IJARCCE

ISSN (Online) 2278-1021
ISSN (Print) 2319 5940

International Journal of Advanced Research in Computer and Communication Engineering
ISO 3297:2007 Certified
Vol. 6, Issue 7, July 2017

BAN: intra-BAN and inter-BAN

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Abstract: Body Area Networking (BAN) is a field of networking in which communication takes place between different sensors or network elements or other electronic equipment at the nodes within the body called intra-BAN and between two or more bodies called inter-body BAN. The movement of data or information or packets between nodes is mainly wireless or through the length, breadth and height of the body (this is still a challenge as the human body is a very good conductor of electricity and acts as a short between an electronic component and ground). There are many other types of networks like PAN (Personal Area Network), LAN (Local Area Network), WAN (Wide Area Network), MAN (Metropolitan Area Network) and global network. The above classification is mainly based on the scale of distance or area (Spatial scope). Body Area Network (BAN) is a special type of network used to facilitate communication within a single body/autonomous body or between two or more autonomous human bodies. BAN is a new type of network architecture made feasible by novel advances on lightweight, small size, ultra-low-power, and intelligent monitoring wearable sensors. In this paper we have made serious efforts to simulate both inter-BAN and intra-BAN using wireless technologies, Routing protocols and Network Simulator tools (NS tools). Each human body is considered to be an Autonomous System as compared to another body with its own autonomous BAN. In this paper we have made successful attempts to connect logically divided areas together using Virtual-Links thereby enabling packet transmission between two autonomous areas running their own IGP and using wireless protocols like Bluetooth, IR or Wi-Fi. We have also carried out experiments/trails to make both intra-BAN and inter-BAN secure and data encrypted.

Keywords: PAN (Personal Area Network), LAN (Local Area Network), WAN (Wide Area Network), MAN (Metropolitan Area Network) and global network, Network Simulator tools, intra-BAN, inter-BAN and wireless.

I. INTRODUCTION

A computer network is a group of computer systems and other computing hardware devices that are linked together through communication channels to facilitate communication and resource –sharing among a wide range of users.

Networks are classified into following

- PAN- Personal Area Network called PAN is a computer network used for communication among personal devices itself like computers, tablets, mobile phones etc… and its range or scale varies from a few centimeters to a few meters. PAN can also be used for connecting to a higher level network and the internet.
- LAN- Local Area Network or LAN is a computer network interconnecting computers and other resourceful devices within a residence, office, university campus etc… with the help of Ethernet or Wi-Fi (most commonly used) or any other transmission technology.
- WAN- WAN or the Wide Area Network is a computer network that extends over a large geographic area, maybe about 100 km or more. WAN often makes use of leased telecommunication lines. The internet is the world's largest WAN.
- MAN- MAN or Metropolitan Area Network lies between that of LAN and WAN and is used for a computer network or interconnection of networks in a city or several local area networks by bridging them with backbone lines.
- BAN- In the past few years, much of the research in the area of Body Area Networks are related to developing lightweight, small size, ultra-low-power and intelligent wearable sensors and wireless connecting technologies for their communication. This type of network is restricted within the body called intra-BAN and can also be used to

IJARCCE

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Vol. 6, Issue 7, July 2017

handshake with other BAN's called inter-BAN. The basic idea is to allow secured interconnection of sensors and other electronic equipment and regulate communication between them.

Figure 1, 2, 3 and 4 shows PAN, LAN, MAN and WAN respectively.

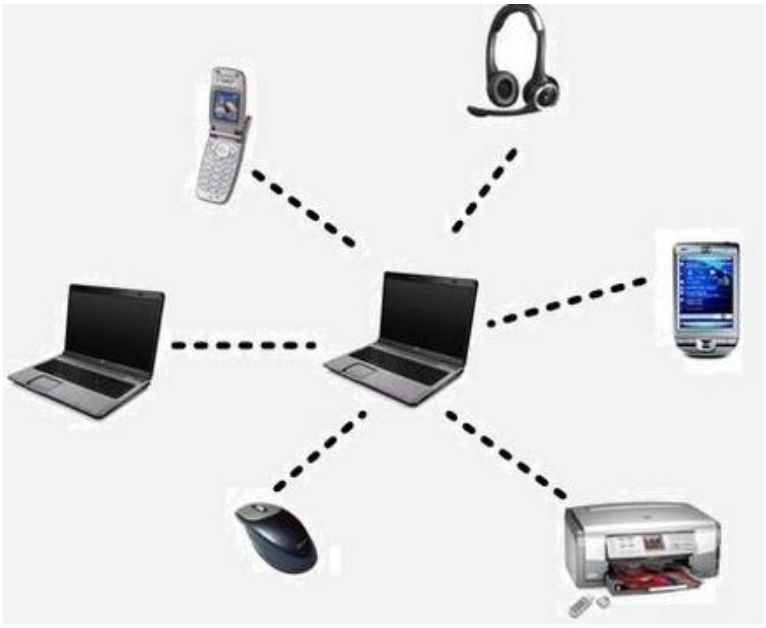

Figure 1- Personal Area Network (PAN)

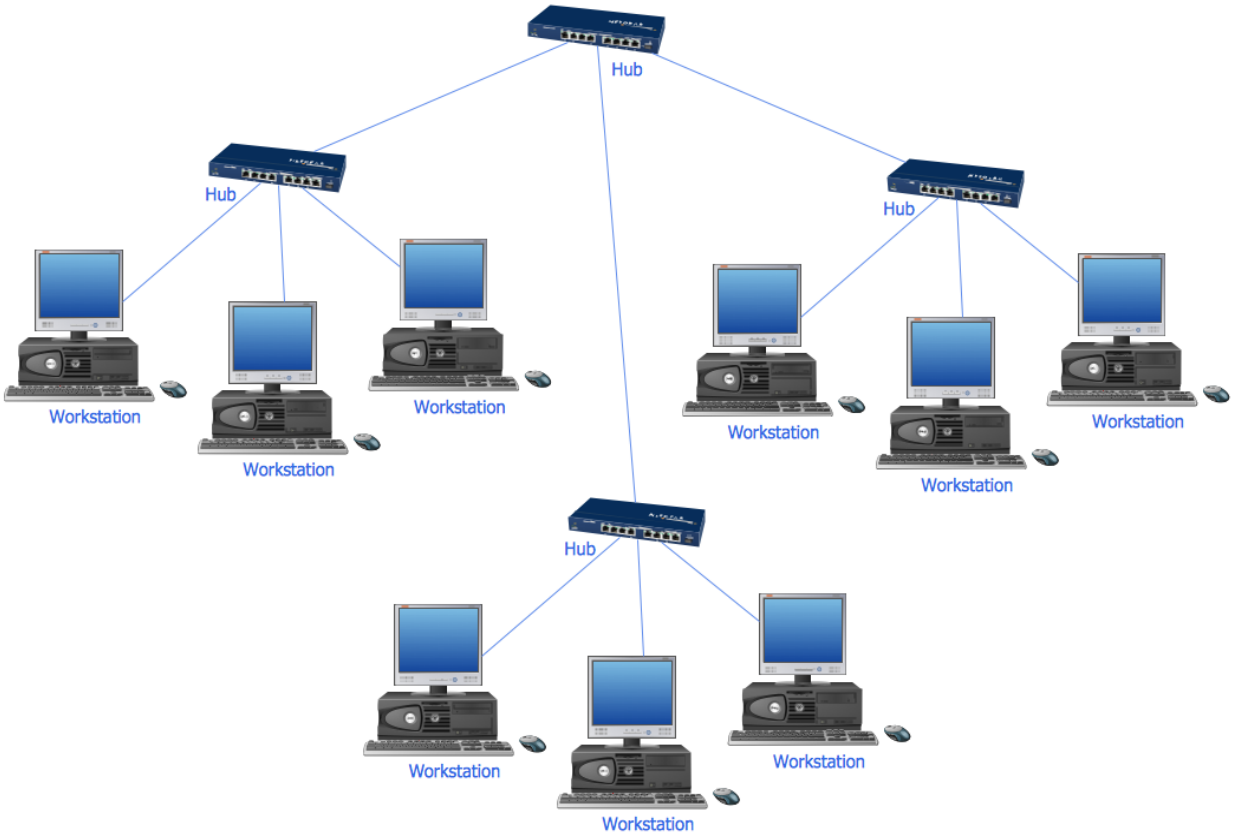

Figure 2- Local Area Network (LAN)

IJARCCE

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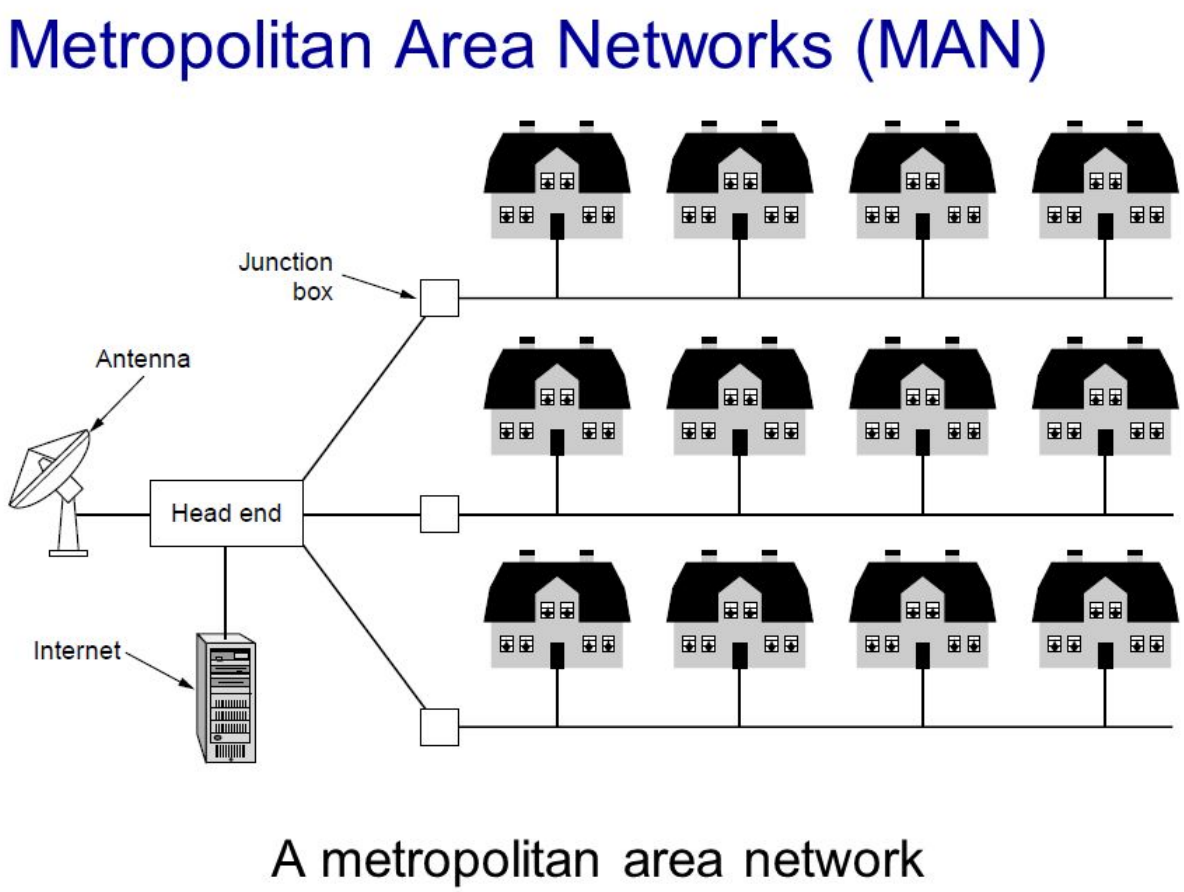

Figure 3- Metropolitan Area Network (MAN)

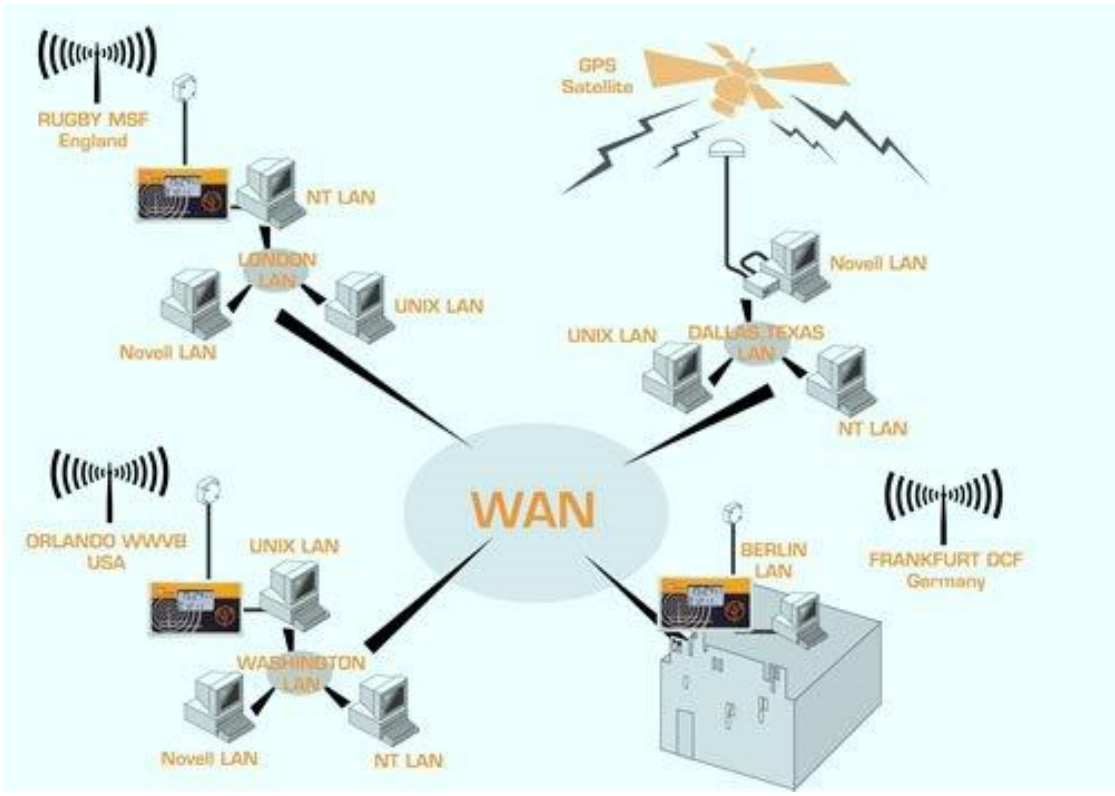

Figure 4- Wide Area Network (WAN)

DOI10.17148/IJARCCE.2017.6756

IJARCCE

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II. INTRA-BODY COMMUNICATION (INTRA-BAN)

Intra Body Area Network [1] is a type of BAN in which sensors/computing devices/electronic wearable equipment/ bio sensors are embedded on to the body at the nodes of the Body Area Network. These sensors/ computing devices/electronic wearable equipment/ bio sensors at the nodes are inerconneced using wireless technologies and are called the intra-body communicaton links. Figure 5 shows the block diagram/ Network topology of intra –BAN.

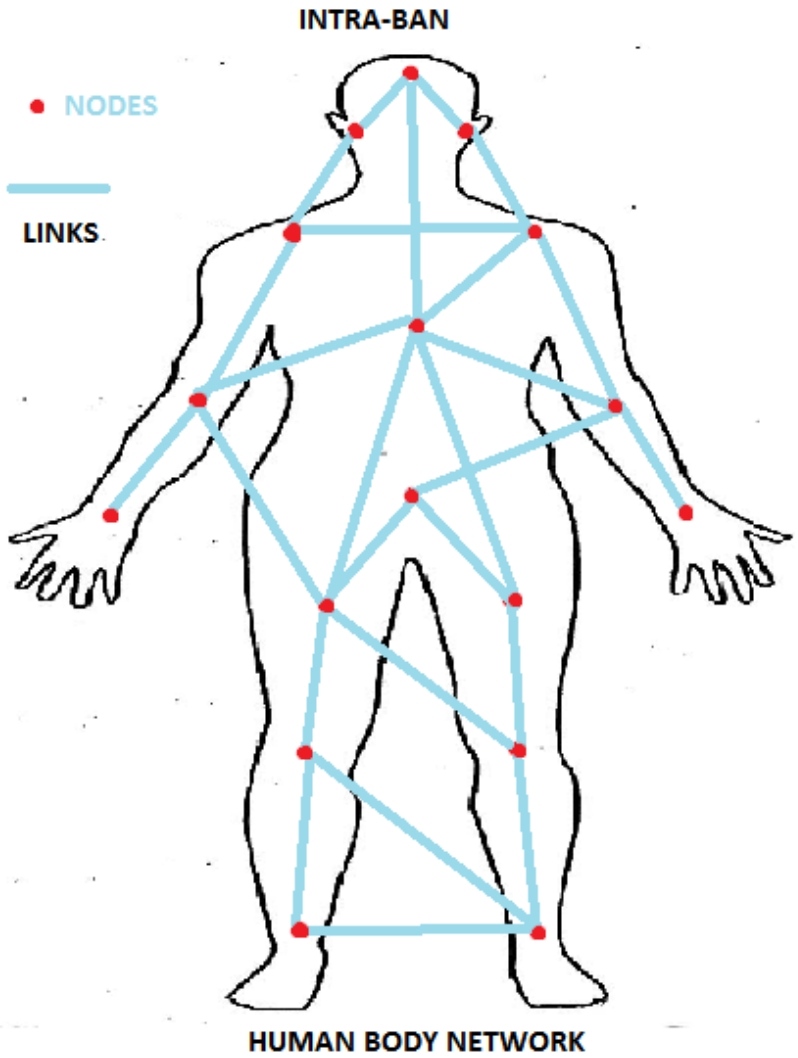

Figure 5 shows the block diagram/ Network topology of intra –BAN

Each BAN on a human body is considered to be an autonomous/independent network and in this paper we have configured IGPs – OSPF on each nodes to dynamically route the packets between each and every router at the nodes. OSPF is chosen because it follows the Dijkstra algorithm and link-state routing protocol for its communication by choosing the optimal path between any two nodes. In OSPF, there is a provison to divide the BAN into logical area and follows classless and hierarchical architecture thereby enabling logical subdivisions of the network. Figure 6 shows the implementation of OSPF on intra-BAN as the dynamic routing protocol.

III. INTER-BODY COMMUNICATION (INTER-BAN)

Unlike intra Body Area Networks which operate as autonomous systems, inter-BAN [2] or inter body communication is a networking model in which communication takes place between two autonomous bodies which run their own internal dynamic routing protocols and are connected to each other by using Virtual-Links [3]. This communication is only possible through three-way handshaking [4]. Figure 7 shows the block diagram/ network topology of inter-BAN. Figure 8 shows the inter-BAN simulated using network simulation tool [5]. In figure 8 Virtual-Link is used to connect

IJARCCE

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ISSN (Print) 2319 5940

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area 1 to area 0 using Virtual-Link of area 10. Figure 9 shows inter-BAN in which other backbone area n being connected to the backbone area 0 through another backbone area.

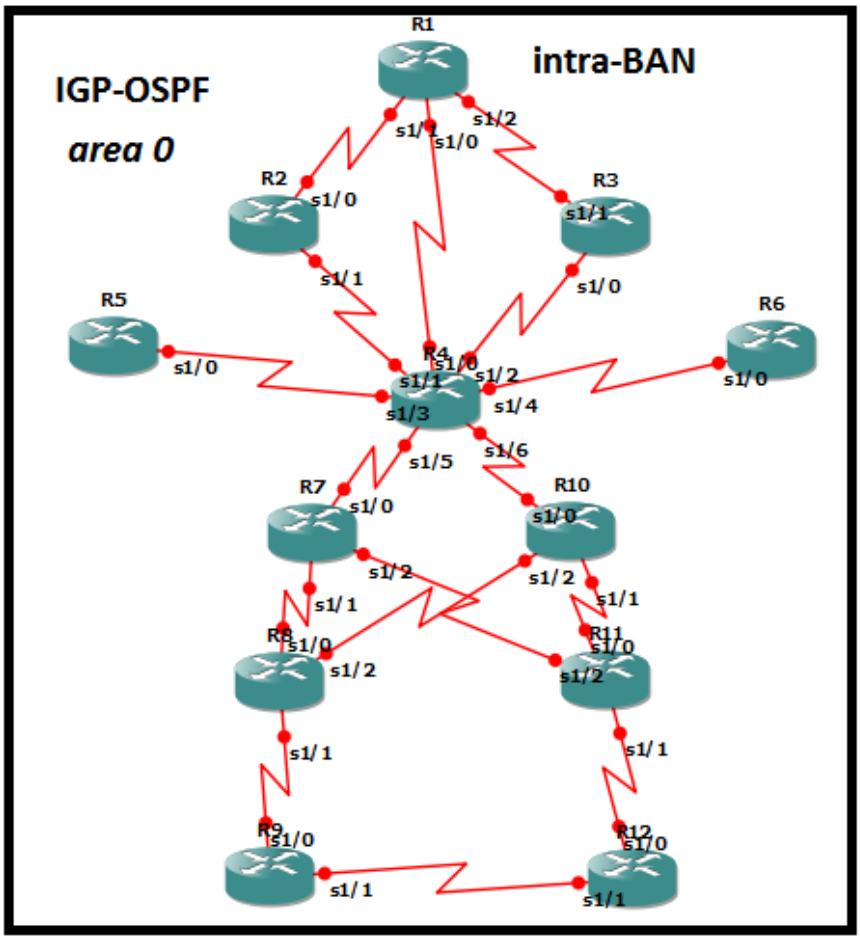

Figure 6 shows the implementation of OSPF on intra-BAN as the dynamic routing protocol.

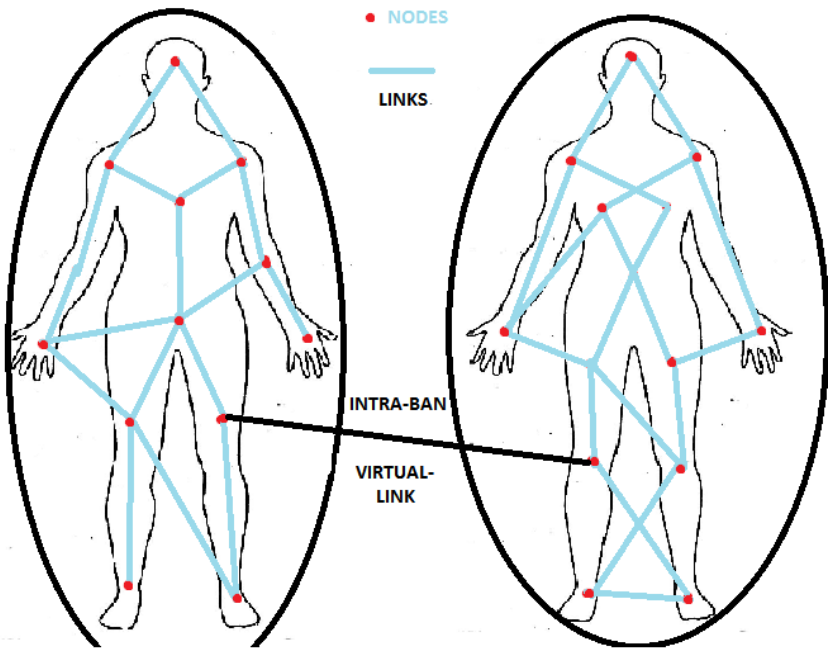

Figure 7 shows the block diagram/ network topology of inter-BAN.

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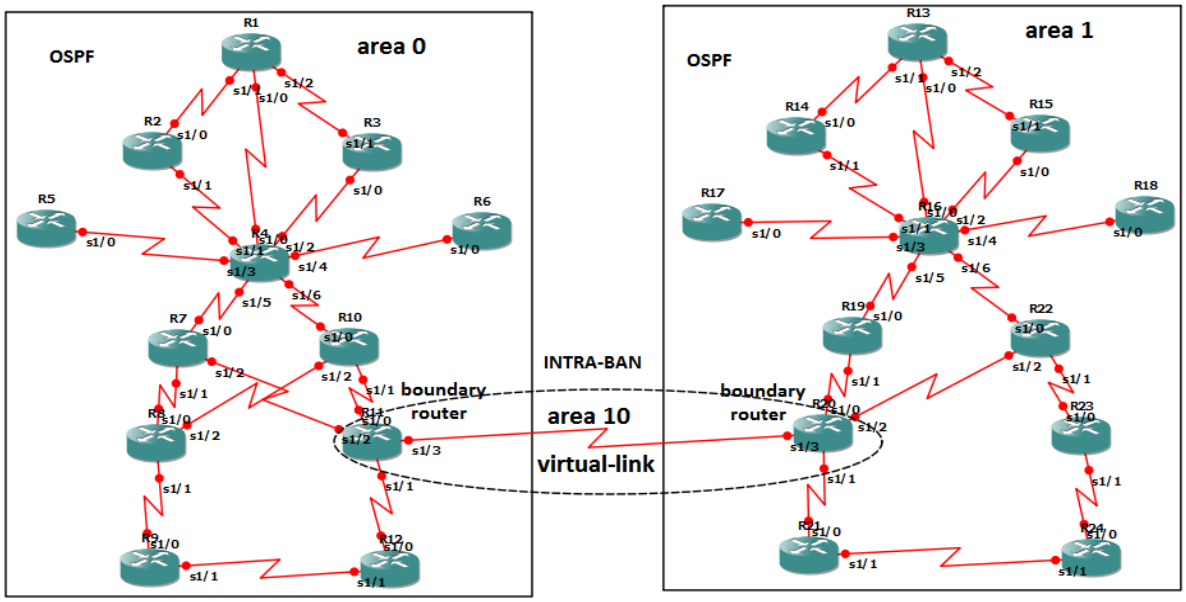

Figure 8 shows the inter-BAN simulated using network simulation tool.

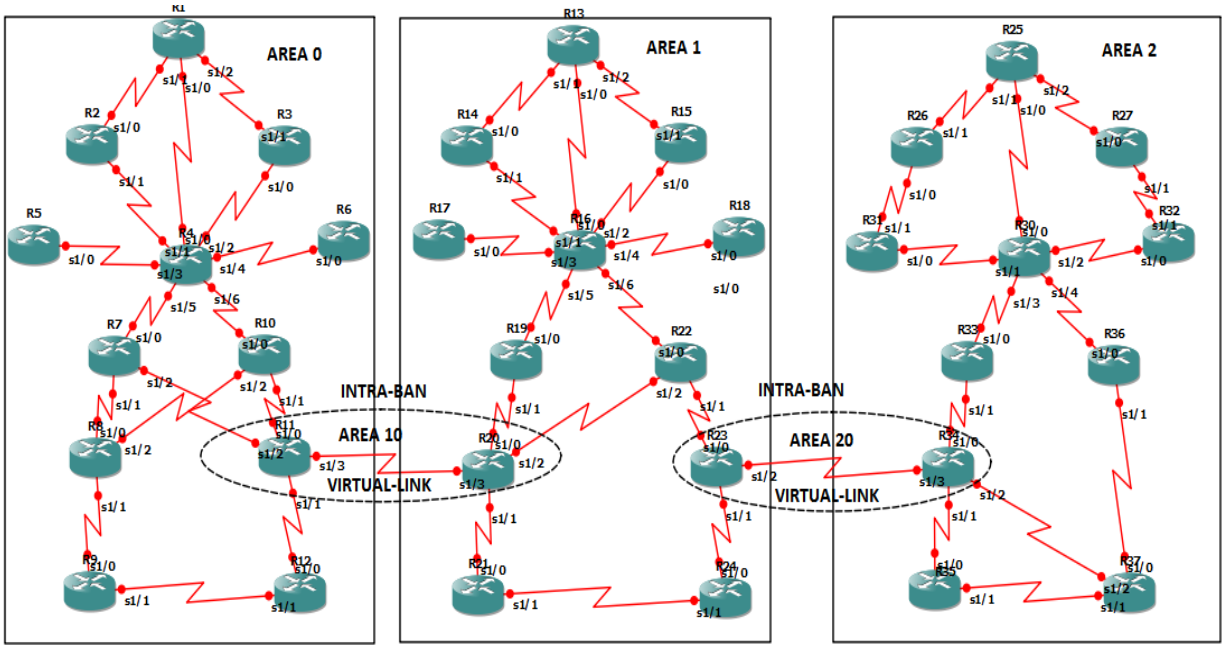

Figure 9 shows inter-BAN in which other backbone area n being connected to the backbone area 0 through another backbone area.

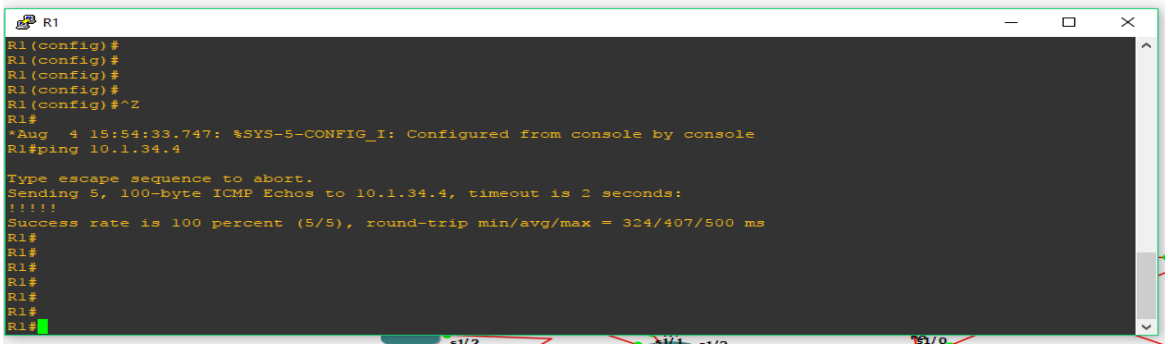

Figure 10 shows intra-body ping

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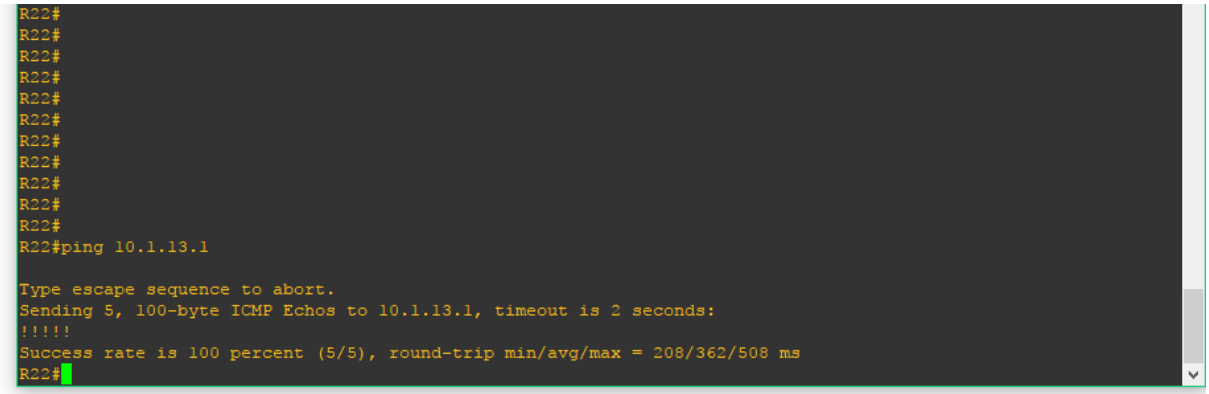

Figure 11 shows inter-body ping

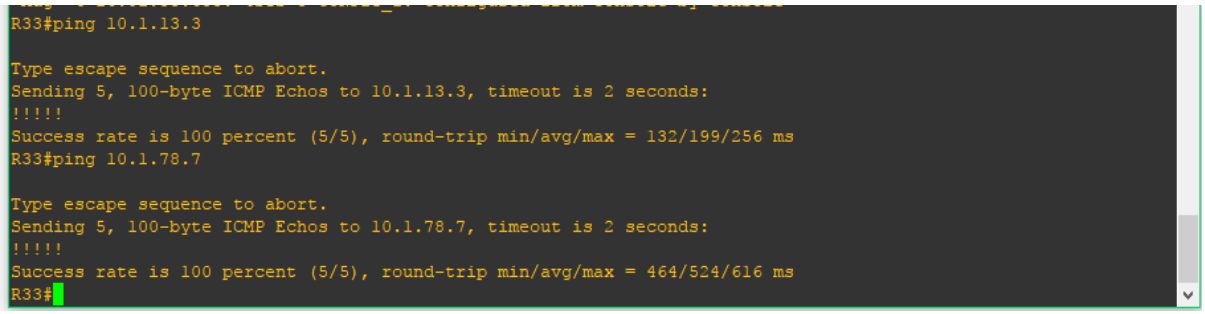

Figure 12 shows an effort by a router in area 2 and area 1 to send packets to autonomous body 0 using ICMP echoes.

IV. RESULTS AND FINDINGS

Figure 10 shows intra-body ping. Figure 11 shows inter-body ping and the use and configuration of Virtual-Links to connect two or more areas or autonomous Human bodies. Figure 12 shows an effort by a router in area 2 and area 1 to send packets to autonomous body 0 using ICMP echoes [6]. All our efforts in connecting the nodes using wireless communication links were successful. All the nodes were interconnected using dynamic routing protocol such as the OSPF routing protocol. Static routes were also configured in regions where there was a necessity and network admin intervention was necessary. This will be dealt in detail in our coming research papers.

V. CONCLUSIONS

Body Area Networking (BAN) is a contemporary and special field of networking and wireless communication in which packets are forwarded to a specific destination within the human body. This is possible only when the sensors or computers or other electronic components at the nodes are properly interconnected and every node is reachable. In this project efforts were made to interconnect all the nodes within an autonomous body using a dynamic routing protocol such as the OSPF. Inter body communication was also made possible using Virtual-Links configured between two boundary routers of the two autonomous systems. Inter body communication between two or more autonomous human bodies were also made possible by configuring OSPF on routers and dividing the networks into logical areas (backbone area and other areas called the non-backbone areas)

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