CRITICAL DATA AND LOCATION DEPENDENT HANDOVER ALGORITHM FOR WIRELESS BODY AREA NETWORK UNDER MOBILITY CONDITION

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Abstract : In the field of healthcare, Wireless Body Area Network (WBAN) has come up as a important innovation which can be giving better way for monitoring wellbeing of the patient and observing at health centers, remote area and even at their homes. WBAN includes communication among sensor nodes with as often as possible evolving condition. Subsequently bunches of issues still should be tended to. A portion of the significant issues are Physical layer issues, interoperability and portability issue. WBAN Gateway is a physical gadget or programming program that fills in as the association point between the server and controllers, sensors and astute gadgets. All information moving to the cloud, or the other way around, experiences the passage, which can be either a devoted equipment apparatus or programming program. There is a need for a Gateway which is capable of enhancing the services compared to the existing Gateways like mobile phone and PDA. The limitations can be the handover mechanism, noise in the signal due to the channel allocation problem, changeover from mobile data transfer to voice call allocation and few limitations of PDA can be the processing capability for data analytics, signal strength analysis, speed, velocity and survivability factors which are critical in WBAN. In this paper a new gateway architecture is proposed, the architecture describe in detail how the location dependent critical data communication performance can be enhanced through newly proposed gateway architecture .

IndexTerms- WBAN, Gateway, Network, 5G network, Location

I. INTRODUCTION

Dealing with Data sensitive communication in different sectors, play a major role in defining the importance of data. Data generated in sensitive network like WBAN considers the criticality of the data as the data is extracted by the patient who is in critical condition. Handling such data without loss of communication channel is a challenge in WBAN network. Analysis of critical data in case of emergency is a need in WBAN which leads to smooth handling of patient data with continues stream. The Architecture of WBAN is as shown in figure 1. Typical WBAN consist of sensor nodes placed over the human body and all the data of sensor are sent to the coordinator. Coordinator collects all the critical data and the regular data and sends it to the Gateway. In figure 1 the gateway used is a newly proposed handheld device which has the unique feature of handling the sensor data as well as handover mechanism better than the existing system because of its unique design, specially designed to handle Handover mechanism in mobility condition to handle critical data by considering survivability factor of the patient using the device.

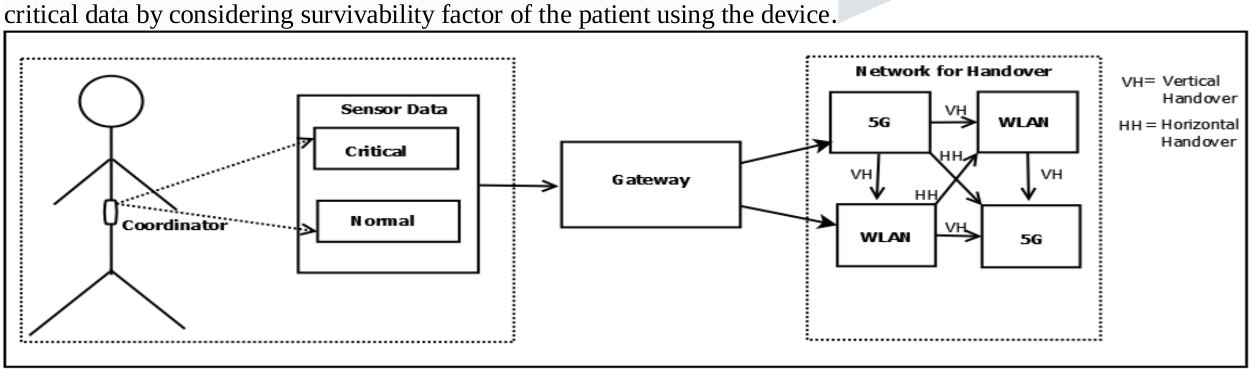

Figure 1. Architecture of Wireless Body Area Network

1.1.Types of Gateway

Many Gateway models are available in the market and among the most, Smart Gateways are the most popular. Infrastructure less gateway is the one which does not require fixed infrastructure to communicate. Examples of infrastructure less gateway are mobile equipment and PDA. Infrastructure gateway requires fixed infrastructure like the gateway which has a fixed location. There is no mechanism available to make handover between 5G and WLAN, using location of a patient under mobility condition for WBAN. There is a need for inculcating the new technology in order to enhance the performance and the security aspects of healthcare system in WBAN.

Smart Gateway which can consolidate edge devices, the Smart Gateway framework also enables the development of higher knowledge to inculcate the property of the environment and to support security. The role of Smart Gateway is to support many features like representation of repository and temporary storage of sensor data and user and providing intelligence by increasing the data fusion, accumulation and interpretation , which is required to provide initial processing of sensors data.

1.2 Challenges in Designing WBAN Gateway

1.2.1 Connectivity to the nodes

A short range radio frequmency (RF) technology has to be chosen to link to the BAN nodes. This would depend on many parameters such as modulation scheme, frequency band, data-rate, channel number, latency etc. This even depends the local regulations.

1.2.2 Local intelligence

Sending all the data to be stored to the cloud is a not a solution as the data processing and the storage must be a part WBAN. Local storage would help the data processing more accurate and the performance can be improved.

1.2.3 Security can be improved

Security play a very important role which can change the performance of large BAN networks..

II. Related Works

The concentrator based and without concentrator based femtocell network architecture is proposed by Authors Mostafa Zaman Chowdhury et.al. [1] . Later they present the signal flow with appropriate parameters for the handover between 3GPP UMTS based macrocell and femtocell networks.. The architecture based on A user-Centric mobile concept in heterogeneous wireless environment is proposed by Aleksandar Tudzarov and Toni Janevski [3]. This is a novel network architecture for next generation 5G mobile networks. . Authors Aki Hakkarainen et.al. [5] have proposed a model for Device Localization in 5G Ultra-Dense Networks in a highly efficient manner. A localization system is designed that m eets the location based service demands. The accuracy of this model is in the sub-meter range. A model for Location Based Beamforming in 5G Ultra-Dense Networks. Here they've used transmit and receive beamforming schemes based on location of UEs is proposed by Authors Petteri Kela et.al. [9]. Particularly, they've proposed a design methodology for the transmit and receive beamforming weight-vectors based on the departure and arrival angles of the line of sight(LoS) path between Access nodes (ANds) and User nodes(UNds). The EKF proposed is based on the concentrated log likelihood function of the radio channel parameters with respect to the path weights. Authors Feras Zenalden. et.al. [8] have proposed a model for vertical handover for heterogeneous networks and provides solution to different types of vertical handovers between the wireless media such 5G to WiFi,4G to 5G,3G to 5G etc. The authors provide a approach for better customer experience such as high quality of service (QOS) and high quality of experience(QOE). Authors Petteri Kela et.al. [7] have proposed a model for Location Based Beamforming in 5G Ultra-Dense Networks. They use transmit and receive beamforming schemes based on location of UEs. Specifically , they propose a design and the methedology to transmit and receive beamforming weight-vectors. The EKF which is proposed is based on the concentrated log likelihood function of the radio channel parameters wrt the path weights [7]. Authors Raed Abduljabbar Aljiznawi et.al. [10], have proposed a model on Quality of Service (QoS) for 5G Networks.. in the proposed worked they have concentrated on important key performance indicators (KPIs) which measures the quality of service (QoS) in 5G networks. The proposed work is on QoS necessities depending on the analysis of functional requirements to 5G networks [10]. Authors Arash Shahmansoori et al. [12]have proposed a method to present a two-stage algorithm for position and rotation angle estimation which attains the CRB for average to high signal-to-noise ratio. The algorithm is on multiple measurement vectors matching pursuit for coarse estimation, and later by a processing stage which is based on the space-alternating generalized expectation maximization algorithm [12].

Author Aki Hakkarainen et.al. [16] have proposed a model for Device Localization in 5G Ultra-Dense Networks in a highly efficient manner. Here they concentrate on the localization system which is designed to meet the location based service demands. The accuracy of this model is in the sub-meter range [16].

III. PROBLEM STATEMENT

Our goal is about presenting location based services to the patient under mobility condition using Horizontal handover between multiple 5Gs networks and Vertical handover between WLAN and 5G networks, dissimilar architectures are better suited for diverse application domains. Therefore, seamless handover in wireless technology plays an important role to get the better service from two different networks. Especially during handover from one network to another network. Handover should be seamless. During handover, decision plays a major role considering different parameters like location and Quality of Service metrics. Therefore, there is a need to propose optimized decision algorithm and considering location of UEs in WBAN.

a. To minimize the bandwidth usage.
b. To maximize the user satisfaction level.
c. To minimize the latency.
d. To assure the required degree of Quality of Services (QoS).
e. To optimize decision algorithms during handover.
f. To handle data sensitivity

IV. PROPOSED MODEL

A new model is proposed Critical Data and Location Dependent Handover (CDLDH) gateway model that is capable of handling multiple networks like 5G and WLAN.

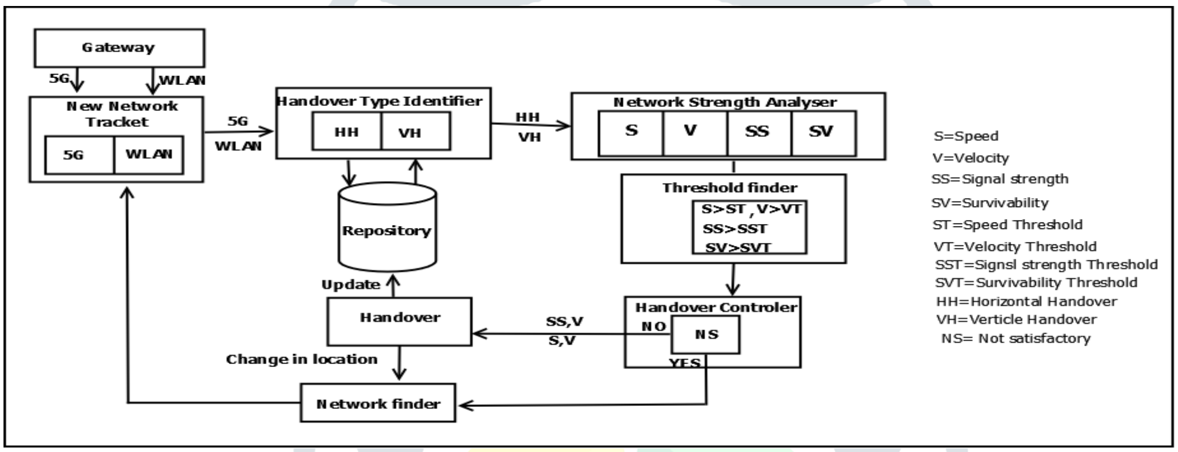

Figure 2. Proposed CDLDH-Gateway model architecture`

Gateway: The Gateway initially transfers the information about the current network to the New Network Tracker.
New network tracker: Mobility of the handheld gateway will lead to the variation in the available signals to transmit and receive the data with maximum signal strength as specified in the parameter threshold. Networker tracker keeps track of all the network, both 5G and WLAN within the specified range and continuously transfer the available network information to the Handover type identifier.
Handover type identifier: Details of the available network is processed to evaluate the type of handover. After receiving the information about the updated network available, the Handover type identifier will fetch the existing network information stored in the repository, to evaluate the type of handover. The type of handover depends on the Handover type identifier. If the new network is 5G and the current network is also 5G then the handover is considered as horizontal handover. If the new network is 5G and the current network is WLAN then the handover is considered as vertical handover. If the new network is WLAN and the current network is WLAN then the handover is considered as horizontal handover. If the new network is WLAN and the current network is 5G then the handover is considered as vertical handover.
Repository: This keeps the update of the entire network recently visited by the gateway.
Network strength analyzer: In order to measure the required strength of network to establish the connectivity, the network strength analyzer maintains the list of parameters that should be satisfied. The list includes the Speed, Signal strength, Time, Velocity and Survivability. Threshold value for each and every parameter is fixed and the handover process will be activated only if the required potential of the available parameter is greater than or equal to the Threshold parameter.
Threshold finder: The Threshold finder compares the parameters with the threshold fixed for the parameters to be executed**.**
Handover controller: The handover controller compares the current strength of the network with respect to parameters to that of the available parameters. This checks for each and every parameter individually. Time taken by the gateway to reach the node is calculated by considering the trajectory of the gateway, Velocity, signal strength and survivability parameters are compared and checked for the status of their strength as against the current status of parameter. If the current status of all the parameters is grater than the threshold parameter value then the parameters are sent to the handover mode. If the parameter value is less than the threshold then the parameters are not sent to the handover instead goes to the find new network mode.
Handover: if all the parameters are satisfied then the handover controller initiate the handover process by initiating the handover module to switch the handover or retain the same depending on the parameter specification. Switching can be either horizontal handover or vertical handover.After the handover process is successfully done the handover module will update the repository and search for new available network as it is in mobility state by switching over to find new network mode. If the new network parameters

are not in the range of expected parameter metric then the handover will not take place and the gateway will search for new network available.

Network finder: It takes the input from handover and handover controller and shift to search for new network mode as the device is in mobility state.

V. ALGORITHM

In this section the algorithm for the proposed model is presented.

Algorithm 1 shows the order in which the connection to the tower is established. For n towers, n users are allocated within the specific range. to find the distance check if the distance is minimum and the distance is less than the tower range. If the distance is less than the tower range then distance will be set to minimum. If the distance is minimum then the tower will handover access to the user.

Algorithm:1 Connect to the tower

Input : Tower [x][y], user [a][b],Tower Range, nTower, nUser
Output : Every node is connected to the tower within the tower range.
Begin
For every $user_i$ in nUser
For every $tower_i$ in nTower
D⇒ $\sqrt{(x-a)2+(y-b)2}$
If d < min && d < Tower range then,
Min = d
Node= $tower_i$
End
End
// Tower for $user_i$ is tower with min (d)
Connected to tower[i]=node
End

Algorithm 2 shows For n WLANs, n users are allocated within the specific range. To find the distance check if the distance is minimum and the distance is less than the WLAN range .If the distance is less than the WLAN range then distance will be set to minimum. If the distance is minimum then the WLAN will handover access to the user.

Algorithm:2 Connect to the WLAN

Input : WLAN [x][y], user [a][b],WLAN Range, nWLAN, nUser
Output : Every node is connected to the WLAN within the WLAN range.
Begin
For every $user_i$ in nUser
For every $WLAN_i$ in nWLAN
D⇒ $\sqrt{(x-a)2+(y-b)2}$
If d < min && d < WLAN range then,
Min = d
Node= $WLAN_i$
End
End
// WLAN for $user_i$ is WLAN with min (d)
Connected to WLAN[i]=node
End

Algorithm 3 shows the vertical handover, where the handover to the user is done from WLAN to 5G.User is connected to WLAN initially. During mobility the user moves away from the WLAN. Distance between the WLAN and new network is calculated. If the distance is within the threshold distance from the target then the tower will handover the 5G network to the user. If the distance is more than the threshold distance then handover will not take place.

Algorithm 3 : Vertical handover from wlan to 5g

Input : $User1_x$,$User1_y$,$User2_x$,$User2_y$,connected WLAN1,connected WLAN2,threshold distance.
Output : Return true if handover occurs else return false.
Begin
If (connected WLAN1 == connected WLAN2)
Then
D1⇒ $\sqrt{(User1_x-WLAN_x)2-(User1_Y-WLAN_Y)2}$
D2⇒ $\sqrt{(User2_x-WLAN_x)2-(User2_Y-WLAN_Y)2}$
If distance1 && distance2 < Threshhold distance
then,
Return False
end if
else
Return true
//initiate handover from WLAN to 5G
end if
end

Algorithm 4 shows the vertical handover, where the handover to the user is done from 5G to WLAN.User is connected to 5G initially. During mobility the user moves away from the 5G network. Distance between the 5G network and new network is calculated. If the distance is within the threshold distance from the target then the wireless device will handover the WLAN network to the user. If the distance is more than the threshold distance then handover will not take place.

```
Algorithm 4 : Vertical handover from 5G to WLAN

Input : User1x,User1y,User2x,User2y,connected WLAN1,connected WLAN2,threshold
distance.
Output : Return true if handover occurs else return false.
Begin
    If (connected WLAN1 == connected WLAN2)
       Then
           D1⇒√((User1x − WLANx)2 − (User1Y − WLANY)2
           D2⇒√((User2x − WLANx)2 − (User2Y − WLANY)2
              If distance1 && distance2 < Threshhold distance
                 then,
                 //initiate handover from 5G to WLAN
                 Return True
              end if
       else
       Return False
    end if
end
```

MATHEMATICAL MODEL

1. Position

The position provides the latitude and longitude of a node with the help of Global Positioning System (GPS), The node can be a User Equipment (UE) node, a Network Tower node or a WLAN Access Point (AP) node. Let $P_{i,t}$, lat and long represent position of node 'i' at time 't', latitude of the node given by the GPS at time 't' and longitude of the node given by the GPS at time 't'. The position of each node 'i' in a rectangular area of simulation at the time 't' is calculated as

$$\mathbf{P(i,t) = (lat,long)} \quad (1)$$

2 .Velocity

The velocity vector provides the speed and direction of a node. Let P1 and P2 be the two positions of a single node 'i' at time t_1 and t_2 The displacement of node 'i' between two positions P1 and P2 at instance t is given by Euclidean's equation, as shown in equation 2

$$dist(i,\theta,t) = \sqrt{(lat1 - lat2)^2 + (long1 - long2)^2} \quad (2)$$

where lat1 = latCosϴ1, lat2 = lat Cosϴ2, long1 = long Cosϴ1, long2 = long Cosϴ1 and ϴi= angle of displacement of node i. Velocity v(i,j,t,ϴ) for displacement of node n from position i to position j from time t1 to t2 is given by,[Reference 1]

$$\vec{v}_{(i,j,t,\theta)} = \frac{d_{(n,\theta,t)}}{t_2 - t_1} \quad (3)$$

Mobility

1. **Constant Position Mobility Model**

Mobility model for which the current position does not change once it has been set and until it is set again explicitly to a new value. [2]. The nodes such as Tower nodes and Wi-Fi Access Point (AP) nodes use this mobility model in the simulation of the proposed model. The position of the nodes in this mobility model remains in a constant position unless otherwise changed explicitly. Hence the ability to change node position can be defined by,

$$ChangeLocation = \begin{cases} 1, & \text{if explicitly set location to a new value} \\ 0, & \text{otherwise} \end{cases} \quad (4)$$

2. **Constant Velocity Mobility Model**

Mobility model for which the current speed does not change once it has been set and until it is set again explicitly to a new value. [3]. The User Entity (UE) node use this mobility modelin the simulation of the proposed model.The position of the nodes in this mobility model remains in a constant position unless otherwise changed explicitly. The velocity of the nodes in this mobility model remains constant unless otherwise changed explicitly. Hence the ability to change node velocity can be defined by,

$$ChangeVelocity = \begin{cases} 1, & \text{if explicitly set velocity to a new value} \\ 0, & \text{otherwise} \end{cases} \quad (5)$$

3. Threshold Distance

The Threshold distance is the maximum distance over which the vertical handover occurs. Consider an ideal condition with no obstructions, reflections from buildings and no reflections from the ground between the sender and the receiver. The threshold distance can be calculated using Friss transmission equation [Reference 4].

$$P_r = P_t + D_t + D_r + 20\log_{10}\left(\frac{\lambda}{4\pi d}\right) \quad (6)$$

Using equation (X.6) 'd' can calculated as,

$$d = \left(\frac{\lambda}{4\pi}\right).10^{(P_t+G_t+G_r-P_r)/20} \quad (7)$$

Where, Pr = Power of receiving antenna, Pt = Power of transmitting antenna, Gr = Gain of receiving antenna, Gt = Gain of transmitting antenna and λ= wavelength of radio wave. d =Friss transmission distance. Threshold distance Td is given by,

Td=d (8)

4. Handover

Consider two nodes with position 'P1' and 'P2' with lat1, lat2 and long1, long2 as their respective latitiude and longitude let 'dist' be the Euclidean distance between the two nodes. 'dist' is calculated using Equation (X.2). Hence the handover is defined by,

$$Handover = \begin{cases} 1, & \text{if (Td > dist)} \\ 0, & \text{otherwise} \end{cases} \quad (9)$$

V. RESULTS AND ANALYSIS

The simulation was setup for the proposed model by creating nodes of wifi and handover tower in the simulation area using NS3.The result clearly shows that the architecture proposed has changed the performance of the handover mechanism in terms of throughput, Delay, Jitter and Packet Delivery Ratio. In all the cases there is an enhancement of the performance in terms of time with respect to delay. Simulated results are as shown from figure 3 to figure 6.

1 Throughput

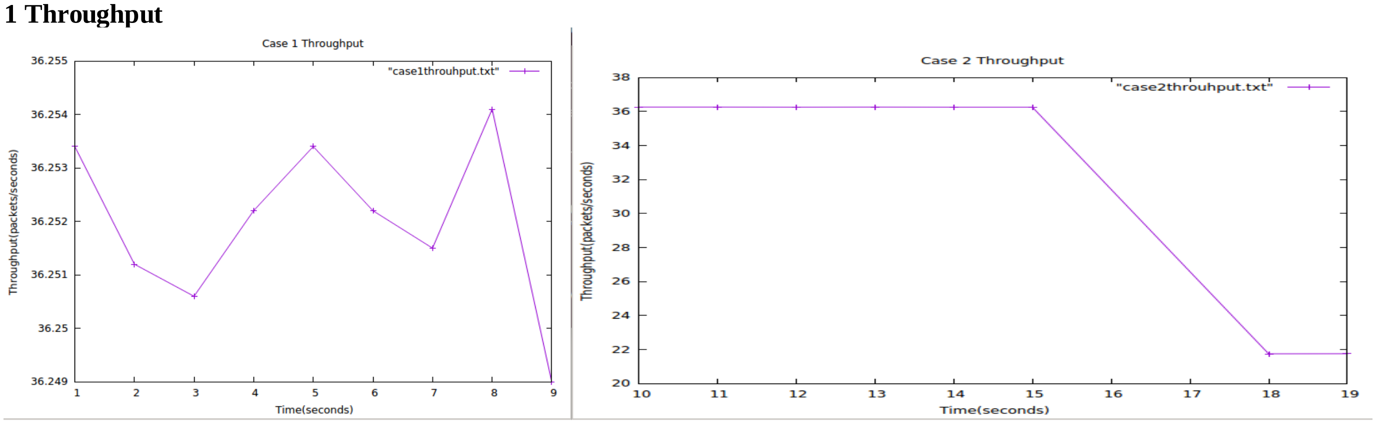

Figure 3 Throughput variation in existing vs proposed model

2 Delay

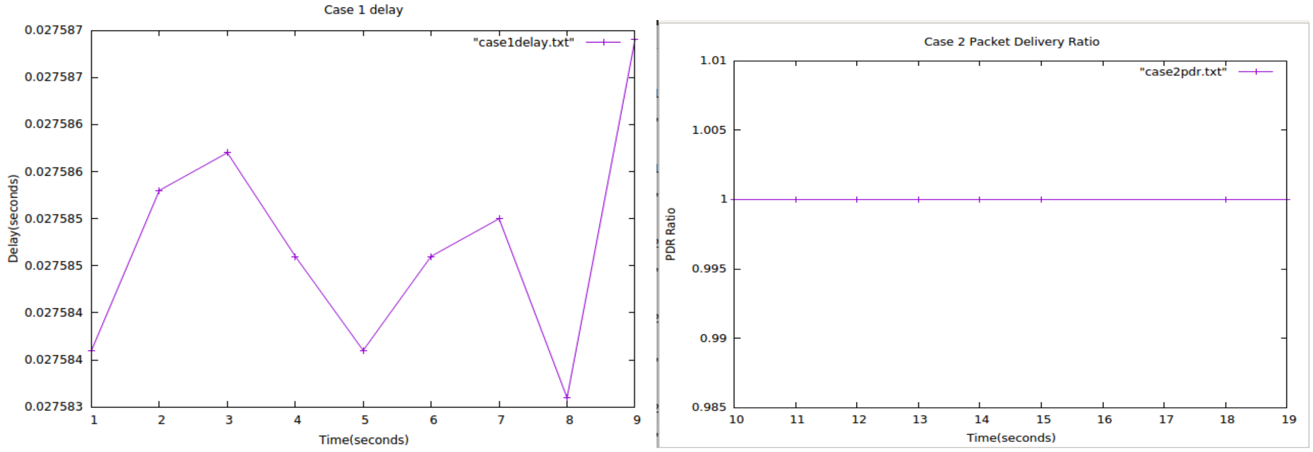

Figure 4 Delay variation in existing vs proposed model

3 Jitter

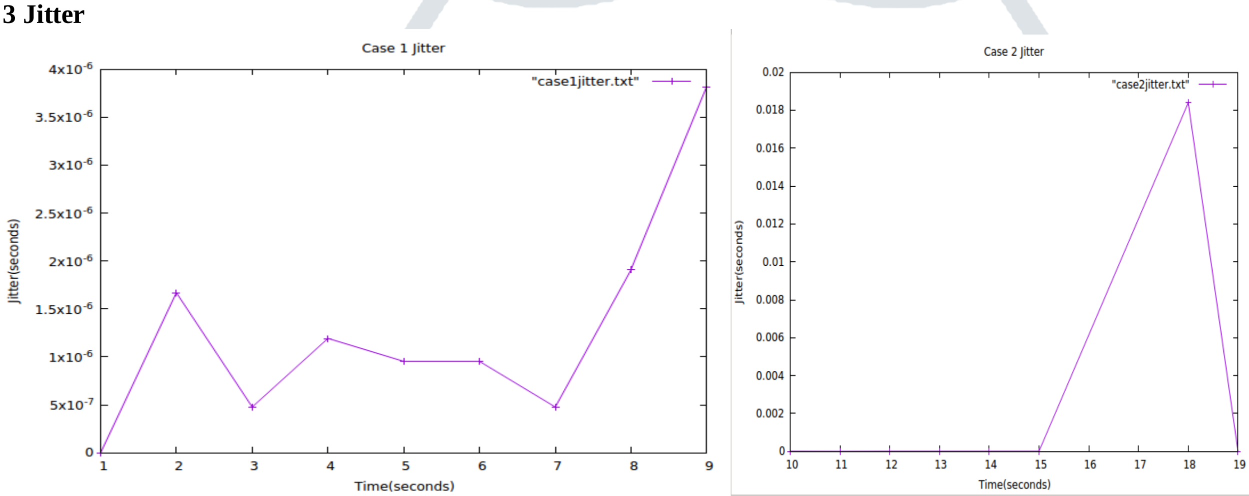

Figure 5 Jitter variation in existing vs proposed model 4 Packet Delivery Ratio

4.Packet delay

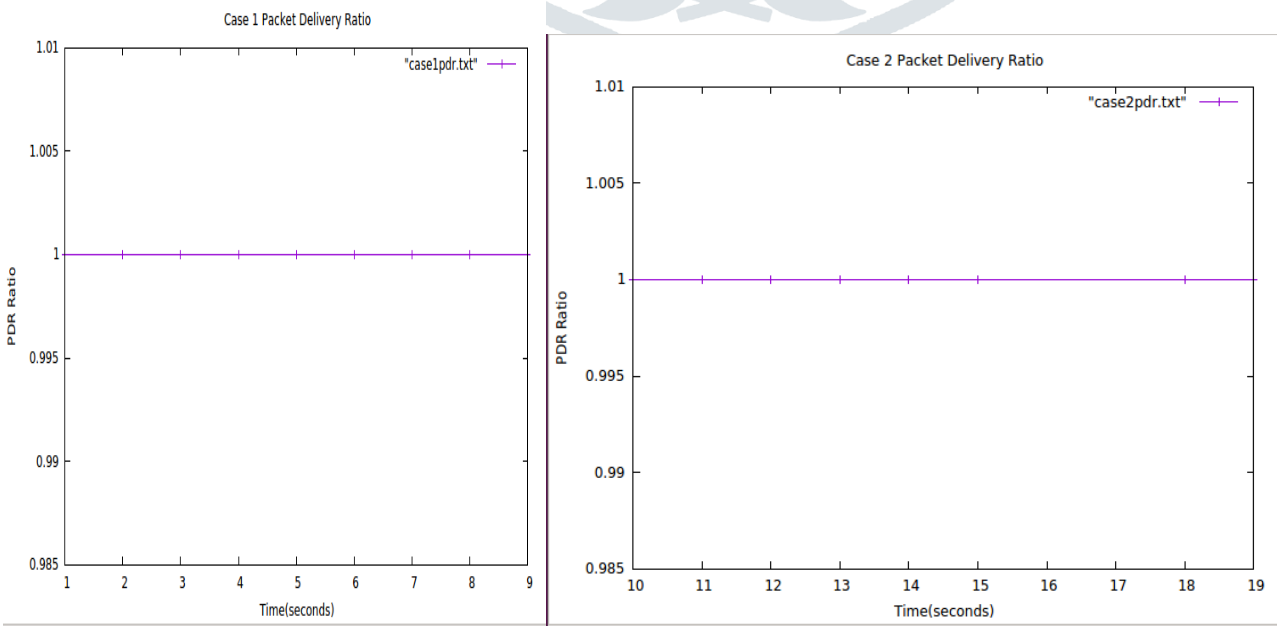

Figure 6 Packet delay ratio variation in existing vs proposed model

V. CONCLUSION

WBAN data communication is always critical as the information transmitted and received are vital. Loss of data or security breach in the communication will lead to the loss of life in specific conditions. A new CDLDH-Gateway model architecture and handover algorithms are proposed to reduce the disruption which occurs due to various factors in the network. The results have shown that there is an improvisation in the performance of data commun ication over the BAN network.

VI. ACKNOWLEDGEMENT

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