

## **Full Duplex Secure Communication: Human Area Network**

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### **ABSTRACT**

With so many researches going on wired and wireless network communication, this paper guides through the important aspects of one type of network communication called Human Area Network (HAN). It comes from the branch of Personal Area Network (PAN) where the human body is used as a transmitting medium or connection wire between two communicating devices to transfer data. This paper gives in detail information about the electronics used to recover data from the fleshy human body. In today's world of modern science, it is still not very common to believe that actually a human body can be used to pass information of data to other communicating device. This paper is also the effort to take this technique out to everyone in the light of science for tomorrow's generation and beginning of vast research in this field.

This technique of data transmission is considered to be more reliable and more dedicated way as the only way to transmit data is through one's body. The important point to remember here is that the data is more secured as in any transmitting technique as the data to be sent is within the sender's body before transmission and it is upto the sender to whom he wished to transmit data, without being hacked in the air or other types of data malfunction. The path is well dedicated before transmission and it's a two way communication network.

The paper gives thorough information about Human Area Network (HAN) technology and opens a huge gate for research in this field. Though the research is already going on in this field with a device called Red Tacton which is responsible for controlling signals to and from the body but this paper approaches the method to replace this device with a copper plate and processor to control the signals.

**Keywords:** Communication, Red Tacton, Human Area Network(HAN), Personal Area Network(PAN), data transmission, human body, dedicated channel, two way communication.

### **INTRODUCTION**

In the era of digital communication, data transmission is a common need of every individual to communicate their devices with the remote devices or sometimes nearby devices. Even a common man now is everyday indulged in transferring data in some or the other way like the voice calls, SMS, chats, etc. This is nothing but transmission of data from one end to the other.

Some data are securely transferred that should not be readable or writable to public as in the case of defense, bank data, etc. But still there is a vast risk of data being hacked by the anti-social elements.

As for far type communications also called far field communication requires radio frequency (RF) waves to transmit data over long distance where Personal Area Network is not possible to setup and hence Human Area Network (HAN). But for communication type that is reached within our hands also called as near field communication we can introduce Human Area Network as a medium for transmission of data from start point to end point. Places where data security is must in near field communication. We can replace the system with more adequate and more reliable system called Human Area Network. The idea proposed by T.G. Zimmerman in MIT laboratory in the early 1990s can be implemented now giving a new way for communication world and more dedicated and secured connection [1] . Though we have other techniques like Wi-Fi and Bluetooth for short range or as said near field communication or short range communication the problem still exist with it in crowded places where the throughput is ultimately reduced due to collision of packets. Even the signal in the air can be intercepted with some misuse. Even the strict line of sight direction based activity of Infrared Data Association (IrDA) makes it not appropriate to be used here.

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Hence, as a result of these problems only a better network type can solve this problem and that can be Human Area Network. It is independent on the number of people in a particular area and moreover the signal is more dedicated towards receiving end. If we can setup a system in our surroundings where electronic devices communicate within each other when coming in close contact with human body and we utilize the human body as a medium for transmission then we are basically building a new network called Human Area Network. Through this we can actually solve throughput reduction caused by number of people at one place and jamming the network, increasing the security of data in transmission where the receiver end is dedicated and reducing the cost of setting high networks. A human body can use every electrical signal passes through the body to deliver information on the other side.

## HISTORY

Human area networking (HAN) is still a nascent technology. It has very short history. HAN came into existence by merging sensor network technology and biomedical engineering. Professor Guang - Zhong Yang was the first person who defines the phrase "body sensor network" in his book in 2006.

HAN technology can be developed for different cases like for body sensor network, wireless audio, mobile device integration, sports and fitness monitoring and personal video device. For different cases Human Area Network (HAN) require different bandwidth, latency, power usage and signal distance. The WPAN (wireless personal area network) working group [IEEE 802.15] established a Task group to develop the standers for Human Area Network (HAN). The task group gave the decision how to balance data rate and power. Nippon Telegraph and Telephone (NTT) got breakthrough in HAN and developed a technology called Red Tacton.

Though the concept "communication using a human body" was 1st given by T.G. Zimmerman from the IBM Almaden Research Center in 1999 [1], NTT got the success in 2004 [5]. In between many research groups evaluated and reported this communication mechanism but they all were having problem with data rate and operating range [1]-[4]. NTT resolved these issues with the help of Red Tacton technology.

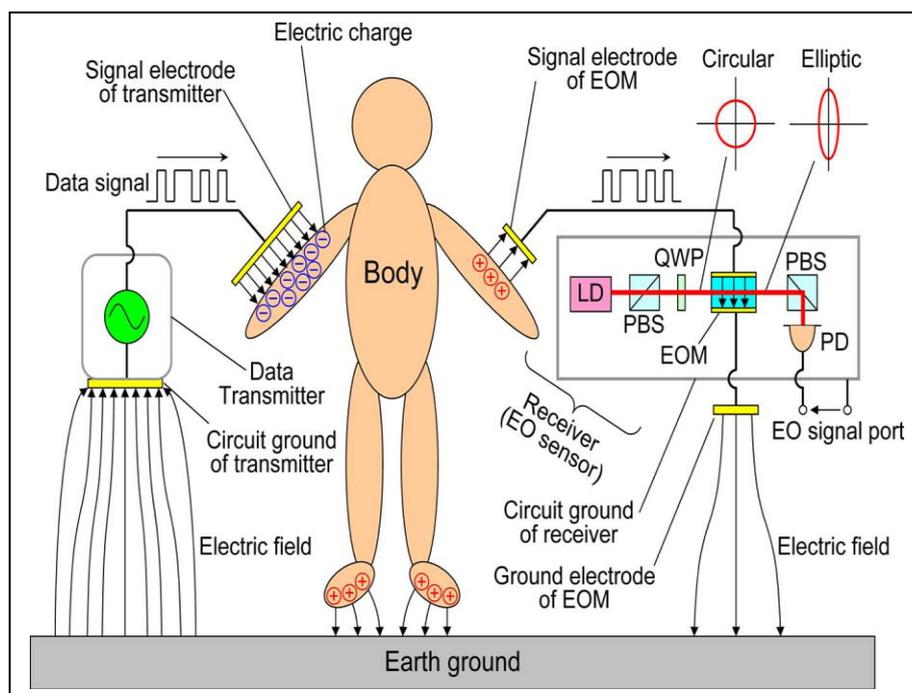


Fig1. HAN Communication model using EO sensor [7]

From Fig. 1 it's clear that Red Tacton contains electro optic (EO) sensor which is composed of a laser diode (LD), a quarter-wave plate (QWP), an electro optic modulator (EOM), polarizing beam splitters (PBSs), and a photodiode (PD) which makes the device complex and costly. It got modified in 2009 by Ai-ichiro Sasaki, Mitsuru Shinagawa, and Katsuyuki Ochiai to obtain better result, they are in integration with the NTT laboratories and they got the result of high data rate 10 Mb/s [7]. As Red Tacton technology is still in the research part and many methods are being implemented to increase the rate of the device and so does this design need it. It's still open for researches and needs work to

be done to amend the quality of performance but though with all these cons today communication is still possible through human body with copper plate and without using Red Tacton.

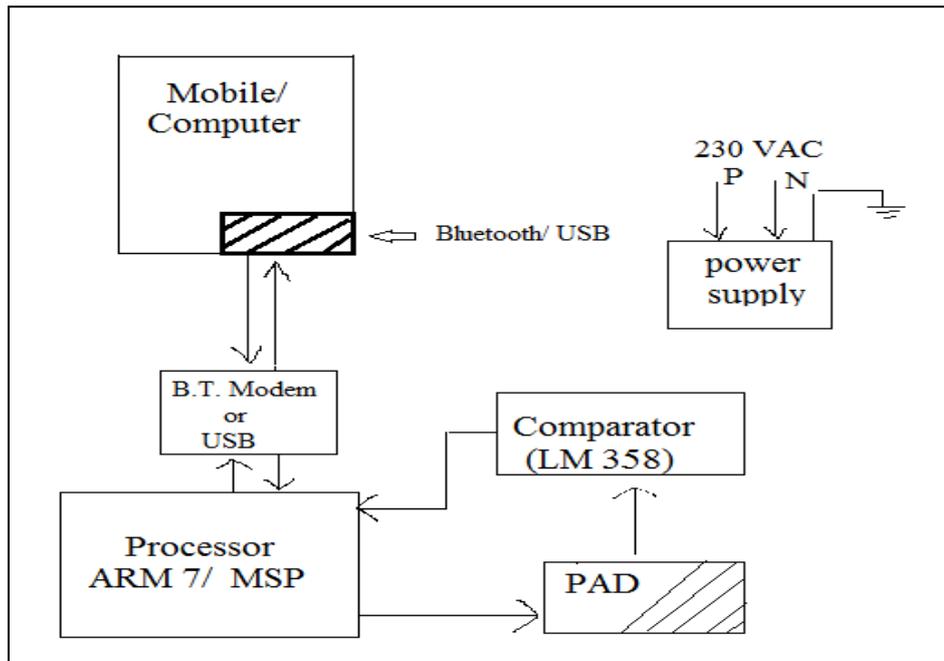


Fig2. Device without using Red Tacton

### Principle

The technique behind this design is that when the transmitting device wants to send the information or digital data to the other device to which it wants to communicate then the human body form the connection wire between the two devices. This is possible only if the data flows through the body and can deliver it successfully on the receiving end. The data or the information is converted into electrical signal so that it is easily transferred all over the body as a human body is a good conductor of electricity. This concept is behind the mind that the data in the form of electrical signal will flow throughout the body and when the body with this electrical signal comes in contact with the receiver, which is ready to accept such electrical signal, will amplify, reduce noise and convert this electrical signal back into digitized form to recover the data back at the receiver. The communicating devices could be any mobile devices like PDA, cell phones, wrist watch, headphone or any other thing as long as it is a conducting material.

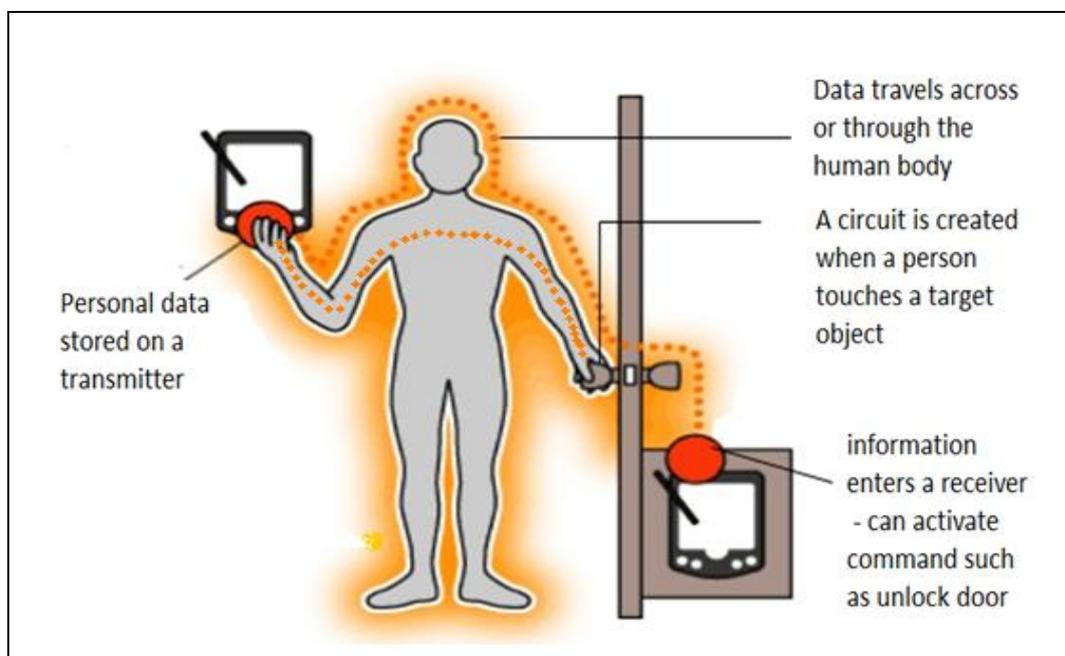


Fig3. Data Flowing on Surface or through of Body

## MECHANISM

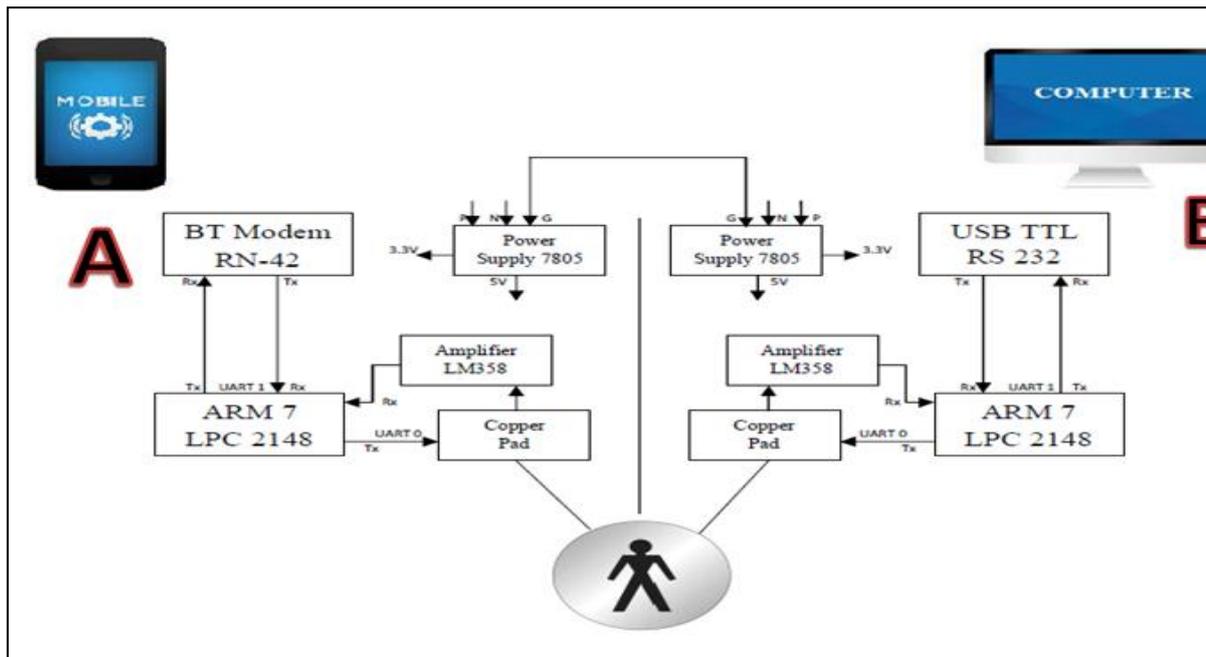


Fig.4. Communication with Human Area Network Using Copper Pad

Fig. 5 shows the complete block diagram of how the communication will take place between two communicating devices through human body in between. The design is simple to understand and much easy to implement as compared to Red Tacton technology. Both has its own pros and cons in the working scenario and expense. For the experiment purpose the two devices taken into consideration are the normal mobile phone and the personal computer. The mobile phone is connected to our device responsible for data carriage to the body through Radio Frequency (RF) technology Bluetooth. Whatever the data information needs to transmit is initially stored in the mobile phone memory obviously in the digitized form. Our device is equipped with Bluetooth modem RN- 42 to easily communicate with other mobile Bluetooth equipped devices. The Bluetooth is just required to send the required information to the designed equipment for further process of the data.

The device amplifiers are maintained with the 5V regulated voltage with the power supply and processor and BT modem are maintained at 3.3V. Now on the transmitter side that is the side marked 'A', the data is stored in the mobile phone memory. The side marked 'B' is the receiver side. The data is send from the mobile phone to the device Bluetooth modem using RF Bluetooth technology. The data received by the Bluetooth modem is given the processor for logical approach. The device uses ARM 7 Microprocessor IC LPC2148 for distinguishing the required signal from the unwanted signal. LPC2148 chip is used as it is relatively small and has low power consumption. It works on either 16 or 32 bit architecture and has 8kB to 40kB on chip static RAM. It has multiple UART connections and it is this chip responsible for deciding the acceptance or rejection of incoming signals and collision avoidance of transmitting and receiving signal. It allows the system to develop a two way communication full duplex. Now, before introducing the signal into the human body, we knew that a human body, most of the electrical signal in it, dissipates in the ground. So there is a requirement of using amplifier to amplify this useful signal before inducing it into the body. This maintains the strength of the signal inside the human body and easily flows through the surface of the body. A human body can conduct electricity from the surface of the body and other the can conduct from inside the body. This technique is based on the surface conduction as this requires less power and strength of the signal as compared to inside the body. The electrons present on the surface of the body are totally responsible for the flow of data. When the data is send to the body in electrical form and it usually enters with adequate voltage representing the data. This adequate voltage gives a definite direction to the flow of electrons in the body and thus the data flows in the body with this voltage with electrons. Now since the data is in the human body and this data will remain flowing in the body till the power is switched on. A human body performs a memory type that when the power cuts off the memory also gets erased up. So at the time of transmission of data to other devices the body should be

in contact with the equipment that will represent that the data is successfully flowing through the body. The contact part is nothing but a simple copper plate from where the body receives the amplified electrical signals. For the amplification ICLM358 is used which is a dual Operational Amplifier (Op-Amp). Now there could be many ways to transfer the signal in further process like one we transfer the signal to the copper plate like above case and then the this body can further transfer to other device with handshake with other person who has the same setup to receive signal thus making a full duplex communication line. In our case we kept two copper plates, the copper plate on side ‘A’ has the data information induced in it with the above process. And it is this copper plate which should be in contact with the human body which keeps the data continuously flowing in the human body. Now the copper plate on side ‘B’ is also connected to amplifier LM358 and ARM 7 Microprocessor LPC2148 which ultimately is connected to Personal Computer (PC) through serial connection RS232. The data on from mobile is transmitted to this PC through human body as a connection wire and that too two way communication. Now the body possessing electric data signal now just need to touch the copper plate on side ‘B’. This makes a complete circuit for the data to flow with earth ground as reference voltage. The electric signal given to the copper plate ‘B’ needs to be amplified for proper detection and recovery of data. The signal is amplified by IC LM358 and for noise reduction and control logic the electric signal is further given to the LPC2148 chip. The chip serial communicates with the computer with RS232 as a mediator connection. Thus, with this method the data can be transferred from point A to point B with human body as connection between them. And this setup doesn’t require Red Tacton at all but still able to transfer data through human body. Red Tacton and this design have its own pros and cons as said earlier. Red Tacton is complex to implement and is relatively expensive but has a speed of about 10 MB/s while this design setup is easy to implement and very cheap but relatively less speed than Red Tacton but still for a specific task this design achieves the result too.

### **Human Safety**

The important issue of Human Area Network (HAN) is human health. While using the Red Tacton transceiver, transmitting and receiving electrode is completely covered with insulating material. But in this case there is no isolation of the body from the transmitting and receiving electrode. Human body depends upon the amount of current flow thorough the body and the length of the time of for which the current passes. In this case the current though the body is much less than 10mA which remains under the bar of Human safety.

### **RESULT**

The idea before the starting of the task was to able to create a physical human body into a connection wire between two devices so that they can communicate. The result is achieved with successful transmission of data at the data rate 9600bps.

We got the successful full duplex transmission through the human body without involving Red Tacton in the design. In this approach of human body transmission we took the body touch as a resistive touch on the copper plate. Though we came up with some drawbacks like speed still we managed to create a Human Area Network (HAN). This technique involves very less amount of current to pass through the body to transfer data. In our case it comes out to be 2mA to 5mA which less than the human body precaution standard. After achieving result, this opens a gate to initiate more research works on Human Area Network and improves the technology to make it like state of the art for people of today and the next generation.

### **CONCLUSION**

Thus, the paper in detail discuss about the communication possible with intra body communication in Human Area Network. Also it explains the working of the communication network where using Red Tacton is not necessary to transmit data from one end to other end or between two communicating devices. Hence, a human fleshy body can successfully be used as connection wire to join a communication line as human body is a good conductor for electrical signals. It assures almost null throughput reduction even in crowded places and because the dedicated route the data is much secured during transmission. For a specific task, an equipment can be designed to achieve great result even without using the Red Tacton which eases the complexity and relatively very cheaper than using Red Tacton.

## Future Scope

Though we discussed the research done so far extensively, Human Area Networking has a scope for improvement in this field. One of the major parts of Human Area Networking is the behavior of such communication when the body is in motion as it effects on the signal strength. Most of the practical application of this communication will involve body movement. Hence research needs to be done on data transfer rate variation due to movement of human body.

Human tissue limits the dispersion of frequency of high frequency carrier and data rate so the new technique should be there to improve the data rate with low frequency. It will have a great impact on medical studies as this technology involves passing signal through human body.

Now-a-days, e-payment system is in great demand where techniques like Radio Frequency Identification (RFID) or Near Field Communication (NFC) are used to pay the bills in the shopping mall. Research can be made to evolve hand touch payment method and introduce an altogether new technique of payment.

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