening questionnaire to describe their health-related condition. From the point of personal information, an individual's lifelog of everyday life is a good record of behavior. Therefore, using the personal lifelogs is good approach to provide personalized healthcare service after the analysis of individual's behavior.

In addition to individual's behavior, we can consider health-oriented information to configure screening questionnaire. As one solution to describe individual's condition and current status of body, we describe a health screening form leveraging personal lifestyles, biometric information, and medical treatments. By the health screening form, individual's health-related data can be commonly utilized in private and public medical institutes. To this end, users can generate and leverage their screening form. As the result, users can provide their screening form with medical staff on demand when they visit a medical center.

On the other hand, the health screening form is melting pot of various personal data and maybe used various entities of healthcare service. Therefore, we also consider the cooperation and compatibility of them. To meet this need, we propose SFML (screening form markup language) to embrace various data and to exchange them with associated entities.

In this work, we define and specify XML elements for control and data transmission and describe case study for personal lifelog-based screening form, as a part of screening system architecture.

The remainder of this paper is organized as follows. In section II, we present related background of this work. Section III shows the concept of the health screening form, a prototype implementation and related data specifications. In section IV, we present SFML scheme and a case study including data transfer. Section V discusses related studies and the needs for standardization. Finally, we conclude this paper in Section V.

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Kyuchang Kang is with Electronics and Telecommunication Research institute, 218 Gajeongno Yuseong-gu Deajeon 305-700 Korea (phone: +82-42-860-1695; fax: +82-42-860-5545; e-mail: k2kang@ etri.re.kr).

Seonguk Heo is with Electronics and Telecommunication Research institute, 218 Gajeongno Yuseong-gu Deajeon 305-700 Korea (e-mail: h75304@ etri.re.kr).

Changseok Bae is Electronics and Telecommunication Research institute, 218 Gajeongno Yuseong-gu Deajeon 305-700 Korea (e-mail: csbae@ etri.re.kr).

II. Background

This section presents the background environment of this work.

In the medical field, it is necessary to gather as much personal information as possible about patients in order to achieve high-quality diagnosis and treatment. Until now, the personal information used in diagnosis and treatment has basically been gathered and used only within medical facilities. It consists of clinical records, test results, medical images, and other such information. However, the medical information that can be gathered within a medical facility is very limited. It would seem that there is a large amount of data that would be useful for medical purposes within the voluminous and varied data gathered in daily life, most of which is spent outside medical facilities, but such lifelog data has gone unused in most cases [3].

In Korea, SBI (systems biomedical informatics) research center aims to create personalized 'health avatar', representing individuals genomic through phenomic reality (or 'digital self') using multi-scale modeling and data driven semantics for the purpose of personalizing healthcare [4].

'The health avatar platform' will be created as an agent space and health data integration pipeline. 'Health avatar platform' will create a space for interacting plug-in intelligent health agents and data analysis toolkits and provide a data and access grid for heterogeneous clinical and genomic data. The health avatar platform will function as an infra-structure for the development and evaluation of intelligent health applications for personalized medicine.

Fig. 1 shows the conceptual diagram of health avatar and this work is conjunction with the 'Connected Self' of health avatar project supporting lifelogs and stream-type data mining for health protection.

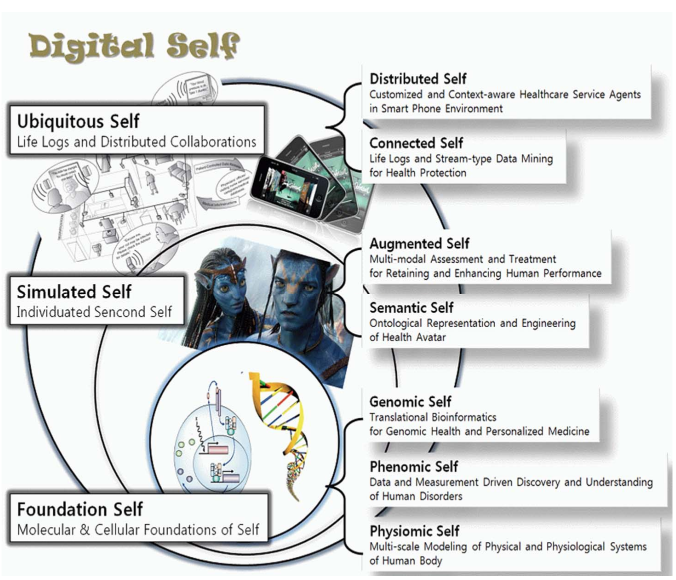

Fig. 1. Conceptual diagram of health avatar

III. Health Screening Form

Basically, the health screening form should reflect individual's lifestyles, health-related information and medical treatments. And it is also compatible with a conventional paper-based screening questionnaire.

In order to satisfy these requirements, we can summarize components of the health screening form as three categories of data as followings:

- Lifestyle logs: representing user's lifestyles such as activity, sleeping patterns, and eating habits
- Health logs: representing biometric information of individuals such as height, weight, blood pressure, heart rate, blood glucose, total cholesterol, high-density lipoprotein (HDL), low-density lipoprotein (LDL), triglycerides and so on
- Medical logs: representing medical treatments such as genetic disease history, previous drug reaction and so on

Additionally, we can also consider interactive question & answer tool on behalf of paper-based screening questionnaire.

Fig. 2 shows the conceptual model of a health screening form and operational flow.

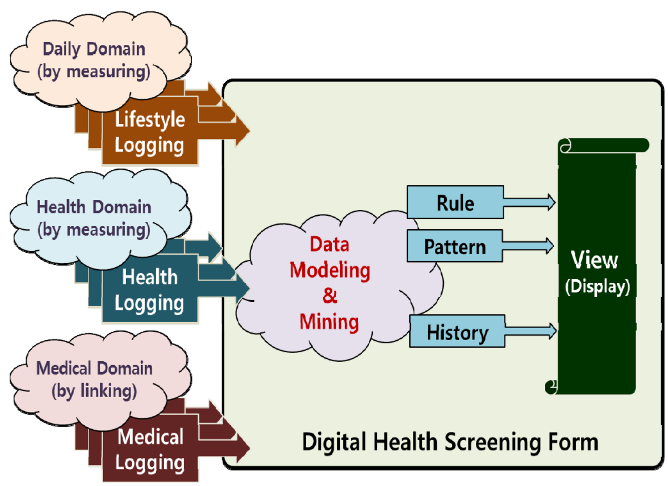

Fig. 2. Basic concept of a health screening form and its operational flow

Basically, the health screening form consists of user's data from daily, health and medical domain. Then, these data are mixed and mined with knowledge from various expertises. From these processing, we can summarize the user's lifelogs as 'rule', 'pattern', and 'history'. These elaborated data can be seen to user through a smart device and transferred to a care giver for an advanced care.

Fig. 3 shows the screenshot of prototype implementation for health screening form in current project [5-6]. Current version of the health screening form focuses on gathering and displaying data.

Fig. 3. The screenshot of prototype health screening form

As data items considered in daily domain for generating screening form, we can leverage data such as activity, sleeping pattern, and eating habits associated with lifestyle. The data associated with lifestyle in daily domain can be collected by wearable or portable life logging device or a smartphone embedding various sensors.

These data are formalized as 'lifestylelog descriptor' in XML document. Fig. 4 shows the example of the lifestylelog descriptor.

```
<?xml version="1.0"?>
<lifestylelog name="Lifestylelog Descriptor"
  xmlns:xsi="http://www.w3.org/2001/XMLSchema-instance"
  xsi:noNamespaceSchemaLocation=
  "http://www.etri.re.kr/ncrc/connectedself/lifestylelog.xsd">
    <log_info>
        <owner name="Gildong Hong"/>
        <id>gd_hong</id>
        <device>
            <description>smart phone lifestylelog collector</description>
            <identifier>kr.re.etri.ncrc.lifestylelogger.type1</identifier>
            <vendor>ETRI</vendor>
            <model_number>2000-1000</model_number>
            <model_info>http://www.etri.re.kr/ncrc/lifestylelogger/2000-1000
            </model_info>
        </device>
    </log_info>
    <items>
        <item data="sleeping">
            <start_time>2011.11.22.23:00:00</start_time>
            <end_time>2011.11.23:07:00:00</end_time>
        </item>
        <item data="meal" type="lunch">
            <menu>Chines Noodle</menu>
            <start_time>2011.11.22:12:00:00</start_time>
            <end_time>2011.11.22:12:45:00</end_time>
            <base_calorie>1200</base_calorie>
            <photo>13098896899.jpg</photo>
        </item>
    </items>
</lifestylelog>
```

Fig. 4. Example of the lifestylelog descriptor

As data items considered in health domain for generating screening form, we can leverage data used in home healthcare or mobile healthcare which are usually gathering data with dedicated devices from a user. In general, the device collects data associated with user's biometric information such as height, weight, blood pressure, glucose, heart rate and so on.

These data are formalized as 'healthlog descriptor' in XML document. Fig. 5 shows the example of the healthlog descriptor.

```
<?xml version="1.0"?>
<healthlog name="Healthlog Descriptor"
  xmlns:xsi="http://www.w3.org/2001/XMLSchema-instance"
  xsi:noNamespaceSchemaLocation=
   "http://www.etri.re.kr/ncrc/connectedself/healthlog.xsd">
    <log_info>
        <owner name="Gildong Hong"/>
        <id>gd_hong</id>
        <device>
            <description>wearable bio-signal collector</description>
            <identifier>kr.re.etri.ncrc.healthlogger.type1</identifier>
            <vendor>ETRI</vendor>
            <model_number>1000-2000</model_number>
            <model_info>http://www.etri.re.kr/ncrc/healthlogger/1000-2000
            </model_info>
        </device>
    </log_info>
    <items>
        <item data="blood_pressure">
            <value time="2011.11.22.13:00:00" option="min">80</value>
            <value time="2011.11.22.13:00:00" option="max">120</value>
        </item>
        <item data="heart_rate">
            <value date="2011.11.22:13:00:00">80</value>
        </item>
    </items>
</healthlog>
```

Fig. 5. Example of the healthlog descriptor

As data items considered in medical domain for generating screening form, we can leverage data generated by medical institute such as disease history, genetic disease history, total cholesterol, high-density lipoprotein (HDL), low-density lipoprotein (LDL) and so on. These data associated with medical field should be linked with the database of medical institute. Therefore, we define the element for the healthlog descriptor but do not specify the consisting sub-elements. We use just link of the medical data sources instead of defining sub-elements because the medical data allow only very constrained access.

IV. SFML: Screening Form Markup Language

This section describes SFML (screening form markup language) defining 'action' and 'data' elements and case study for data transfer.

The components that comprise a health screening form have a hierarchical structure. The top layer consists of 'action' element and 'data' element. The 'action' element defines control action messages including 'request' element and 'response' element. The 'data' element defines three categories of items such as 'lifestylelog', 'healthlog' and 'medicallog'. Each category item has its own sub-items. Each item is represented by XML elements and includes formatted data respectively.

A. Action and Data Elements

Fig. 6 describes XML structure, named as SFML, including ‘action’ and ‘data’ elements.

The root element is ‘sfml’ representing ‘screening form markup language’. The root element has ‘action’ element for control action message and ‘data’ element for data presentation. As a sub-element, ‘data’ element has ‘items’ element containing three ‘category’ properties such as ‘lifestylelog’, ‘healthlog”, and ‘medicallog’.

```
<?xml version="1.0"?><!DOCTYPE sfml []>
<sfml name="Health Screening Form"
  xmlns:xsi="http://www.w3.org/2001/XMLSchema-instance"
  xsi:noNamespaceSchemaLocation=
  "http://www.etri.re.kr/ncrc/connectedself/sfml.xsd">
    <action>
        <request>...
        <response>...
    </action>
    <data>
        <items category="lifestylelog">...
        <items category="healthlog">...
        <items category="medicallog">...
    </data>
</sfml>
```

Fig. 6. XML structure of SFML

Fig. 7 shows the ‘action’ element of SFML in detail. The ‘action’ element consists of ‘request’ and ‘response’ elements. The ‘request’ element is a request form for any action and can have multiple messages encapsulated by ‘message’ element. The number of each ‘message’ element is mapped with the number of ‘session’ element in ‘response’ element.

Each ‘message’ element is composed of three sub-elements such as ‘target’, ‘command’ and ‘parameter’ elements. The ‘target’ element indicates the action executor such as a module name of a message recipient. The ‘command’ element indicates the method name of the action executor. The ‘parameter’ element contains parameter values needed to run the method of the action executor. The sub-elements of ‘parameter’ element such as ‘id’ and ‘interval’ depend on the value of command.

The ‘response’ element is a response form for any action execution. The ‘response’ element can have multiple ‘session’ elements for each control action respectively. The number of each ‘session’ element is mapped with the number of ‘message’ element in ‘request’ element.

Each ‘session’ element is composed of two sub-elements such as ‘result’ and ‘results’. The ‘result’ element only indicates success or failure for the request action. If the action is performed successfully, the ‘results’ element is filled with the results of the action execution. The sub-elements of the ‘results’ element depend on the executed command.

The description of the ‘message’ element of request action shown in Fig. 7 is as following.

- The value of the ‘target’ element indicates that the logmanager module of SFML recipient may process this request
- The value of the ‘command’ element indicates that the ‘getWeight’ method of the logmanager may be executed
- The values of the ‘parameter’ element indicates; the related data owner is ‘gd_hong’, the response data should start from November 22, 2011, and the data is needed two days

The description of ‘session’ element of the response action shown in Fig. 7 is as following.

- The ‘true’ value of the ‘result’ element indicates that the request action is successful
- The ‘results’ element indicates that the ‘gd_hong’ has 70kg in November 22, 2011 and 71kg in November 23, 2011

The XML document of Fig. 7 is just an example so that we describe the ‘request’ and ‘response’ elements together. In practical case, the request action includes only ‘request’ element and the response action contains only ‘response’ element respectively.

```
<action>
    <request>
        <message num="1">
            <target>kr.re.etri.ncrc.connectedself.
                healthlog.logmanager</target>
            <command>getWeight</command>
            <parameter>
                <id>gd_hong</id>
                <start_time>
                    <unit>day</unit>
                    <time>2011.11.22</time>
                </start_time>
                <duration>2</duration>
                <interval>1</interval>
            </parameter>
        </message>
        <message num="2">
        </message>
    </request>
    <response>
        <session num="1">
            <result>true</result>
            <results>
                <id>gd_hong</id>
                <time>2011.11.22</time>
                <data>70</data>
                <time>2011.11.23</time>
                <data>71</data>
            </results>
        </session>
        <session num="2">
        </session>
    </response>
</action>
```

Fig. 7. Example for the ‘action’ element of SFML

Fig. 8 shows the ‘data’ element of SFML in detail. The ‘data’ element can have three items which have category properties such as ‘lifestylelog’, ‘healthlog’ and ‘medicallog’. Each ‘items’ element has ‘id’ and ‘item’ elements. The ‘id’ element indicates the owner of the item data and the ‘item’ element contains real data values. The ‘data’ property of the ‘item’ element indicates what kind of data.

```xml
<data>
    <items category="lifestylelog">
        <id>gd_hong</id>
        <item data="sleeping">
            <start_time>2011.11.22:23:00:00</start_time>
            <end_time>2011.11.23:07:00:00</end_time>
        </item>
        <item data="meal" type="lunch">
            <menu>Chinese Noodle</menu>
            <start_time>2011.11.22:12:00:00</start_time>
            <end_time>2011.11.22:12:45:00</end_time>
            <base_calorie>1200</base_calorie>
            <photo>13098896899.jpg</photo>
        </item>
    </items>
    <items category="healthlog">
        <id>gd_hong</id>
        <item data="blood_pressure">
            <value time="2011.11.22.13:00:00"
              option="min">80</value>
            <value time="2011.11.22.13:00:00"
              option="max">120</value>
        </item>
        <item data="heart_rate">
            <value date="2011.11.22:13:00:00">80</value>
        </item>
    </items>
    <items category="medicallog">
        <id>gd_hong</id>
        <link>http://healthportal.org/sfml/gd_hong</link>
    </items>
</data>
```

Fig. 8. Example for the ‘data’ element of SFML

Generally, the ‘data’ element of SFML can contains lifestylelog descriptor, healthlog descriptor and medicallog descriptor in a manner of full text. In a case of just simple querying data, the ‘response’ element of SFML can support the action. However, in case of the request action requires full data of the user, the ‘data’ element is used by embracing mentioned three descriptors.

The XML document example of Fig. 8 contains three descriptors of ‘gd_hong’. The ‘items’ element with ‘lifestylelog’ category property contains the ‘item’ elements following the lifestylelog descriptor. And the ‘items’ element with ‘healthlog’ category property includes the ‘item’ elements following the healthlog descriptor. On the other hand, the ‘items’ element with ‘medicallog’ category property, the link to the medical information is used.

B. Case Study for Data Transfer

This section describes cases of data transfer from data sources to Screening Form Generator, functional module of health screening form.

As the device of data sources, we can use smartphones, tablets or 3rd party’s devices. In this case, for gathering lifelogs, we can use built-in sensors of the smart devices such as accelerometer and GPS or connected 3rd party’s devices such as blood pressure meter, weighting scale and blood glucose meter.

Fig. 9 shows the data transfer example of daily and health domain. In this configuration, each Collector Driver is gathering data from built-in sensors of the smart device and 3rd party’s devices as a proprietary format. Then, Convertor transforms and formalizes the data sent from Collector Driver by referencing Schema such as lifelog descriptor or healthlog descriptor according to the data sources respectively.

In this case study, we only consider lifestylelog and healthlog descriptors for gathered data in Lifelogging application. However, this module can be extended or modified according to the standardization activities described next section.

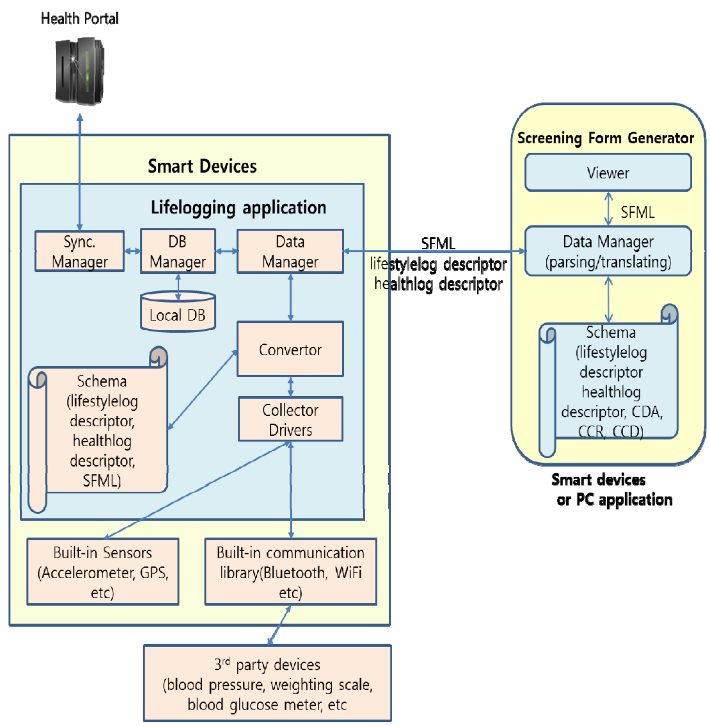

Fig. 9. Data transfer for daily and health domain

Data Manager can store the transformed data in Local DB, which can be used as data cache. The transformed data can be also sent to Screen Form Generator. Then, Data manager module of Screening Form Generator refers Schema description and can extract data values. Consequently, the data values can be displayed in Viewer user interface.

Generally, Screening Form Generator can be running in smart devices or conventional personal computers.

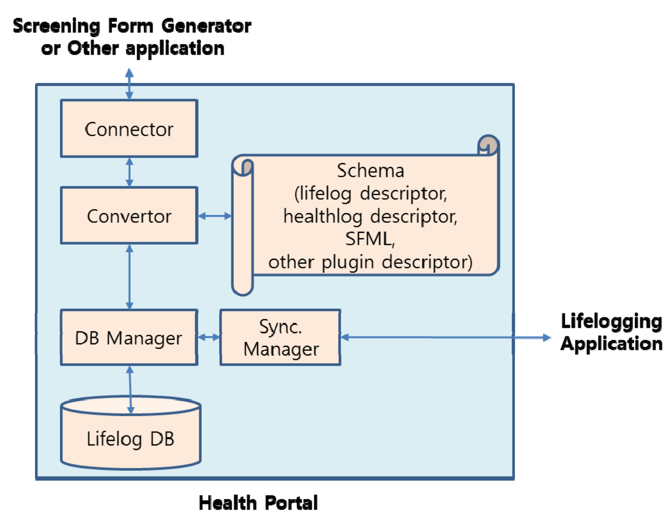

Fig. 10. Data synchronization and its utilization for daily and health domain

On the other hand, the transformed data by Convertor can be synchronized with the DB of Health Portal through Sync. Manager. In this case, the synchronized data can be used in another screening form generator or independent other application shown in Fig. 10.

In the result, data structured by SFML can be exchanged and transferred to SFML viewer of a care giver for an advanced care.

In order to define the data sets for transferring medical treatment documents, we can use CDA (Clinical Document Architecture) [7] of HL7 (Health Level Seven), CCR (Continuity of Care Record) [8] of ASTM (American Society of Testing and Materials), or CCD (Continuity of Care Document) [9], combined model of CDA and CCR.

As the data transfer specification in health screening form, we can use those international standards. Therefore, we only parse and translate the data, encapsulated with standardized XML format, instead of defining new 'medical descriptor'. This operational flow is shown in Fig. 11.

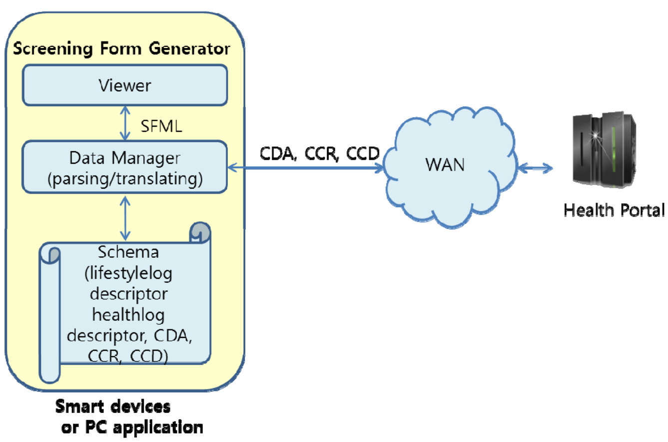

Fig. 11. Data transfer for medical domain

V. DISCUSSION

From the perspective of a health screening questionnaire, Chris et al [10] proposed an adaptable health screening questionnaire that is computer-based lifestyle questionnaire allowing individual doctors to modify the questionnaire to their requirement. K. D. Akan et al [11] developed electronic screening tool providing a graphical user interface with audio outputs for users who may be functionally or computer illiterate. However, these previous trials are only subsidiary function of the health screening form described in this paper and does not suggest how to transfer data and control messages.

From the lifelog utilization point of view, NTT have studied several subjects [12-13] enabling lifelogs to be used in the practical service implementation. In case of these NTT's previous work, we can coordinate these results as a lifestyle category of the health screening form.

From a device point of view, there are several commercial life logging devices [14-17]. These devices can provide a health screening form with the lifestyle data.

As increasing of multiple vendors' devices, we need to standardize the transmission of data and control messages. For this needs, we are participating in standardization activities of TTA (Telecommunication Technology Association) in Korea.

Currently, two standard documents are released with respect to digital health screening form. TTAK.KO-10.0516 [18] is a standard document for a reference model for personal lifelog based system. TTAK.KO-10.0517 [19] is a standard document for link data specifications based on personal lifelog. However, these standardization activities are now on the initial phase of work. Therefore, we also need to do additional work to update and specify standard documents in detail.

Furthermore, from the perspective of user interfaces, the Viewer of Screening Form Generator may need to be changed into HTML5-support. To support the concept of "Write Once, Run Anywhere" by providing compatibility of heterogeneous devices such as Android-based devices and iOS-based devices, we need to do more work by keeping pace with standardization activities in [18-19].

VI. CONCLUSION

This paper proposes a markup language, SFML, to describe and deliver the contents of health screening form and case study for data transfer.

In this paper, we define elements and schema needed to generate health screening form based on personal lifelogs including data from daily, health and medical domain.

SFML defines 'action' element and 'data' element. The 'action' element is used to control any action through 'request' and 'response' elements. The 'data' element is used to present data including lifestylelog, healthlog and medicallog.

Currently, because this work is an initial phase to make a health screening form, we lack of an elaborate algorithm or a breakthrough idea. However, we think this work will contribute to make a personalized and mobilized health screening form reflecting personal lifestyles, health information and medical histories.

In the future, we plan to continue our research efforts in this field with the aim of making an intelligent screening form. So we need to allow for an interpretation of relationship between data by means of data mining algorithm.

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Kyuchang Kang (M'06) received his B.S. and M.S. degrees in electronic engineering from Kyungpook National University, Korea, in 1994 and 1997 respectively. From 1997 to 2000, he worked on Test and Evaluation Center at Agency for Defense Development as a member of engineering staff, where he developed Doppler signal analyzer and measurement system. Since 2001, he is working on BigData software laboratory and post-computer research division at Electronics and Telecommunications Research Institute, where he is developing open service platform for the healthcare service. He is also interested in mobile applications, distributed computing and network management.

Seonguk Heo received his B.S. degrees in computer engineering from Korea University of Technology and Education, Korea, in 2011. He is currently working toward the M.D. in computer engineering from the University of Science and Technology, Korea. He is interested in mobile applications, embedded computing, and lifelog data mining.

Changseok Bae (M'03) received his B.S. and M.S. degrees in electronic engineering from Kyungpook National University, Korea, in 1987 and 1989 respectively. He also received his Ph.D. degree in electrical and electronic engineering from Yonsei University, Korea, in 2003. From 1989 to 1996, he was a senior researcher at Systems Engineering Research Institute, where he worked on image processing and pattern recognition. From 1997 to 1999, he worked with Korea Ministry of Information and Communication, where he participated in establishing national software research and development policy. Since 2000, he has been a principal research staff of Post-PC Platform Research Team and the team leader of Personal Computing Research Team at Electronics and Telecommunications Research Institute (ETRI). From 2004-2005, he was a Research Fellow at School of Information Technologies, University of Sydney, Australia. His research interests include image processing, multimedia codec, information hiding, personal life-log and stream type data mining.