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Design of Health Monitoring Framework Model using oneM2M Standard

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***Abstract*— The causes of traffic accidents are affected by human factors. Driver's illness, such as exhaustion, drowsiness, and other chronic diseases, are the critical reasons for this. The creation of the Internet of Things (IoT) technology has tried to resolve these issues. The emphasis is on tracking and regulating driving safety and conditions. Unfortunately, there is no uniform IoT standard for this device. This study aims to provide a model for monitoring and handling the situation of drivers by combining the E-Health Tracking (EHM) and the Automotive Health and Safety (AHS) frameworks. The results of the system design are referred to as In-vehicle E-Health Monitoring (IV-EHM). The IV-EHM framework model analysis based on the oneM2M standard has been carried out. Based on the study, it can be said that the system has the specified requirements.**

Keywords— Health Monitoring, Internet of Things (IoT), Framework Model, oneM2M Model

I. Introduction

For financial reasons and work schedules, drivers are more likely to drive in developing countries in poor conditions, especially commercial vehicle drivers. Regrettably, studies in developing countries of commercial and public road transport have revealed that transport owners often force their drivers to speed up, to work unduly long hours and to work in exhaustion and to ignore safety regulations. This condition increases the number of serious victims of traffic [1]. The condition of the driver has already become a major cause of road accidents. Fatal road accidents and collisions resulting in injuries are related to the condition of the driver. Most of them are caused by half-asleep while driving, and the others are caused by fatigue [2], drowsiness-related [3], drunk [4], or any health problems, such as sudden heart attack [5]. Therefore, it needs a system that can collect several parameters that indicate the health and fitness conditions of the drivers. Also, the system is also expected to work online so that certain parties from different places can monitor it.

There have been many studies that have tried to implement the Internet of Things (IoT) to develop a driving system. These systems connect different sensors and intelligent devices to gather data about health and fitness indicators from the driver's environment in real time. These data are then integrated with the report and monitoring process [6-7]. Several research results prove that monitoring the health and fitness condition of drivers based on IoT can progress the efficiency of the transportation business, cut the cost of driver health care and reduce the risk of road accidents [5] [8-13]. Health services that are integrated into vehicles are certainly a challenge for developers as well as users [14]. In addition, the system must also ensure the reliability of the connectivity of sensor devices in vehicles [15] with the application of health care centres on the internet, as well as produce responses in emergencies [12] [16]. Generally, the IoT framework is built based on stakeholders' interests for specific business needs based on the chosen architecture and standardization models [17]. Unfortunately, there is no convergent standardization for developing an IoT framework in its application to driver health surveillance [18].

Therefore, the aim of this paper is to design an IoT-based driver health monitoring framework model. The framework model tends to be a standard for an application to driver health surveillance. The named of framework model is In-vehicle E-Health Monitoring (IV-EHM). The contribution of this paper is trying to adapt the IoT health monitoring framework E-Health Monitoring (EHM), and the IoT sensor integration framework on vehicles with Automotive Healthcare and Safety (AHS) cloud computing. This framework model refers to the oneM2M IoT standardization. So, it could have interoperability capabilities with other applications or systems. It is hoped that the developed IoT

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framework model can be implemented to reduce the risk of traffic accidents due to driver health factors.

II. METHOD

A. Model and Architectural Framework

In general, the framework is a real or conceptual structure that is intended to function as a support or guide to develop something that expands the structure into something useful. Referring to the ISO / IEC / IEEE 42010, this standard defines the description of an architectural framework for the Internet of Things (IoT) that complies with international standards [19]. The description of the architecture framework is motivated by the interests that are generally shared by stakeholders of the IoT system in various domains, such as transportation, health care, or smart grids. The architecture framework establishes standard practices for creating, interpreting, analyzing, and using architectural descriptions in the domain of the application or community of specific stakeholders [20].

Fig. 1 shows an architectural framework. In the figure, it appears that a framework considers stakeholder and purpose as a concern to produce a system. The system is expected to be implemented in a particular environment. Finally, the system will be displayed in architecture and explained by an Architecture Description.

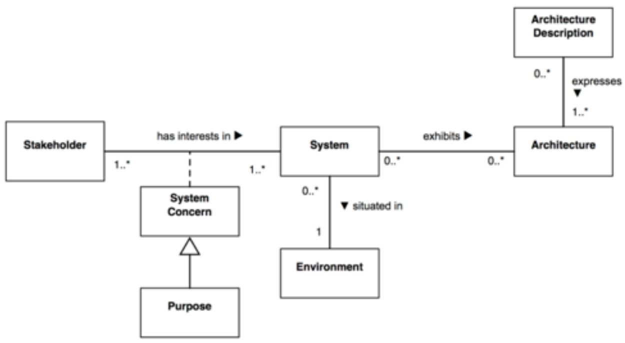

Fig. 1. Block Diagram of Architectural Framework [19]

B. E-Health Monitoring (EHM) Framework

Nowadays, most of the vital monitoring parameters of patients are very limited to hospitals or other health care centres. This condition causes the monitoring process to be time-consuming and expensive. Rapid advances in information and communication technology are great opportunities for the development of remote systems. This system is useful for reducing costs and travel time and increasing the efficiency of health services and user satisfaction [21].

To develop the system, researchers start by producing a framework. One of these systems is called the EHM Framework [7] [21]. An EHM Framework is shown in Fig. 2.

Fig. 2 shows see several parts of an EHM Framework, namely: Medical sensor devices and virtual medical sensors, mobile application and service application, and platform manager for healthcare and REST API. Medical sensors and virtual medical sensors contain medical sensor devices, for example, blood pressure monitors and glucose meters, are also versatile applications associated with several devices and other administration

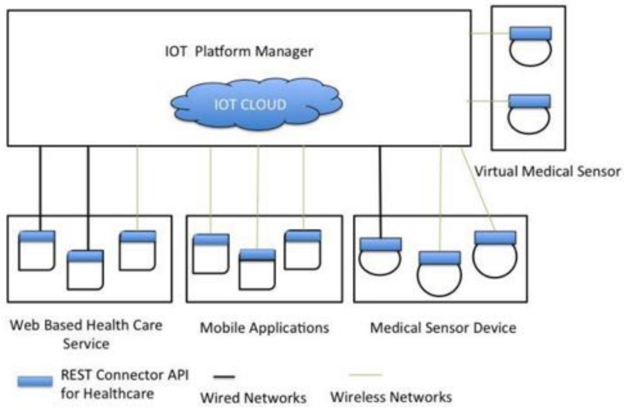

Fig. 2. An EHM Framework [21]

A virtual sensor is a type of sensor construct programming by considering the IoT stage. Mobile and service application is a mobile application in addition to the user interface. The administration application provides specialist data to break down and analyze the patient's condition. Finally, the platform manager for healthcare and REST API is a lightweight interface for exchanging data. Agencies need to have the capacity to open administrative access, asset registration, access control, and power control by the agency director. The EHM Framework makes it possible to operate health services with a variety of devices, with the help of medical personnel or without medical personnel (self-service).

In practice, the Cyber Physical System (CPS) can be an EHM framework. The integration of computing, networking and physical processes in the Cyber Physical System (CPS). Embedded computers and networks monitor and control physical processes with feedback loops where computer is affected by physical processes and vice versa. CPS integrates software and network physical process dynamics to provide the complete integrated abstraction and modelling, design, and analysis techniques [22]. Fig. 3 shows an E-Health CPS block diagram.

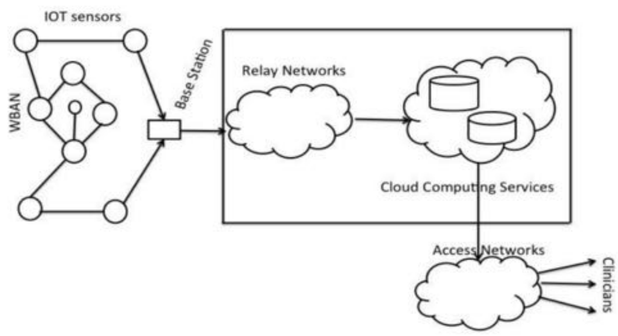

Fig. 3. A CPS Architecture for EHM [22]

C. Automotive Healthcare and Safety (AHS) Framework

The AHS framework represents a system architecture in the form of a set of biometric sensors that enter data in a certain control unit in real time. The system can be set to change the vehicle's character on the basis of configurable parameters. The AHS framework is composed of a

Healthcare Systems Control Unit (HSCU), which communicates with other vehicle networks such as a Telematics Control Unit (TCU), a Motor Control Unit (ECU), a Global Positioning System (GPS) and others and works in conjunction with these networks. The HSCU control sensor is installed in the vehicle and uses the display, such as the head unit (HU) and the specially designed AHS display [16]. The AHS Framework depicted in Fig. 4.

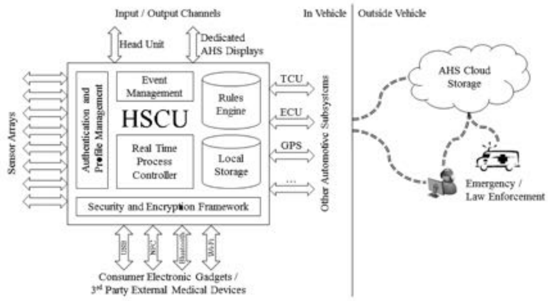

Fig. 4. An AHS Framework [16]

The AHS framework can be set to use other devices like smart devices, medical devices and the communication system via NFC, Bluetooth, Wi-Fi and cable channels such as Universal Serial Bus (USB). The AHS Framework has the potential to cover all vehicle occupants, provided the passengers have adequate sensors configured. Data protection problems may require a number of special biometric sensors for each passenger.

The AHS framework enables the use and loading of adequate AHS cloud health profiles. This condition enables interoperability in certain vehicles and also enables proper third parties to use information for a swift and effective response in the event of an accident. The condition is consistent with the AHS framework to support a driver's health monitoring system in real-time and independently. The system ability to integrate can be combined with the local process to speed up decision making.

D. *IoT Standardization using oneM2M*

The oneM2M is a global standard initiative that includes requirements, architecture, Application Programmable Interface (API) specifications, security, and interoperability solutions for Machine-to-Machine (M2M) and IoT technologies. The oneM2M specification provides a framework to support applications and services such as smart grids, connected cars, home automation, public safety, and health. The oneM2M technical specification document (number: TS-0001-V3.15.1) discuss and determine the functional architecture for the oneM2M Service Platform [23]. The model ole oneM2M is shown in Fig. 5.

Fig. 5 illustrates an oneM2M layered model to support from upstream to downstream M2M (Machine-to-Machine) services. This layered model consists of three layers: the application layer, the common services layer, and the underlying network service layer. The architectural model reference refers to the following functional architecture, as depicted in Fig. 6.

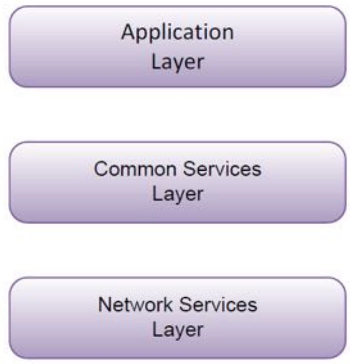

Fig. 5. oneM2M Layered Model [23]

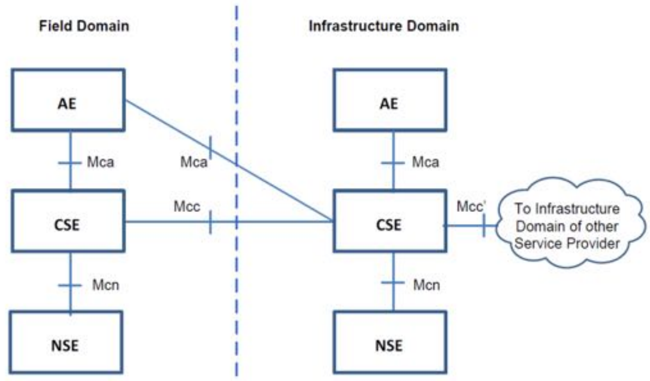

Fig. 6. Functional Architecture of oneM2M Layered Model [24]

The oneM2M functional architecture in Fig. 6 consists of the following functions that contain Application Entity (AE), Common Services Entity (CSE), and Network Services Entity (NSE) [27].

E. *In-Vehicle E-Health Monitoring (IV-EHM) Framework*

In this research, there is an analytical comparison between EHM and AHS, as listed in Table 1. Based on Table 1, it can be said several things. First, there are similarities between EHM and AHS, which can be implemented on IoT-based systems, supporting the use of monitoring applications and health services as well as interactions with actuator devices, gateways, and servers. Second, EHM has the advantage of supporting various medical sensors in the clinical environment and processing medical history data. At the same time, AHS have the benefit of supporting the integration of various medical sensor devices in the vehicle environment.

This paper integrates the EHM (Fig. 2) and the AHS framework (Fig. 4) by adopting advantages and reducing the weaknesses of each framework. The new framework developed is named as In-Vehicle E-Health Monitoring (IV-EHM) Framework. An HSCU based on AHS is inserted in EHM Framework. Fig. 7 illustrated this integration.

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TABLE I. TYPE STYLES

No.	Criteria	EHM	AHS	Proposed Model
1	Applying the Internet of Things (IoT) technology	Yes	Yes	Yes (EHM Adopted)
2	Supporting the use of the health monitoring application	Yes	Yes	Yes (EHM Adopted)
3	Supports integration with various healthcare applications	Yes	Yes	Yes (EHM Adopted)
4	Supports integration with various medical sensor devices in static environments such as clinical terminals	Yes	No	Yes (EHM Adopted)
5	Supports integration with various medical sensor devices in mobile environments such as vehicles	No	Yes	Yes (AHS Adopted)
6	Supports processing of sensor input data on the device	No	Yes	Yes (AHS Adopted)
7	Supports medical history data processing on gateways and servers	Yes	No	Yes (EHM Adopted)
8	Supports interaction with actuator devices on devices, gateways, or servers	Yes	Yes	Yes (AHS Adopted)

The HSCU [16] adopted from the AHS framework is an embedded system in vehicles that involves communicating and collaborating with in-vehicle networks, including communicating with the IoT server platform. HSCU functions as one of the medical sensors in the EHM framework to be facilitated by the IoT Platform Manager, which is integrated with health service applications. In contrast, the HSCU feature was successful in collaborating with medical sensor devices such as heart rate detection sensors, blood pressure, body temperature to analyze the driver's health condition [16]. In addition, HSCU functions as a gateway, where it can connect local networks in vehicles with public networks that are connected with IoT service providers.

Another function of the HSCU is to carry out calculations related to the input of each sensor in the vehicle. For example, evaluating the monitoring of physical safety through heart rate sensors and then setting the rules that have been provided to then change the vehicle access control [12][13] as an actuator. With the existence of HSCU in E-Health Monitoring, it supports input from sensors in real-time in responding to decisions or preventive actions.

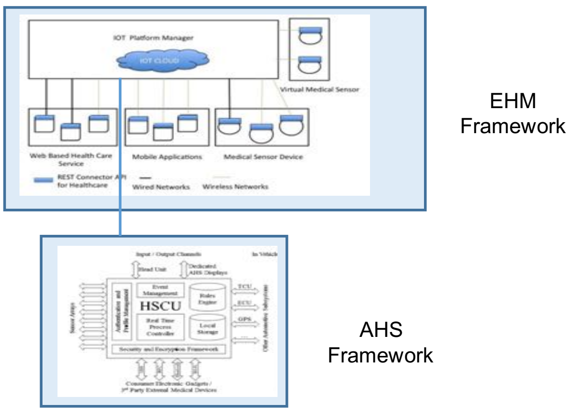

Fig. 7. The IV-EHM Framework

III. RESULTS AND DISCUSSION

Based on the design principles described earlier, the IV-EHM framework has been produced, as shown in Fig. 8. In the IV-EHM framework model, there are three parts, namely:

1. Server. The server functions to process and respond to every request sent. The server is the centre of health service applications where data is stored and managed to support periodic or continuous health services. Servers can be cloud computing services [25] [26], virtual machines [27], or physical computers, including cloud, VM, physical, or hybrid computer clusters.
2. Gateway. The gateway is a smaller device and is capable of performing light computing, for example, a mini PC, single-board, or microcontroller [28]. Gateway [29] functions as a liaison device with the service centre. It plays an essential role in doing rule-based computing [30] to accelerate the response of decisions or actions from input devices. The gateway can also be configured to connect with the actuator to perform specific actions as a form of response from the input device.
3. Devices. Devices in the form of various devices such as sensors, actuators, including mobile and desktop devices. Devices as data sources (sensors, manual inputs, scheduled periodic inputs), destination data (graphical/web data on the desktop, instructions on the actuator), source of requests (requests, reports), and are not limited to functional clients.

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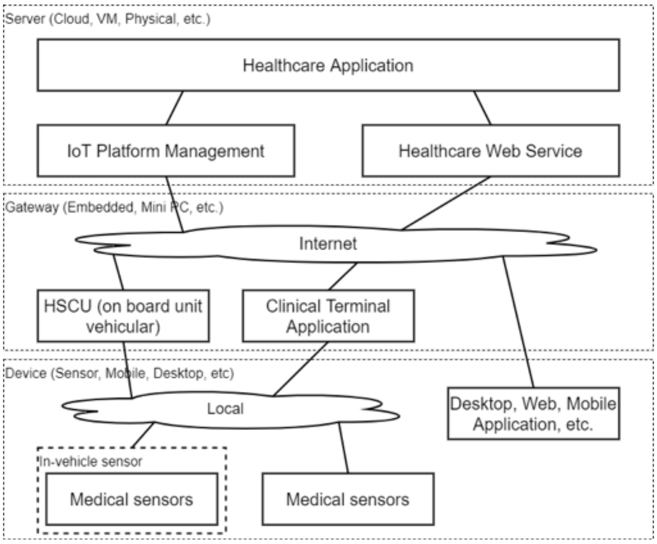

Fig. 8. The IV-EHM Framework

After that, the IV-EHM framework is integrated with the oneM2M standard. This integrated is carried out to prove the interoperability of the framework. The results of this integration are shown in Fig. 9.

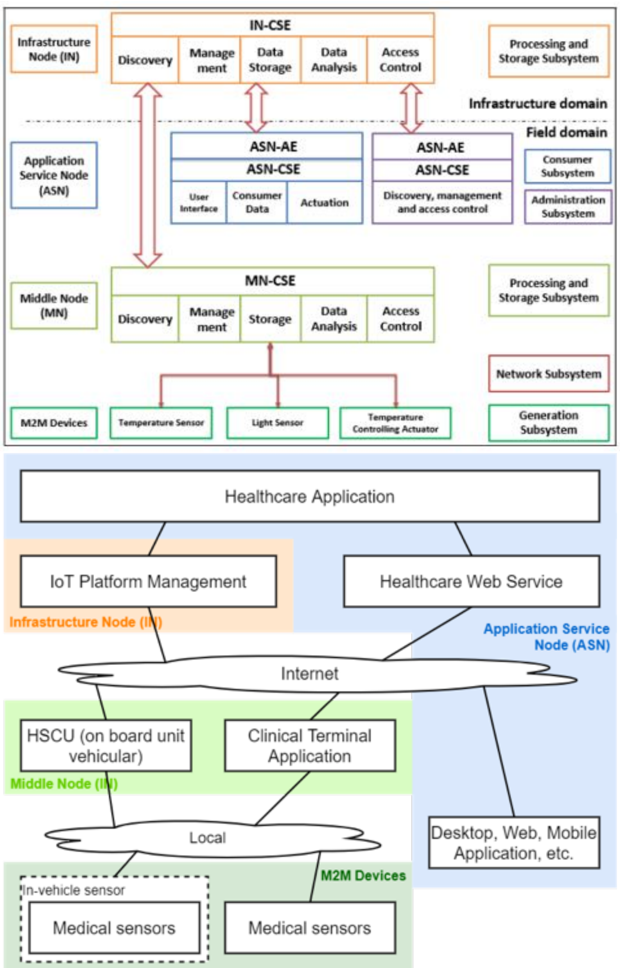

Fig. 9. Integration of IV-EHM with oneM2M Standard

In Fig. 9, it appears that the oneM2M Model is mapped to sensors and actuators of vehicles and other devices on the IV-EHM framework. The middle node (MN) holds software elements for resource discovery, management, storage, data integration and analysis, and access control and maps the IoT framework server. The vehicles are connected based on consumer-centric application logic run on smart devices or the vehicle itself [15].

The IV-EHM framework can be implemented, for example, in monitoring the health of drivers in logistics companies. Some health checks can be done either at the beginning of the driver joining the company, daily, monthly, or random. Besides, actuators are integrated into vehicles such as vehicle speed controllers [13], alarms, and emergency notifications. Based on the use case, as mentioned, the architecture is illustrated in Fig. 10.

Application of IV-EHM to logistic companies where there is footage from service centres that have health service systems that have web service support features or integrators that provide application programming interfaces (APIs) for development and integration with applications others are also connected with IoT device management. In the hospital, there is a clinical application that can receive input from medical personnel or examiners for examinations that cannot be done with the help of sensors or IoT devices. Then there is also a clinical terminal (clinical terminal), which is a gateway for sensor devices to be able to connect with IoT Platform Management. Whereas for vehicles, for example, in the form of trucks, there is an HSCU that connects all sensor devices and actuator devices, also functions to connect with IoT Platform Management. From IoT Platform Management, it is connected with the health service system to be able to send data and also receive instructions for the actuator.

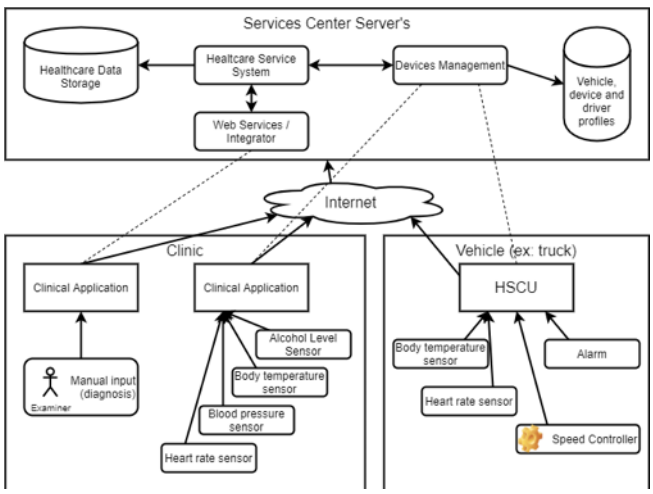

Fig. 10. Application of IV-EHM in Logistic Enterprise

With this architectural set, at least, it can illustrate the application of the EHM-based IoT driver health monitoring framework model. Of course, by fully adapting the EHM framework, all of its capabilities have also been deployed to support the life-cycle of health services and full monitoring, making it possible to apply on a small, medium, or enterprise scale.

IV. Conclusion

This study produced an IoT-based driver health monitoring framework model that can process input from health sensors, process medical history data, and respond with an actuator called the In-vehicle E-Health Monitoring

(IV-EHM). Designing a model has been done to meet the criteria needed in presenting solutions, adopting E-Health Monitoring (EHM). Also, integration with various medical sensor devices in an in-vehicle environment, processing of sensor input data on the device, and interactions with actuator devices on the gateway or server equipment are adopted from Automotive Healthcare and Safety (AHS) by placing the Healthcare Systems Control Unit (HSCU) as a Medical Sensor. The IV-EHM framework model analysis based on the oneM2M standard has been carried out. Based on this analysis, it can be said that this design has met the specified standards. This research has only designed a framework model. Further research is needed to implement the framework model in the actual system.

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