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# Intelligent E-Health Gateway Based Ubiquitous Healthcare Systems in Internet of Things

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## Abstract

In recent days there have been significant advances in the field of Internet of Things (IoT). At the same time there exists an ever-growing demand for ever-present healthcare systems to improve human health. Most of IoT based patient monitoring systems, in particular at smart homes or hospitals, there exists a bridging point (i.e., gateway) that connects the sensor network and the Internet established to perform basic functions such as translate between the protocols used in the Internet and sensor networks. The strategic position of gateways to offer several higher-level services to store the data in local memory, processing the real-time local data, embedded data mining, etc., proposing thus a Intelligent E-Health Gateway. In this proposed paper, an intelligent home-based platform, the iGateway Health-IoT, is proposed and implemented using simulator. Intelligent E-health gateway platform includes an open-platform-based intelligent medicine box (iMedBox) with enhanced connectivity and integration of devices and services with interchangeability. Intelligent pharmaceutical packaging (iMedPack) with communication facility enabled by passive radio-frequency identification (RFID) and actuation capability are enabled by efficient materials through flexible and wearable bio-medical sensor device (Bio-Patch) empowered by the state-of-the-art inkjet printing technology and system-on-chip. The proposed platform effortlessly fuses IoT devices (e.g., wearable sensors and smart medicine packages) provides in-home healthcare services (e.g., telemedicine) for improved user familiarity and service efficiency. The feasibility of the implemented iGateway Health-IoT platform has been proven in field trials. The results show that it is reliable and has low latency and high data transfer.

*Keywords: Internet of Things, Intelligent E-health gateway, radio-frequency identification, bio-medical sensor device*

## 1. Introduction

Internet of Things (IoT)[3] is a promising paradigm to integrate several technologies and communication solutions. These are the major key elements for bringing new devices or solutions into healthcare fields. By considering the aforementioned issues, an intelligent home-based healthcare IoT system,iGateway Health-IoT, is proposed in this paper. The concept of the iGateway Health-IoT System consist of an intelligent medicine box (iMedBox) serves as a home healthcare gateway. IoT devices [e.g., wearable sensors and intelligent medicine packaging (iMedPack)] are seamlessly connected to the iMedBox via a heterogeneous network, which is compatible with multiple existing wireless standards. The body-worn Bio-Patch can detect and transmit the user's bio-signals to the iMedBox in real time. The iMedPack is connected with the iMedBox via an RFID[5] link to assist the users with their prescribed medication. All the collected information is interpreted, stored, and displayed locally on the iMedBox. The processed information can also be forwarded to the Health-IoT network for a clinical diagnosis or further analysis. One major contribution of the proposed

iGateway Health-IoT system is that it dramatically expands the scope and coverage of traditional healthcare information systems (HIS), extending from a confined hospital environment to a patient's home and body, thus makes it possible to fully realize integrated HIS (IHIS) as introduced. In recent years, RFID technology has become more and more popular in the applications of manufacturing industries, logistics providers, supply chain management, retail outlets, banks, location tracking, and process detection. With the rise of Gen 2 protocol, RFID tags are becoming more powerful in terms of larger memory, faster reading speed, and higher information security. Therefore, RFID tags provide more opportunities for commercial applications. By doing so, the overall healthcare system could be optimized at the top level, turning from the conventional Enterprise Resource Planning into the Entire Resource Planning. Internet of Things (IoT) is a promising paradigm to integrate several technologies and communication solutions. As defined by European Commission Information Society, the Internet of Things is a manageable set of convergent developments in sensing, identification, communication, networking,[1] and informatics devices and systems. Wireless Sensor Network (WSN), as a fundamental enabling technology of IoT, integrates a number of spatially distributed autonomous sensors into a network and cooperatively pass their data through wireless communication. This network can be connected to a higher level system via a network gateway. WSN is built of sensor/actuator nodes, from a few to several hundreds or even thousands nodes, where each node is typically portable, lightweight, low-cost, and simply deployable. WSN is extended to a network commonly called Ubiquitous Sensor Networks (USN) when it is integrated into a system of IoT.Medical monitoring, memory enhancement, control of appliances, medical data access, and emergency communication. The IoT is in the revolutionary road and it will remodel the healthcare sector on the way in terms of social benefits and penetration as well as economics. Enabled by ubiquitous computing, all the healthcare system entities (individuals, appliances, medicine) can be monitored and managed continuously.

## 2. Related Work

There have been many efforts in designing gateways for one or more several specific applications for architectural layers. For example the works presented in the propose gateways are transparently connect to the networks with different protocols[4] such as ZigBee, Bluetooth and Ethernet. These gateways has limited flexibility as they are not be customized for different applications. In a different category the related work of Mueller[2] present are present in a gateway called SwissGate which handles to optimize the operation of the sensor network. They specifically apply SwissGate on home automation applications such as measure heating, ventilation, and air conditioning control (HVAC)[11] parameters. The main aim is to provide some levels of intelligence to gateways by enable them to execute application code[2]. It propose a middleware for the gateway to offer three possible services: They uses protocol conversion, request aching, and bright caching discovery. There have been many efforts in designing gateways for one or more several specific applications for architectural layers. It should be noted in designing an efficient IoT-

based healthcare systems. It is a difficult task to faces the following challenges.

- First, the sensor networking mechanism must be resource-efficient and customized for E-Health applications as medical sensor nodes, especially implanted ones, have much lower processing power, memory, transmission speed, and energy supply than sensors in other sensor networks.
- Second, in spite of general sensor networks where interval-based data transmission is used (e.g., temperature and humidity monitoring), E-Health applications often need to manage stream the iMedBox works as a home healthcare platform.

According to the clinical prescriptions stored inside, it timely sends commands to the targeted iMedPack, and in the meantime, it emits magnetic waves to power the passive iMedPack. In return, the selected iMedPack sends back local information, e.g., packaging's ID, the number of medicine slots opened, and the number of intact slots, and acts according to the commands received, e.g., to open specific medicine slots.

## 3. Implementation Details

### 3.1. Intelligent E-Health Gateway

Intelligent E-Health gateway main requirement of a gateway is to support various wireless protocols and inter-device communication. The extended role is used to support several features such as a temporarily store sensors and users information by bringing intelligence and enhancing with data fusion, aggregation, and interpretation techniques by essential to provide preliminary local processing of sensors data to becoming a Intelligent E-Health Gateway. These gateway which supports different communication protocols, such as touching point between a sensor network and the local switch/Internet. It receives data from different sub- networks, performs protocol conversion, and provides other higher level services such as data aggregation, filtering and dimensionality reduction.

### 3.2 Medical Sensor Network

In ubiquitous identification and sensing communication capacity, biomedical and context signals are captured from the body/room used for treatment and diagnosis of medical states. The signal is then are transmitted to the gateway via wireless or wired communication protocols such as Serial, SPI, Bluetooth, WI-FI or IEEE 802.15.4.

### 3.3 Intelligent Medical Packaging

The senior citizens have patients with chronic diseases and it uses with critical to follow the doctors' advice to take their prescribed medicine at the proper time. However noncompliance with medication is becoming more prevalent. The levels of noncompliance may be affected by psychological factors such as the patients' levels of anxiety, motivation to recover, attitude toward their illness, as well as the fact that many senior citizens suffering from amnesia often forget to take the prescribed medicine on time. Prescribing clinicians frequently do not often detect or ask about noncompliance and are not always good at recognizing when patients stop taking their medication. If possible, it is important to maintain routine contact with the

doctor to discuss, among other things, compliance issues. However, this is not as easy as it sounds. Moreover, the misuse and abuse of prescription medication can cause a range of adverse drug reactions, sometimes even leading to death .An intelligent medication administration system is desirable to timely remind and dispense the medicine to individuals, and in the meantime, register and track their medication history. RFID technology has become more and more popular in the applications of manufacturing industries.

## 4. Architecture of IMedBox

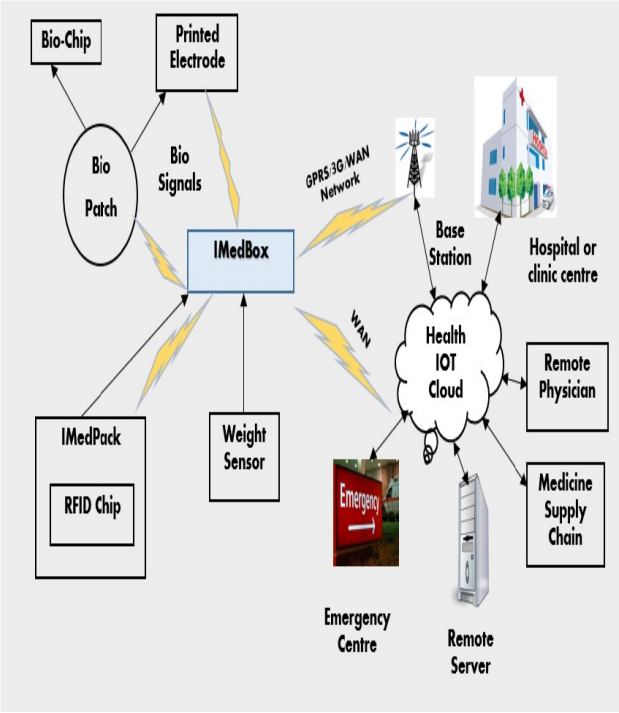


Fig .1 Architecture of IMedBox

An intelligent medicine box (iMedBox) represented in Fig.1 serves as a home healthcare gateway. IoT devices [e.g., wearable sensors and intelligent medicine packaging (iMedPack)] are seamlessly connected to the iMedBox via a heterogeneous network, which is compatible with multiple existing wireless standards. The body-worn Bio-Patch can detect and transmit the user's bio-signals to the iMedBox in real time. The iMedPack is connected with the iMedBox via an RFID link to assist the users with their prescribed medication. All the collected information is interpreted, stored, and displayed locally on the iMedBox. The processed information can also be forwarded to the Health-IoT network for a clinical diagnosis or further analysis.

## 5. Performance Evaluation

Our proposed system was tested using simulator and we have taken the performance with respect to time factor. We checked the performance with parameters like Average delay and Average Throughput. We have consider our simulation parameters as mentioned in Table 1

**Table 1: Simulation Parameters**

| PARAMETER | VALUE |
|---|---|
| Number of nodes | 20 wireless nodes |
| Routing protocol | AODV |
| No.of Gateway | 3 |
| No.of internet server | 1 |
| Mac protocol | 802.15.4 |
| Propagation model | Two ray ground |
| Terrain dimensions | 800*800 |
| Channel | Wireless channel |
| Queue type | Priqueue |
| Queue length | 50 |

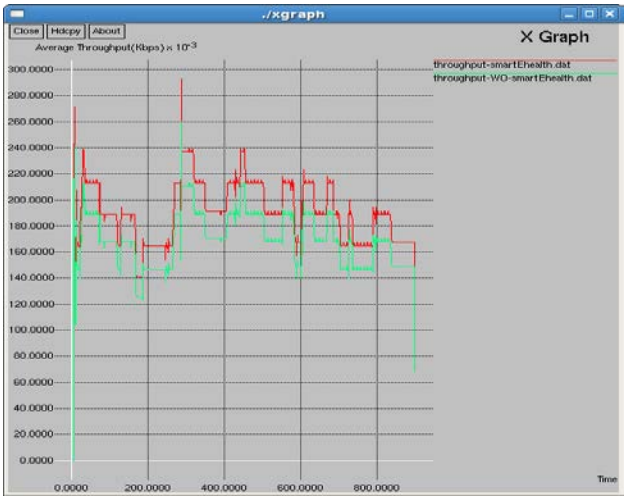


Fig 2 Time vs Average throughput

The fig 2 shows that our proposed Intelligent E-Health gateway med box system gives better throughput compared to existing method and speed of transmission will be high in our method. due to implementation imedbox and Intelligent E-health gateway process we have increased the speed of data transfer due to data compression and fusion process.

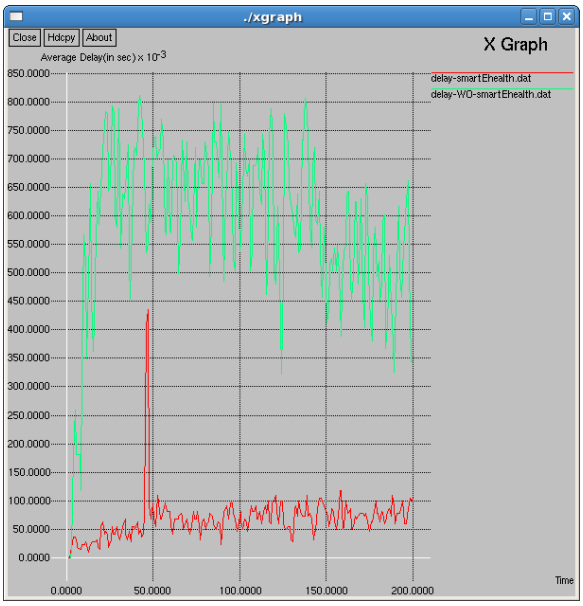


Fig 3 Time vs Average Delay (in s)

The fig 3 shows that our proposed Intelligent E-Health gateway med box system gives less delay compared to Existing method and it proves that our method completes the data transmission with less delay due to data compression process.While compression, packet size will be decreased and due to this reason we can transfer much data comparing to existing system in the queue.so our delay is greatly decreased.

## 6. Conclusion

The gateway serves as a bridge for medical sensors and home/hospital building automation appliances to IP based networks and cloud computing platform. The unique strategic position of gateways in IoT architectures, an Intelligent E-Health Gateway can tackle many challenges in ubiquitous healthcare systems such as energy efficiency, scalability, interoperability, and reliability issues. The gateway serves uses bridge for medical sensors and home/hospital building automation appliance to IP based networks and cloud computing platforms. The proposed IGateway system consists of three key blocks including iMedBox, iMedPack, and Bio-Patch. In this paper we propose to exhibit the step by step development methodology concept in prototyping the Intelligent E-health gateway with intelligent medical box method using data compression, data fusion and security features .The simulation results proves that our proposed Intelligent ehealth gateway imedbox method improves the reliability and energy efficiency of the network compared to existing system.

## 7. Future Work

The iMedBox serves as a home healthcare station by providing strong interoperability and IoT network connectivity. In order to continuously an unobtrusively monitor a user's vital signs, a miniaturized flexible Bio-Patch has been developed. Security and privacy of patients' medical data are crucial for the acceptance and ubiquitous use of IoT in healthcare. We can enhance our proposed work with security and authentication for IoT-Based Healthcare using Intelligent Eheath Gateways.

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