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# An Overview: iButton (1-Wire Technology) and ZigBee Wireless Protocol

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***Abstract*— Many wireless applications in the world require identification and authorisation of a device or a person for carrying information. Also there is a need of transmission schemes for transmitting such signals to the host computer over the network. In such applications different tools are used for authentication, that includes barcodes, magnetic stripes, chip cards, RF tags, iButton, etc. Similarly, different wireless technologies are available viz. Bluetooth, ZigBee, Wi-Fi, etc. A review of different applications based on ibutton and ZigBee used for accessing and data transmission schemes are discussed in this paper.***

***Index Terms*— Access control, anycast, authentication, data logging, fall monitoring, home automation, iButton®, interrogation, ZigBee, ZigBee power adapter (ZPA..**

## I. INTRODUCTION

There are many applications such as access control, cashless transactions, PKI (Public Keying Infrastructure), authentication, identification, e-commerce and many other solutions that require portability and security that uses different technologies for their operations. These applications are based on password protection, punch cards, barcode, RFID (Radio Frequency Identification), magnetic stripes, iButton and so on.

Barcode system uses electromechanical printer and complicated electro-optical readers for its operation. Magnetic stripe (e.g. credit cards) on plastic carrier card is another option for authentication. Here an analog signal is used for data communication. Chip cards are similar to credit cards with additional memory or microcontroller that have gold plated eight (8) point contact area provided for power supply and connection to the host computer. RF tag is another option that uses radio signals for the operation.

There is one more technology developed in recent years called as iButton (1-Wire technology) which has several advantages over these technologies. iButton is a computer chip enclosed in 16 mm thick stainless steel can. As the container is unique and durable, up-to-date information can travel with a person or an object anywhere in the world. There is no need of optics or decoding which is required in barcode as the information is stored in the form of ASCII codes, alignment is not required which is necessary in magnetic stripes.

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It can withstand against large mechanical strengths and needs only two contacts for its communication as compared to chip cards. The ibutton is immune to electromagnetic fields as it is shielded in metal can. The range of ibutton network is up to 300 m. These days many wireless technologies are available such as Bluetooth, Wi-Fi, ZigBee, *etc.* These technologies are having specific applications in different areas of communication. Bluetooth with short range communication is used in mobile phones. It forms a small wireless network called a piconet. It uses radio link working in the 2.4 GHz ISM (Industrial, Scientific, and Medical) band, which is a global standard. Maximum data transfer speed by using the TDD (Time-Division Duplex) to 1 Mbps. Bluetooth wireless point device is having distance range of 10 cm to 10 meters. Wi-Fi is trademark of the Wi-Fi Alliance belongs to class of wireless local area network (WLAN) devices based on protocol from IEEE 802.11 standards. Wi-Fi allows local area networks (LANs) to be deployed without wires for client devices, typically reducing the cost of network deployment and expansion. Places where cable cannot reach, such as outdoor areas and historical buildings, can host wireless LANs. Due to excessive requirements for wireless LAN applications, power consumption is very high as compared to other protocols. ZigBee wireless protocol is based on the IEEE 802.15.4 standard. ZigBee wireless protocol has three frequency bands *viz.* 2.4 GHz, 915MHz and 868MHz which are within ISM (Industrial, Scientific, and Medical) radio band with data transfer rate of 250 kbps, 40 kbps and 20 kbps respectively. A ZigBee module has a range of 10-100 meters in line of sight communication. The low power requirement of ZigBee module is one of the advantages over the Bluetooth and Wi-Fi technologies. Based on iButton and ZigBee protocol, a new system is proposed which performs the medical history tracking of a patient and generates a token with useful information printed on it. In the paper, section II is divided into three parts. Section (II. A) is a discussion of previous work based on iButton, section (II. B) is a discussion based on ZigBee wireless protocol. Section (II. C) gives an overview on the proposed work using iButton and ZigBee combinely. Section III presents the conclusion of the discussed literature.

## II. SYSTEMS BASED ON IBUTTON AND ZIGBEE

Applications based on iButton and ZigBee are discussed here in this section. iButton is useful in access systems, warehouses, data logging system *etc.* and have a secure mode of transmission. ZigBee protocol is useful in small area networks and where there is a need of low power consumption. Using both these technologies a new application is proposed. All these points are discussed below.

### A. *IButton*

Different technologies in the domain of identification are available such as barcodes, magnetic stripes, chip cards, RFID tags etc. To these technologies a new technology is added called iButton which is based on 1-wire technology. An iButton is a micro-system having two external wire connections *viz.* signal and ground.

Eugen Diaconescu and Cristian Spirleanu [1] developed an application based on 1-wire technology in combination with hardware and software. The application is basically developed for identification and authorization of iButton on the 1-wire network and it is also used for 1-wire network interrogation and data processing. Here, *DS9090* and its graphical interface were used for developing a prototype. The software includes different functional switches for interrogating the devices present on the 1-wire network. Each switch has its own function. The application is basically developed for the iButton devices such as addressable switches and also temperature sensor devices. The conclusion is made that the iButton devices are ideal for applications where information is to be transmitted by means of an object or a person. The application developed can be useful at the intelligent buildings for monitoring and control of different parameters. The different domains also suggested for the 1-wire network such as meteorology, parameter control in embedded systems, vehicle security, banking applications, sensor networks etc.

Kai-Xin Tee *et al.* [2] presented another approach based on the 1-wire technology. Here, data logging system and stock management system in the warehouses are developed using the 1-wire technology. Each and every container in the warehouse is affixed with a small electronic tag (called iButton). The tag keeps all the information of the container such as storage loading and unloading history, goods contents, ownership, etc. Another iButton identified as location tag is placed in every storage cell. An iButton is similar to RFID tags but it is immune to electro-magnetic interference, signal distortion and absorption that happen in case of RFID tags and its reader. The system is developed in such a way that all the warehouse cells are connected to the host computer using the 1-wire network. The network configuration is based on MicroLAN architecture [11]. Each warehouse cell is attached to the network through the separate iButton given to it. Whenever any container is placed into the shelf these two iButtons gets connected with each other on the network and the unique 64-bit iButton ID is read by the host PC. The information (container content, ownership, packing history *etc.* and shelf location) present inside the tag are immediately captured by the host computer through the network and updated in the central database (as well as in the tag memories if required).

An algorithm is given for the complete process of hardware detection in the warehouse data logging system. The status of the network is continuously checked at the intervals of 50ms for polling the new container added or removed on the network. Whenever any change detected in the network it is updated on database server. The conclusion is made that this data logging system based on iButton technology and 1-Wire communication protocol is more useful and simple as compared to conventional storage and stock management systems.

An application is developed for access control based on iButton by Goran Martinovic *et al.* [3]. Here an iButton is referred as an electronic key for providing an access to the particular resource, system or place. The system basically used as an electronic lock on the door that allows people to move in and out. The access is provided to only those persons having the electronic key (iButton) which is already registered in the system controller. The operation is broadly divided into two parts *viz.* hardware and software. In hardware part the lock is electro-mechanical in nature *i.e.* when the key touches the key reader; the door opens mechanically and gives access to the person. Software part performs actions such as device search, grant access or restrict the access according to the program. The functionality test of the system was performed for three months duration and different performance ratings (in the range of 1-5) were awarded by users based on different parameters [3]. The average rating obtained is 4.36 out of 5. The conclusion is made that the electronic lock is inexpensive and simple for access control at the same time system needs improvements for better performance.

Skin temperature measurement is one of the complicated process while considering wired sensors. This process is studied and performed by Wouter D. *et al.* using thermochron iButton DS1219H [4]. The experiment deals with iButton validation and its mounting over human skin. The experiment is performed in different parts. Firstly the iButton properties such as accuracy, response time and spatial sensitivity are studied individually. After finding these parameters, actual mounting of iButton over human skin is studied. It's observed that iButtons react slower but gives similar information as given by thermocouples. Also iButtons are applied and studied in the field and clinical studies for finding the results of temperature during sleeping time, circadian rhythm and hypothermia during cardiac surgery. Thus different results are obtained for accuracy and time response of the iButton. It is concluded that, iButtons are portable as they are wireless, can be used for large time span and easy to sterilize. It's found that the sampling rate is one per minute which is considered as disadvantage of iButton.

### B. *ZigBee*

Shyr-Kuen Chen *et al.* [5] developed a ZigBee based patient monitoring system for detecting the fall of the patient in the hospital. Here, the ZigBee protocol is used to transmit the emergency messages of the patient to the concerned person in the hospital. The network is divided into three main nodes as it is a three hop ZigBee network. These nodes are sensor, router and receiver. The sensor node which is mobile in nature senses the signals from the patient and sends to the nearest router. Router routes those messages to the receiver. The transmission of the data from sensor node to the receiver is shown in Fig. 1.


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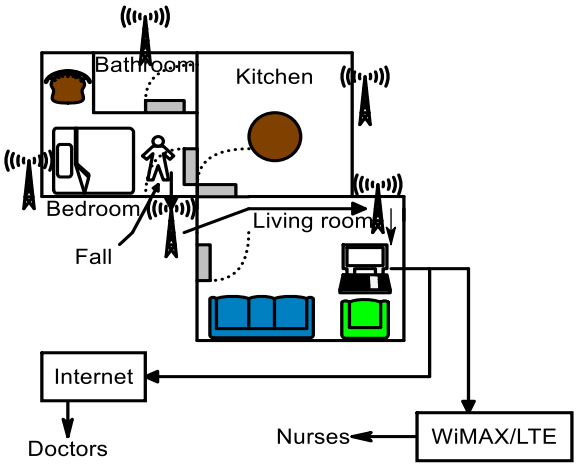


Fig. 1 Network architecture of fall monitoring system [5]

The ZigBee protocol is used for forwarding the data packets, which transmits the emergency messages with vital signs on a multi-hop network with multiple data receivers. The protocol uses anycast scheme [9] to find the nearest available data receiver. When the signal is sent to the desired data receiver and it fails to receive it, then the protocol selects another receiver automatically for the faithful transmission. As compared to multicast and broadcast techniques, anycast scheme reduces the traffic overhead by maintaining the reliability at the same level. A ZigBee device is developed for fall monitoring includes the functions *viz.* fall detection [10], indoor positioning and ECG monitoring. Whenever the fall is detected by the triaxial accelerometer of the device, the current position of the patient is generated and transmitted to the router through a ZigBee network. The 4-s ECG signals are transmitted along with the emergency message for registering the situation of fallen patient. According to the state of the patient different data frames are generated and transmitted over the ZigBee network to the doctor(s).

An experiment is carried out for finding the end to end delay of transmission of fall event and ECG signals through a three-hop ZigBee network and a cellular network. Three different generations of cellular networks *viz.* 2.5G (GPRS), 3G (UMTS), and 4G (WiMAX) are used. From the results obtained it is found that the average time for transmitting an SMS (Short Message Service) message is 39.1 s, with a delay of 35 s between SMS module and cell phone and the transmission delay of three-hop ZigBee network consumes 3.3 s. The packets of ECG signals are transmitted through a cellular network using GPRS (General Packet Radio Service) have the average transmission time of 23.3 s, with the dial-up and transmission delay of 10 s each. The average transmission time with universal mobile telecommunications system (UMTS) is improved to 9.3 s, which includes 5 s dial-up delay and 1 s transmission delay. The average transmission time with WiMAX (Worldwide interoperability for Microwave Access) is further reduced to about 4.3 s. Hence, the conclusion is made that the scheme is fast and reliable and can be employed on wireless WAN or WiMAX to achieve real-time patient monitoring. The 4G technology can replace the present technology for improving the transmission latency. A home automation system based on ZigBee is developed by Khusvinder Gill *et al.* [6] for connecting the home appliances. Here the adoption rate and capability of ZigBee is studied and implemented. A Wi-Fi network is included in coordination with ZigBee that facilitates flexibility for network interoperability and user interface. A user can access the system using the device having internet connectivity. The Wi-Fi network is included for handling high data rate applications such as multimedia entertainment. A partial mesh topology is used to form the ZigBee network. ZigBee based systems like light switch, radiator valve and safety sensor are developed and evaluated to demonstrate the practical implementation. The switching operations are performed on these devices using ZigBee and Wi-Fi network alternately. It is found that ZigBee network has lower access delay as compared to Wi-Fi network. The conclusion is made that the ZigBee based home automation system are lower in expense and can be easily installed. Also the system is flexible and secure in comparison with the existing home automation systems. Another home automation system for controlling electrical appliances is proposed by I1-Kyu Hwang *et al.* [7]. As communication protocols for electrical appliances at home are different, it is difficult to interface it with automatic system. So the integrated remote controller is developed to control the electric appliances. The integrated remote control combines ZigBee protocol and infrared remote controller technology. The remote controller system is consists of three components *viz.* infrared remote controller (IRC), ZigBee to infrared converter (ZB2Ir) and ZigBee power adapter (ZPA). A ZigBee power adapter is useful for the devices which do not have the communication interface. IRC is having a processor unit, ZigBee module, IR receiver and touch screen that form a visual user interface. A mesh topology is used to reduce the problems in line of sight communication. The conclusion states that the integrated remote controller system can make the existing devices useful which were not having the facility of communication. Also the system is flexible for managing all the electrical appliances at home. A network repair scheme is proposed by Meng Shiuan Pan and Yu-Chee Tseng [8] for the data collection applications in ZigBee wireless sensor network. The network repair scheme is divided into two sub-schemes; regular repair and instant repair. The regular repair scheme refreshes the network periodically to maintain the proper shape of the network and deals with two stages *viz.* tree reformation and slot assignment. While the instant repair scheme have extra address space for routers, so that a new path can be selected during failure and deals with localized reconnection and address update. Also two theorems were stated and proved for the proposed scheme. The conclusion is made that the scheme slightly increases the converge-cast latency and the instant repair scheme has fault tolerance capability. Also the scheme maintains the network during frequent link failures.

### *C. Proposed Work*

By combining technologies, iButton and ZigBee, a medical history tracking and token generator system is proposed. The work is featured to facilitate the medical history of the patient anytime and anywhere in the hospital for the reference of doctor(s). The previous information of the patient like, when the patient visited for last check-up, information about prescribed medicine course *etc.* can be made available to the doctor. Here the medical history tracking of the patient will be done using iButton (1-Wire Technology) whereas the token generator system is based on ZigBee wireless network and iButton.


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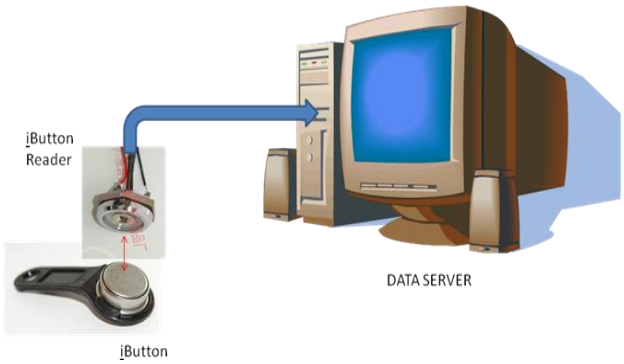


Fig. 2 Proposed block diagram of medical history tracking system

The ibutton is used to read the medical history of the patient from the data server. The reader reads the ibutton, which gives the access to the data on the server related to the patient to whom the ibutton belongs (Fig. 2). This is a secure data access system. After every visit of the patient, his medical records are updated on server by the technical staff of the hospital. The ibutton of particular patient gives access to the data of that patient only. Hence, when the patient gives his ibutton to doctor, then and then only doctor can access his data.

In the proposed token system at the counter, a token is generated having printed information on it, such as patient waiting number, name of consulting doctor, time of appointment, name of department, name of hospital *etc.*

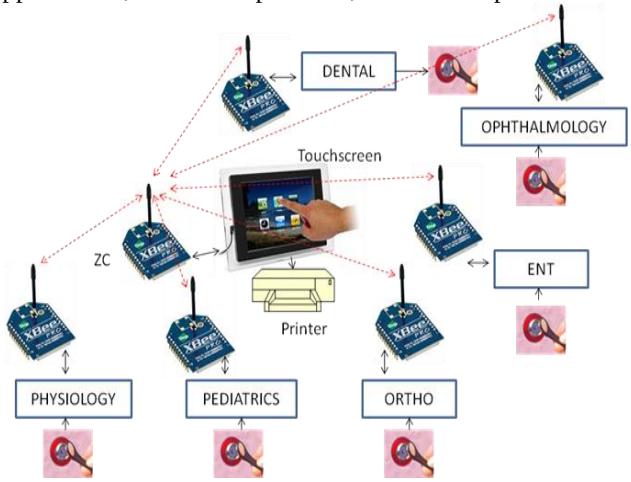


Fig. 3 Proposed block diagram of medical token generator

The medical token is generated using the zigbee wireless protocol and printer with respect to the status updated from different departments on the wireless network. Whenever any patient accesses the touch-screen, the updated data is printed on the paper (token). The current status of the patient is updated by the doctor of respective departments by using their respective iButtons. A simplified block diagram of medical token generator is shown in Fig. 3.

## III. CONCLUSION

Different applications based on iButton and ZigBee are discussed separately. A combined proposed application based on iButton and ZigBee is also discussed. iButton uses only two wires *viz.* signal and ground for communication; hence it is called 1-Wire technology. It has internal memory used to store more information. iButton is more secure than the existing technologies used for transmission of information. It has unique 64-bit ID which can never be repeated or changed. It is portable and can be used for giving the access to the system or place. There are several types of iButtons available in the market developed for different applications. It withstands large mechanical forces and can operate in different temperature range. 1-Wire network is easy to establish and can be used in building premises or company.

The ZigBee wireless protocol is very fast and reliable as compared to Bluetooth and RF transmission. It can be used in different transmission schemes such as broadcast, multicast and anycast. The power consumption of ZigBee module is low as compared to Bluetooth and Wi-Fi. Hence, ZigBee can be a good solution in the applications where there is a need of low power consumption devices. The ZigBee device can sleep when not in used and hence saves the power. It is helpful in transmission of emergency messages over the network. The ZigBee based home automation system is cheaper and easy to install. The network is easy to repair and flexible in nature, so number of devices can be added or removed anytime. Hence, using both iButton and ZigBee technologies a secure and faster transmission based system can be developed.

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