International Journal of Innovative Technology and Exploring Engineering (IJITEE)
ISSN: 2278-3075 (Online), Volume-9 Issue-4, February 2020

Bagging Ensembled Perceptron Classifier for Seamless Mobility System in Heterogeneous Network

D. Somashekhara Reddy, Chandrasekhar

***Abstract:** Wireless mobile devices require a handover decision system to get a seamless connection in a heterogeneous wireless networking environment. The handover process is one of the most significant processes in a cellular network. Few research works have been developed for providing seamless connectivity using different handover techniques. But, controlling data traffic during the process of seamless mobile data connectivity was not solved. So, there is a necessity to introduce a new model to control the traffic and improving the seamless mobility management in heterogeneous network. A new model called Bagging Ensembled Perceptron Classification based Seamless Mobility (BEPC-SM) introduced to achieve higher data delivery rate with minimum packet loss rate and data transmission delay by means of classifying the mobile nodes in heterogeneous network. In BEPC-SM model, randomly considers a number of mobile nodes in the heterogeneous network as input. Then, BEPC-SM model determines signal strength for each mobile node in a heterogeneous network. Bagging Ensembled Perceptron Classification algorithm is used in BEPC-SM model with the aim of accurately classifying all mobile nodes as strong or weak strength node with a lower amount of time consumption. After that, the distance between the weak strength node and the access point in the network is measured. Lastly, BEPC-SM Model selects the nearby access point with maximum bandwidth availability for each weak strength node in the network to perform the handover process. Thus, the performance of seamless data communication in a heterogeneous network is improved in BEPC-SM model. The BEPC-SM model is used in traffic-aware seamless data communication in a heterogeneous network. Simulation evaluation of the BEPC-SM Model is carried out on factors such as data delivery rate, packet loss rate, data transmission delay with respect to a number of data packets. The simulation result depicts that the BEPC-SM Model is able to increases the data delivery rate and also reduces delay when compared to state-of-the-art works.*

***Keywords:** Handover, Seamless Connectivity, Traffic control, Bagging Ensembled Perceptron classifier*

I. INTRODUCTION

For real-time applications running over heterogeneous environments, effective handover methods are needed in order to maintain seamless connectivity. Recently, many research works have been designed for seamless connectivity. However, traffic-aware seamless mobile data connectivity was not obtained.

Revised Manuscript Received on February 28, 2020.
***** Correspondence Author
D. Somashekhara Reddy*, Assistant Professor, JOHN College, Bangalore, India. E-mail: somashekhara.reddy@gmail.com
Dr. Chandrasekhar, Professor, Department of Computer Science, Periyar University, Selam, Tamil Nadu, India. E-mail: ccsekar@gmail.com

In order to address these drawbacks, the Bagging Ensembled Perceptron Classification based Seamless Mobility (BEPC-SM) model is proposed in this research work.

A two-stage fuzzy-logic-based VHO decision algorithm was utilized in [1] to select a suitable access network according to the quality-of-service requirements. However, the data loss rate was higher. Fuzzy based multiple attribute decision making (MADM) method called Fuzzy-MADM was developed in [2] to provide a continuous service. But, traffic control during data forwarding was not considered.

A Hybrid scheme was introduced in [3] to obtain seamless IP communications for mobile Internet access over the heterogeneous vehicular network. However, the delay was more. An enhanced Seamless MIPv6 (e-SMIPv6) was presented in [4] for fast seamless mobility supports. But, seamless mobile data connectivity performance was not sufficient. A Novel Seamless Handover Scheme was employed in [5] to lessen handover delay, packet loss in WiMAX/LTE Heterogeneous Networks. However, the number of data packets that dropped was very higher. Adaptive Multi-fuzzy Engines were utilized in [6] for enhancing handover decision performance in heterogeneous wireless networks. But, handover delay was not solved.

A multi-criteria vertical handoff decision algorithm was employed in [7] to attain seamless mobility while increasing end-users' satisfaction in heterogeneous wireless networks. Modified weed optimization (M-WO) algorithm was applied in [8] to minimize the redundant handoff by means of considering both RSS and velocity of the mobile node during the handoff triggering process.

An Optimized Vertical Handover (OVH) framework was introduced in [9] to get better handover performance and to diminish the handover execution time. However, the data delivery rate was poor. Local Anchor Schemes was developed in [10] for carried out a seamless and low-cost handover process in coordinated small cells. But, the time taken for performing the handover process was more.

In order to resolve the above mentioned existing issues, the BEPC-SM model is developed in this research work.

- ✓ To improve the traffic-aware seamless mobility performance in the heterogeneous network through classification when compared to conventional works, Bagging Ensembled Perceptron Classification based Seamless Mobility (BEPC-SM) model is proposed. On the contrary to existing works, BEPC-SM model is designed using perceptron classification and bootstrap aggregation.

- ✓ To enhance node classification performance in the heterogeneous networks when compared to state-of-the-art works,

The Bagging Ensembled Perceptron Classification (BEPC) algorithm is used in the BEPC-SM model. BEPC algorithm generates 'n' number of weak learner outputs for each mobile node to create a strong classifier to provide seamless mobile data communication and managing traffic in a heterogeneous network.

The rest of the paper is created as follows. In Section II, the proposed BEPC-SM model is explained with the aid of an architecture diagram. Section III presents the simulation settings. The simulation result of the proposed BEPC-SM model is discussed in Section IV. Section V explains the literature survey. At last, the paper concluded in section VI.

II. BAGGING ENSEMBLED PERCEPTRON CLASSIFICATION BASED SEAMLESS MOBILITY MODEL

The Bagging Ensembled Perceptron Classification based Seamless Mobility (BEPC-SM) model is designed in order to increases the performance of traffic-aware seamless mobility in a heterogeneous network. The BEPC-SM model is introduced by combining the perceptron classification and bagging technique called bootstrap aggregation. Let us consider the number of mobile nodes '$\mu_1, \mu_2, \mu_3, \dots .\mu_n$' distributed in the square area '$x * x$'. The mobile nodes in heterogeneous networks are associated with the attachment points '$\delta_1, \delta_2, \delta_{3,\dots} \delta_n$' to carry out the seamless data '$\alpha_1, \alpha_{2,} \alpha_{3,\dots} \alpha_n$' communication. Each mobile node in the heterogeneous network moves freely in different directions and modifies its connections to attachment points whenever it goes out of the communication range. Here, seamless connectivity and traffic control are a considerable problem to be resolved in order to successfully route the data. Therefore, a novel BEPC-SM model is proposed in this research work using the ensemble technique. The architecture diagram of the BEPC-SM model is depicted in below Fig.1

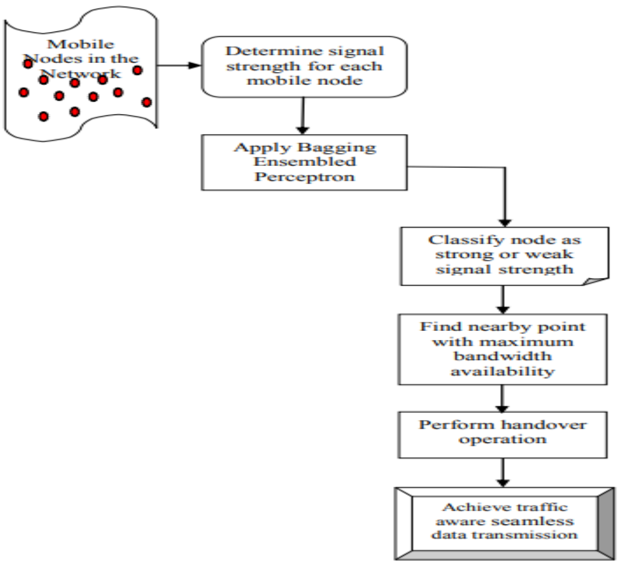

Fig. 1 Architecture Diagram of the Proposed BEPC-SM Model for Seamless Mobile Data Communication.

Fig.1 depicts the overall processes of the BEPC-SM Model to accomplish traffic-aware seamless data communication in a heterogeneous network. As shown in the above figure, BEPC-SM Model initially considers the different number of mobile nodes as input.

After that, BEPC-SM Model calculates signal strength for all the nodes in a network. Then, BEPC-SM Model employs the Bagging Ensembled Perceptron Classification algorithm in order to exactly classify each mobile node as a strong or weak strength node with minimal time complexity. After completing the classification process, BEPC-SM Model chooses the nearby point with maximum bandwidth available to carry out the handover process. From that, BEPC-SM Model obtains traffic-aware seamless data broadcasting in the heterogeneous network.

As a result, BEPC-SM Model gets better seamless mobility performance in terms of data delivery rate, data loss rate, and transmission delay when compared to conventional works. The exhaustive process of BEPC-SM Model is described in below.

A. Bagging Ensembled Perceptron Classification

In the BEPC-SM model, Bagging Ensembled Perceptron Classification (BEPC) algorithm is proposed with aiming at enhancing the performance of node classification in the heterogeneous network.

The BEPC algorithm considers a perceptron classification algorithm as a weak learner. The weak learner used in the BEPC algorithm is a supervised learning binary classifier. In weak learners, neurons learn and process an input number of mobile nodes in the training set one at a time.

The weak learner learns the weights for the input mobile nodes to illustrate a linear decision boundary that differentiates the two linearly separable classes (i.e. strong or weak signal strength nodes).

In weak learners, the input mobile nodes are then multiplied with weights to categorize the node as strong or weak signal strength.

However, the node classification accuracy of weak perceptron classification is not efficient. To attain enhanced accuracy for classifying mobile nodes in heterogeneous networks and thereby increasing the seamless mobile data connectivity performance without any traffic, the BEPC algorithm is introduced by applying the bootstrap aggregation concepts in perceptron classification.

The designed BEPC algorithm takes perceptron classification as a weak learner. The contrary to traditional works, the BEPC algorithm gets 'n' number of weak learner outputs for each mobile node to design a strong classifier to provide seamless mobile data connection and controlling traffic in the heterogeneous network. The flow processes of the BEPC algorithm are presented in Fig. 2.

Retrieval Number: D1378029420/2020©BEIESP
DOI: 10.35940/ijitee.D1378.029420
Journal Website: www.ijitee.org

Published By:
Blue Eyes Intelligence Engineering
& Sciences Publication

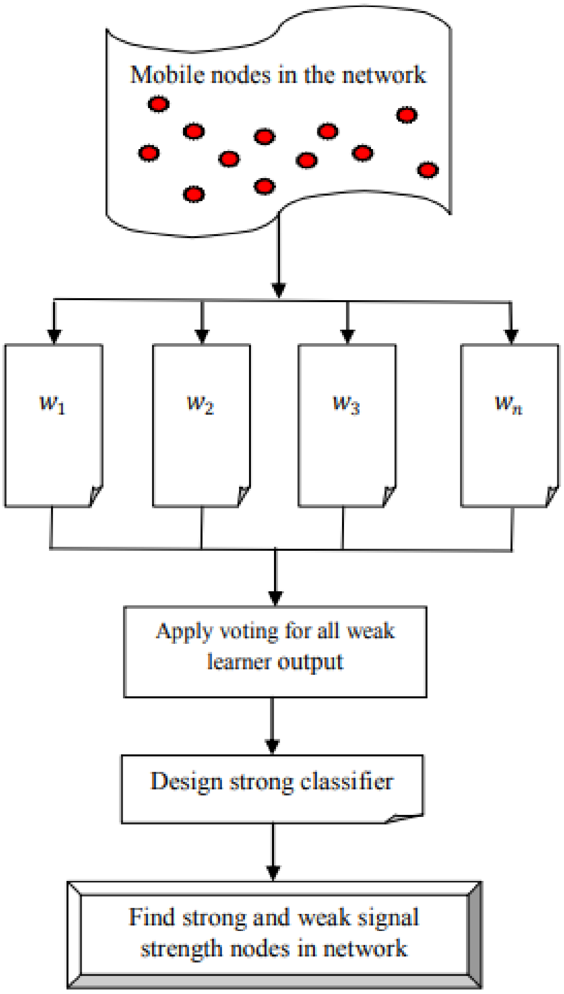

Fig. 2 Processes of BEPC algorithm

Fig.2 presents a block diagram of the BEPC algorithm. As demonstrated in the above figure, let us the number of mobile nodes '$\mu_1, \mu_2, \mu_3, \dots \mu_n$' are positioned in the network. Initially, BEPC algorithm computes signal strength for each mobile node using the below expression,

$$\beta_{\mu_i} = 10 \log\left(\frac{\varepsilon_r}{\varepsilon_t}\right) \quad (1)$$

From the above mathematical representation (1), 'β_{μ_i}' represent the measured signal strength of the node. Here, 'ε_r' indicates a measured power and 'ε_t' signifies reference power. The signal strength is estimated in the unit of the decibel (dB). After determining the signal strength, the BEPC algorithm produces 'n' number of weak learner output for all mobile nodes in the heterogeneous network. The weak learner contains six main components to accomplish the node classification process as below,

- **Input**: Numbers of mobile nodes in the heterogeneous network are considered as input for a weak learner. The input of a weak learner is represented as '$\mu_1, \mu_2, \mu_3, \dots \mu_n$', where 'n' represents the total number of mobile nodes.
- **Weights**: weight value is calculated during the training processing of the weak learner. In the beginning, the weight value is set with initial value and consequently updated for each training error. The weight value of weak learner is indicated by '$k_1, k_2, k_3, \dots k_n$'.
- **Bias**: A bias neuron in weak learners to determine the decision boundary to classify strong or weak signal strength nodes. Bias assists for a weak learner to get faster and better node classification result.
- **Weighted Summation**: it denotes the sum of the values that acquired after the multiplication of each weight associated with each input mobile node.
- **Activation Function**: The activation function in weak learner finds classification output for each input mobile node. The activation function defines the threshold value for signal strength and then compares the measured signal strength of each mobile node 'β_{μ_i}' with threshold 'T' to classify node as strong or weak strength node. From that, the weak learner is mathematically performed using below,

$$w_i(\mu_i) = \begin{cases} \beta_{\mu_i} > T; & strong\ signal\ strength \\ \beta_{\mu_i} < T; & weak\ signal\ strength \end{cases} \quad (2)$$

From the above mathematical equation (2), '$w_i(\mu_i)$' represents the output of the weak classifier, T denotes a threshold, β_{μ_i} is the determined signal strength of the node.

- **Output**: The output unit in weak learner generates classification output for each input mobile node.

The weak learner in the BEPC algorithm performs node classification process. But, the classification performance of weak learner i.e. perceptron classification algorithm is very lower. To improve node classification accuracy, BEPC algorithm ensembles all weak learner outputs to get better mobile node classification accuracy using below

$$w(\mu_i) = w_1(\mu_i) + w_2(\mu_i) + \cdots + w_n(\mu_i) \quad (3)$$

After completing the aggregation process, BEPC algorithm apply vote 'z_i' for each weak learner outputs '$w(\mu_i)$' using below,

$$z_i \to \sum_{i=1}^{n} w(\mu_i) \quad (4)$$

Followed by, the BEPC algorithm considers the majority votes of all weak learner outputs as a strong classifier in order to accurately classify the node as strong strength or weak strength with minimal time. Accordingly, strong mobile node classification output is mathematically obtained using below,

$$S(\mu_i) = arg \max_n z(w(\mu_i)) \quad (5)$$

From the above mathematical formula (5), '$S(\mu_i)$' stand for the final strong classifier output of BEPC algorithm to precisely categorize each mobile node in a heterogeneous network with a lower false-positive rate. Here, '$arg \max_n z$' denotes augmentation function which helps to find majority votes of weak learner output. In this manner, the BEPC algorithm correctly identifies the strong strength or weak strength nodes in the network to perform the handover process. After that, the mobile nodes with weak signal strength are switched from the current attachment point to the nearest attachment point to provide a seamless mobile data connection. The BEPC-SM Model finds the nearest attachment point in the heterogeneous network with the help of the Mahalanobis distance measurement.

The Mahalanobis distance 'dis' determines the distance between mobile node 'δ' and attachment point 'δ' in the heterogeneous network using below mathematical equation,

$$(\mu_i, \delta_j) = \begin{Bmatrix} [(x_j, y_j) - (x_j, y_j)]^T * \\ a^{-1} * [(x_j, y_j) - (x_j, y_j)] \end{Bmatrix}^{1/2} \quad (6)$$

From the above mathematical representation (6), '$dis(\mu_i, \delta_j)$' denotes the distance between mobile node and attachment point whereas (x_i, y_i) and (x_i, y_i) represents the location coordinates of the mobile node and attachment point and a is the covariance matrix. Then, the BEPC-SM Model handovers each mobile node with the weak signal strength to a new attachment point with minimum distance and higher bandwidth availability to attain the seamless mobile data communication. During the data communication process, the attachment point with maximum bandwidth availability is selected to avoid traffic and data loss. Thus, bandwidth availability is mathematically computed using below,

$$b_a = (b_t - b_u) \quad (7)$$

From the above mathematical formulation (7), 'b_a' symbolizes the bandwidth availability of attachment point, b_t signifies a total bandwidth, 'b_u' represents bandwidth utilized. Finally, BEPC-SM Model selects attachment point with minimum distance and maximum bandwidth availability for efficient seamless data communication with higher data delivery rate and transmission delay. In this way, the BEPC-SM Model effectively performs seamless data transmission without any traffic in the heterogeneous network. The algorithmic process of the BEPC-SM model described as follows,

Bagging Ensembled Perceptron Classification based Seamless Mobility model Algorithm

Input: Number of mobile nodes '$\mu_1, \mu_2, \mu_3, \ldots. \mu_n$'; Number of attachment points '$\delta_1, \delta_2, \delta_3, \ldots. \delta_n$'; number of data '$\alpha_1, \alpha_2, \alpha_3, \ldots \alpha_n$'

Output: Improves seamless data transmission and minimize traffic

Begin

1. **For** each node 'μ_i'
2. Measure signal strength using (1)
3. Construct 'n' number of weak learners using (2)
4. Ensemble all weak learner outputs using (3)
5. **For** weak learner output $w_i(\mu_i)$
6. Apply votes 'z' using (4)
7. Find strong classifier using (5)
8. Classify nodes as weak signal strength or strong signal strength
9. **End for**
10. **For each** weak signal strength node
11. Measure distance using (6)
12. Calculate bandwidth availability using (7)
13. Select an attachment point with lower distance and higher bandwidth availability
14. Perform handover operation and thereby avoids data traffic
15. **End for**
16. **End**

Algorithm 1: Bagging Ensembled Perceptron Classification based Seamless Mobility Model

Algorithm 1 explains the step by step processes of BEPC-SM model to get better seamless data connectivity with minimum delay. In first step, the number of mobile nodes is randomly taken as input. Followed by this, the signal strength for each mobile node is measured in BEPC-SM model. Then the number of weak learners is constructed in third step for heterogeneous network. This weak learner provides the output results of mobile node classification. The output of all weak learners is Ensembled or combined in fourth step in order to obtain the higher classification accuracy. After the ensemble process, the voting process is carried out in next step in proposed BEPC-SM model where the majority votes of weak learner taken as strong classifier to categorize the mobile nodes. In addition, the nearest attachment point in the heterogeneous network is identified with the help of measuring the distance using Mahalanobis distance measurement. Furthermore, the bandwidth availability for each node calculated. From that, attachment point with lower distance and higher bandwidth availability is considered to attain the seamless mobile data communication. With the help of the above algorithmic process, the BEPC-SM model enhances the performance of seamless mobile data communication and also avoids the traffic that occurs during data transmission in the heterogeneous network when compared to state-of-the-art works.

III. SIMULATION SETTINGS

In order to measure the performance of the proposed, BEPC-SM model is implemented using NS2.34 simulator by considering 500 mobile nodes is randomly arranged in the square area of $A^2(1200\,m * 1200\,m)$. To conduct a simulation work, the BEPC-SM model employed the Random Waypoint mobility model as a mobility model. The simulation parameters are listed in Table I.

Table -I: Simulation Parameters

Simulation parameter	Value
Simulator	NS2 .34
Network area	1200m * 1200m
Number of mobile nodes	50,100,150,200,250, 300,350,400,450,500
Data packets	25-250
Protocol	DSR
Simulation time	100sec
Mobility model	Random Way Point model
Nodes speed	0-20m/s
Number of runs	10

The simulation of the BEPC-SM model is performed for several instances with respect to a diverse number of mobile nodes density and data packets and averagely ten results are shown in table and graph for analyzing performance. The efficiency of the BEPC-SM model is measured in terms of data delivery rate, packet loss rate, and transmission delay.

He performance of the BEPC-SM model is compared with the existing two-stage fuzzy-logic based VHO scheme [1] and Fuzzy based multiple attribute decision making (MADM) method called Fuzzy-MADM [2].

IV. RESULTS

In this section, the comparative result of the BEPC-SM model is discussed. The efficiency of the BEPC-SM model is compared with a two-stage fuzzy-logic based VHO scheme [1] and Fuzzy based multiple attribute decision making (MADM) method called Fuzzy-MADM [2] respectively using below parameters with the help of tables and graphical diagrams.

A. Performance Measure of Data Delivery Rate

In the BEPC-SM model, Data Delivery Rate 'DDR' determined as ratio of number of data that are correctly received to the total number of data sent. The data delivery rate is measured using the below formula,

$$DDR = \left(\frac{Number\ of\ data\ packets \text{correctly}\ received}{n}\right) * 100 \quad (8)$$

From the above mathematical equation (8), 'n' point outs, the total number of packets sent. The data delivery rate is evaluated in the unit of percentage (%).

Sample calculation:

Proposed BEPC-SM model: The number of data packets accurately received is 23, and the number of data packets sent is 25. Then the data delivery rate is determined as follows,

$$DDR = \frac{23}{25} * 100 = 92\ \%$$

Existing two-stage fuzzy-logic based VHO scheme: Number of data packets exactly received is 19, and a number of data packets sent is 25. Then the data delivery rate is acquired as follows,

$$DDR = \frac{19}{25} * 100 = 76\ \%$$

Existing Fuzzy-MADM: The number of data packets precisely received is 18, and the number of data packets sent is25. Then the data delivery rate is obtained as follows,

$$DDR = \frac{18}{25} * 100 = 72\%$$

The comparative result analysis of data delivery rate is obtained during the seamless data connectivity process based on the different numbers of data packets using three methods i.e. proposed BEPC-SM model and state-of-the-art works two-stage fuzzy-logic based VHO scheme [1] and Fuzzy-MADM [2] is presented in below Table II.

Table- II: Tabulation Result for Data Delivery Rate

Number of data packets	Data delivery rate (%)		
	BEPC-SM model	two-stage fuzzy-logic based VHO scheme	Fuzzy-MADM
25	92	76	72
50	94	82	78
75	96	84	80
100	95	83	78
125	95	82	80
150	93	79	75
175	95	84	81
200	96	86	83
225	94	83	80
250	96	88	83

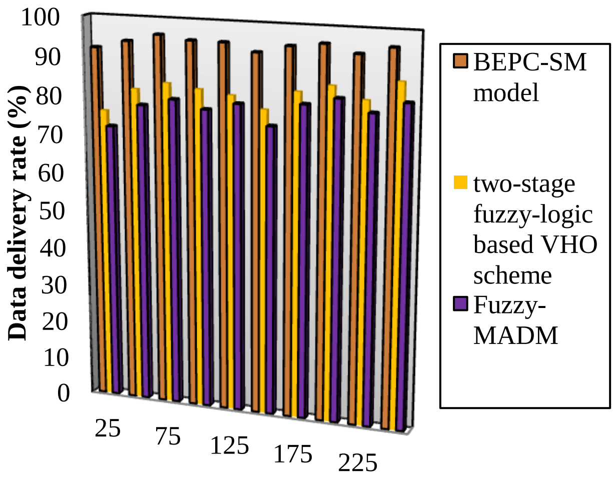

Fig.3 Performance results of data delivery rate versus the number of data packets

Fig. 3 shows the graphical result of data delivery rate along with varied numbers of data packets in the range of 25-250 using three methods i.e. proposed BEPC-SM model and traditional two-stage fuzzy-logic based VHO scheme [1] and Fuzzy-MADM [2]. As exposed in the above figure, the proposed BEPC-SM model obtains a higher data delivery rate in a heterogeneous network when compared to state-of-the-art two-stage fuzzy-logic based VHO scheme [1] and Fuzzy-MADM [2]. This is owing to the application of Bagging Ensembled Perceptron Classification (BEPC) algorithm in the proposed BEPC-SM model on the contrary to state-of-the-art works where it constructs strong node classification result with minimal time. This helps for the proposed BEPC-SM model to select the mobile node with higher signal strength in order to provide seamless mobile data connection in heterogeneous network.

Thus, proposed BEPC-SM model improves the ratio of number of data that are correctly received when compared to other conventional two-stage fuzzy-logic based VHO scheme [1] and Fuzzy-MADM[2]. From that, proposed BEPC-SM model increases the data delivery rate by 15 % and 20 % when compared to conventional two-stage fuzzy-logic based VHO scheme [1] and Fuzzy-MADM [2] respectively.

B. Performance Measure of Packet Loss Rate

In BEPC-SM model, packet loss rate is measured as ratio of number of data packet dropped to the total number of the data packet sent. The packet loss rate is obtained using below formula,

$$PLR = \left(\frac{Number\ of\ data\ packets\ lost}{n}\right) * 100 \quad (9)$$

From the above mathematical expression (9), ‘n’ signifies a total number of a packet sent. The packet loss rate is calculated in the unit of percentage (%).

Sample calculation:

Proposed BEPC-SM: Number of data packets lost is 2, and the number of data packets sent is 25. Then the packet loss rate is evaluated as follows,

$$PLR = \frac{2}{25} * 100 = 8\%$$

Existing two-stage fuzzy-logic based VHO scheme: Number of data packets dropped is 6, and a number of data packets sent is 25. Then the packet loss rate is estimated as follows,

$$PLR = \frac{6}{25} * 100 = 24\%$$

Existing Fuzzy-MADM: The number of data packets lost is 7, and the number of data packets sent is 25. Then the packet loss rate is computed as follows,

$$PLR = \frac{7}{25} * 100 = 28\%$$

The performance result analysis of packet loss rate is acquired during the seamless data communication process with respect to a diverse number of data packets using three methods i.e. proposed BEPC-SM model and existing two-stage fuzzy-logic based VHO scheme [1] and Fuzzy-MADM [2] is depicted in below Table III.

Table -III: Tabulation Result for Packet lo.ss rate

Number of data packets	Packet loss rate (%)		
	BEPC-SM model	two-stage fuzzy-logic based VHO scheme	Fuzzy-MADM
25	8	24	28
50	6	18	22
75	4	16	20
100	5	17	22
125	5	18	20
150	7	21	25
175	5	16	19
200	4	15	18
225	6	17	20
250	4	12	17

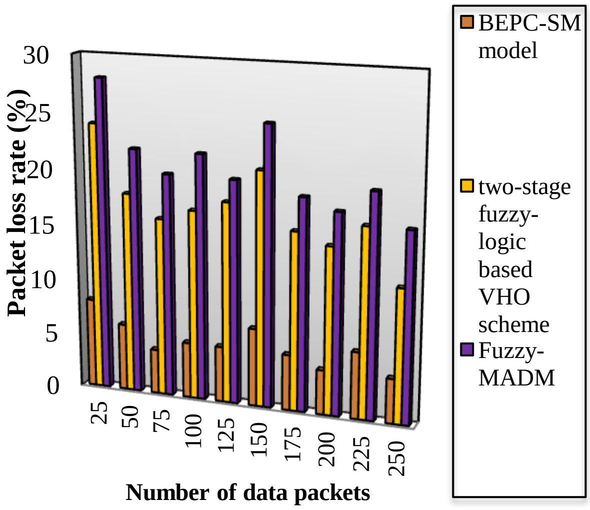

Fig.4 Performance results of packet loss rate versus the number of data packets

Fig.4 demonstrates the graphical results of packet loss rate with respect to different numbers of data packets in the range of 25-250 using three methods i.e. proposed BEPC-SM model and traditional two-stage fuzzy-logic based VHO scheme [1] and Fuzzy-MADM [2]. As shown in the above figure, the proposed BEPC-SM model obtains a minimal packet loss rate in the heterogeneous network when compared to state-of-the-art two-stage fuzzy-logic based VHO scheme [1] and Fuzzy-MADM [2]. This is due to the application of the Bagging Ensembled Perceptron Classification (BEPC) algorithm in the proposed BEPC-SM model on the contrary to conventional works where it chooses the nearest access point with higher bandwidth availability for performing handover process and minimizing traffic occurrence in the heterogeneous network. From that, the proposed BEPC-SM model reduces the ratio of the number of data that are dropped when compared to other existing two-stage fuzzy-logic based VHO scheme [1] and Fuzzy-MADM [2]. Hence, the proposed BEPC-SM model minimizes the packet loss rate by 69 % and 75 % when compared to the existing two-stage fuzzy-logic based VHO scheme [1] and Fuzzy-MADM [2] respectively.

C. Performance Measure of Data Transmission Delay

In the BEPC-SM model, the Data Transmission delay calculates the difference between the transmitting and receiving time of data packets from the mobile node. The data transmission delay is estimated using below,

$$DTD = (t_{Rec} - t_{Tra}) \quad (10)$$

From (10), ‘DTD’ signifies a data transmission delay, ‘t_{Rec} represents data packets receiving time, ‘t_{Tra} ‘symbolizes a data packet transmitting time. The data transmission delay is determined in terms of milliseconds (ms).

Sample calculation

Proposed BEPC-SM model: Let us consider a number of the data packet sent is 25**,** time for receiving the data packet is $12ms$ and a time for sending the data packet from the node is $0ms$. Then the data transmission delay is measured as follows,

$DTD = 12ms - 0ms = 12ms$

Existing two-stage fuzzy-logic based VHO scheme: Let us consider a number of the data packet sent is 25, time for receiving the data packet is $15ms$ and a time for sending the data packet from the node is $0ms$. Then the data transmission delay is determined as follows,

$$DTD = 15ms - 0ms = 15ms$$

Existing Fuzzy-MADM: Let us consider a number of the data packet sent is 25**,** time for receiving the data packet is $18ms$ and a time for sending the data packet from the node is $0ms$. Then the data transmission delay is computed as follows,

$$DTD = 18ms - 0ms = 18ms$$

The simulation result analysis of data transmission delay is obtained during the seamless data connection process according to the varied number of data packets using three methods i.e. proposed BEPC-SM model and conventional two-stage fuzzy-logic based VHO scheme [1] and Fuzzy-MADM [2] is demonstrated in below Table IV.

Table-IV: Tabulation Result for data transmission delay

Number of data packets	Data transmission delay (ms)		
	BEPC-SM model	two-stage fuzzy-logic based VHO scheme	Fuzzy-MADM
25	12	15	18
50	16	19	22
75	21	24	28
100	23	27	30
125	25	28	33
150	27	30	34
175	29	33	36
200	33	36	39
225	36	39	43
250	37	41	46

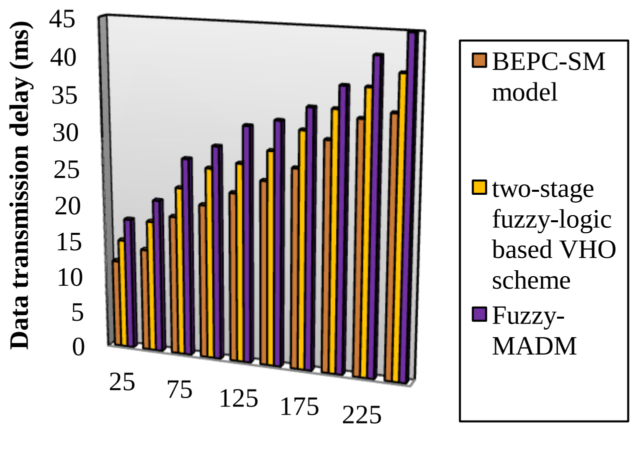

Fig. 5 performance results of data transmission delay versus the number of data packets

Fig.5 portrays the graphical results of data transmission delay based on dissimilar numbers of data packets in the range of 25-250 using three methods i.e. proposed BEPC-SM model and traditional two-stage fuzzy-logic based VHO scheme [1] and Fuzzy-MADM [2]. As depicted in the above figure, the proposed BEPC-SM model obtains lower data transmission delay in the heterogeneous network when compared to state-of-the-art two-stage fuzzy-logic based VHO scheme [1] and Fuzzy-MADM [2]. This is because of the application of Bagging Ensembled Perceptron Classification (BEPC) algorithm in the proposed BEPC-SM model on the contrary to traditional works as to where it picks the nearest access point with higher bandwidth availability to route the data packets without any traffic in a heterogeneous network. This helps for proposed BEPC-SM model reduces the data transmission delay in the heterogeneous network when compared to other two-stage fuzzy-logic based VHO scheme [1] and Fuzzy-MADM [2]. Therefore, the proposed BEPC-SM model decreases the data transmission delay by 16 % and 26 % when compared to the conventional two-stage fuzzy-logic based VHO scheme [1] and Fuzzy-MADM [2] respectively.

V. LITERATURE SURVEY

Physical Constraint and Load Aware (PCLA) handover were presented in [11] to determine a load of access points for congestion detection purposes. Proactive Multipath TCP for Seamless Handoff was performed in [12] for solving handoff and mobility-related service continuity problems in heterogeneous wireless access networks.

A novel handover approach was designed in [13] for accomplishing a seamless mobility process in next-generation wireless networks. Noise Resilient Reduced Registration Time Care of Mobile IP (NR_RRTC: MIP) protocol was applied in [14] to decreases handover latencies and get betters network performance during the handover process.

The integrated intersystem architecture was designed in [15] for seamless mobility support in IP-based next-generation wireless networks. Instantaneous Packet Loss Based Vertical Handover Algorithm was employed in [16] for Heterogeneous Wireless NetworksA novel end-point centric handover approach was introduced in [17] using ant colony probabilistic equation to accomplish the handover operation. A route-selection algorithm was used in [18] to get a better battery lifetime and to balance the load. Kalman filtering and fuzzy logic were employed in [19] to give seamless communication. A survey of different classification techniques designed for the handover decision-making process in heterogeneous wireless networks was analyzed in [20].

Vertical Handover Decision Algorithm was developed in [21] for transmission. The combination of three various wireless networks namely LTE, WiMAX and Wi-Fi, and their vertical handoff analysis were presented in [22]. Fuzzy Logic-based Handover Decision Algorithm (FLHDA) was designed in [23] provides a better efficiency of packet delivery ratio and throughput.

VI. CONCLUSION

In real-world scenario, wireless communication has different range of applications and which it provides a huge change in communication nature. But the ensuring of seamless connectivity in wireless mobile devices has to be resolved in a careful manner before deploying the model.

A new model is introduced called BEPC-SM with the objective of enhancing the seamless mobile data connectivity performance via classifying nodes as higher signal strength or weak signal strength. Through the Bagging Ensembled Perceptron Classification (BEPC) algorithm, the better classifcation of mobile nodes is achieved. Also, the proposed BEPC-SM model increases the ratio of the number of data packets that are correctly received at the destination node in the heterogeneous network when compared to other traditional works. Besides, the proposed BEPC-SM model lessens the number of data packets that are lost during a seamless mobile data communication process when compared to other conventional works. In addition, the proposed BEPC-SM model minimizes the data transmission delay in the heterogeneous network by avoiding and controlling the traffic during the data forwarding process when compared to state-of-the-art works. The obtained simulation result illustrates that the proposed BEPC-SM model provides better seamless mobile data connectivity performance with an enhancement of data delivery rate and minimization of data transmission delay when compared to state-of-the-art works.

REFERENCES

1. Meenakshi Subramani, Vinoth Babu Kumaravelu, "A Quality-Aware Fuzzy-Logic-Based Vertical Handover Decision Algorithm for Device-to-Device Communication", Arabian Journal for Science and Engineering, Springer, Vol. 44(3), pp. 2413–2425, (2019)
2. Aymen Ben Zineb, Mohamed Ayadi, Sami Tabbane, "An Enhanced Vertical Handover Based on Fuzzy Inference MADM Approach for Heterogeneous Networks", Arab Journal of Science and Engineering, Springer, Pages 1-6, (2017)
3. Sandra Céspedes, Xuemin Shen, "On Achieving Seamless IP Communications in Heterogeneous Vehicular Networks", IEEE Transactions on Intelligent Transportation Systems, Vol.16 (6), pp. 3223 – 3237, (2015)
4. Li Jun Zhang, Samuel Pierre, "An enhanced fast handover with seamless mobility support for next-generation wireless networks", Journal of Network and Computer Applications, Elsevier, Vol.46, pp. 322-335, (2014)
5. E. Prince Edward, "A Novel Seamless Handover Scheme for WiMAX/LTE Heterogeneous Networks", Arabian Journal for Science and Engineering, Springer, Vol.41(3), pp. 1129–1143, (2016)
6. Thanachai Thumthawatworn, Piyakul Tillapart, Pratit Santiprabhob, "Adaptive Multi-fuzzy Engines for Handover Decision in Heterogeneous Wireless Networks", Wireless Personal Communications, Springer, Vol.93(4), pp.1005–1026, (2017)
7. Abolfazl Mehbodniya, Faisal Kaleem, Kang K. Yen, Fumiyuki Adachi, "Wireless network access selection scheme for heterogeneous multimedia traffic", IET Networks, Vol.2(4), pp. 214 – 223, (2013)
8. T. Velmurugan, Sibaram Khara, S. Nandakumar, D. Sumathi, "Seamless vertical handoff using modified weed optimization algorithm for heterogeneous wireless networks", Radioelectronics and Communications Systems, Vol.60 (10), pp. 431–448, (2017)
9. Xiaohong Li, Feng Liu, Zhiyong Feng, Guangquan Xu, Zhangjie Fu, "A novel optimized vertical handover framework for seamless networking integration in cyber-enabled systems", Future Generation Computer Systems, Elsevier, Vol.79 (1), pp. 417-430, (2018)
10. Ravikumar Balakrishnan, Ian Akyildiz, "Local Anchor Schemes for Seamless and Low-Cost Handover in Coordinated Small Cells", IEEE Transactions on Mobile Computing, Vol. 15(5), pp.1182 – 1196, (2016)
11. Hamed Shahbazi Fard, Akbar Ghaffarpour Rahbar, "Physical constraint and load aware seamless handover for IPTV in wireless LANs", Computers & Electrical Engineering, Elsevier, Vol. 56, pp. 222-242, (2016)
12. Hassan Sinky, Bechir Hamdaoui, Mohsen Guizani, "Proactive Multipath TCP for Seamless Handoff in Heterogeneous Wireless Access Networks", IEEE Transactions on Wireless Communications, Vol.15(7), pp. 4754 - 4764, (2016)
13. Linoh A. Magagula, H. Anthony Chan and Olabisi E. Falowo, "Handover approaches for seamless mobility management in next generation wireless networks", wireless communications and mobile computing, Wiley Online Library, Vol.12, pp 1414-1428, (2012)
14. Subbe Gowda Bhaskar, Gandluru Arthur Edwin Satish Kumar, Patil Ramana Reddy, "Design and analysis of an adaptive handover protocol for 4G networks", Journal of Shanghai Jiaotong University (Science), Springer, Vol.20(2), pp. 20-217, (2015)
15. Christian Makaya, Samuel Pierre, "An Architecture for Seamless Mobility Support in IP-Based Next-Generation Wireless Networks", IEEE Transactions on Vehicular Technology, Vol. 57 (2), pp. 1209 -1225, (2008)
16. Tariq Ali, Mohammad Saquib, "Analysis of an Instantaneous Packet Loss Based Vertical Handover Algorithm for Heterogeneous Wireless Networks", IEEE Transactions on Mobile Computing, Vol.13(5), pp. 992 -1006, (2014)
17. Muhammad Ariff Bin Baharudin, Tran Minh Quang, Eiji Kamioka, "Improvement of Handover Performance Based on Bio-Inspired Approach with Received Signal Strength and Mean Opinion Score", Arabian Journal for Science and Engineering, Springer, Vol. 40(6), pp. 1623-1636, (2015)
18. SuKyoung Lee, Kotikalapudi Sriram, Kyungsoo Kim, Yoon Hyuk Kim, Nada Golmie, "Vertical Handoff Decision Algorithms for Providing Optimized Performance in Heterogeneous Wireless Networks", IEEE Transactions on Vehicular Technology, Vol. 58(2), pp. 865 - 881, (2009)
19. Iwan Kustiawan, Kuang-Hui Chi, "Handoff Decision Using a Kalman Filter and Fuzzy Logic in Heterogeneous Wireless Networks", IEEE Communications Letters, Vol. 19(12), pp. 2258 -2261, (2015)
20. Atiq Ahmed, Leila Merghem Boulahia, Dominique Gaïti, "Enabling Vertical Handover Decisions in Heterogeneous Wireless Networks: A State-of-the-Art and A Classification", IEEE Communications Surveys & Tutorials, Vol.16 (2), pp. 776 -811, (2016)
21. P. Pramod Kumar, K. Sagar, "Vertical Handover Decision Algorithm Based On Several Specifications in Heterogeneous Wireless Networks", International Journal of Innovative Technology and Exploring Engineering (IJITEE), Vol.8 (9), pp.977-982, (2019)
22. S. Neeraja, A. Abhishiktha, "Implementation of Vertical Handoff Over LTE, Wi-Fi and WiMAX Networks", International Journal of Innovative Technology and Exploring Engineering (IJITEE), Vol.9 (2S3), pp.217-221, (2019)
23. Sandeep Sivvam, Neeraja S, Jyothi Lakshmi T S, Dharma Raj C, "Empirical Analysis of Intelligent Handover Mechanism using Numerous Fuzzy Strategies", International Journal of Innovative Technology and Exploring Engineering (IJITEE), Volume 9, Issue-2S3, pp.259-264, (2019)

AUTHORS PROFILE

Mr. D. Somashekhara Reddy, has been completed ME (CSE) in the year 2011 with first class from the Adhiyamaan College of Engineering, Hosur, Affiliated to Anna University Coimbatore, Tamil Nadu,INDIA. At present working as an Assistant professor in T.John College, Bangalore and also Pursuing PhD Degree from Periyar University, Tamil Nadu. INDIA.

Dr. C. Chandrasekhar, is working as a Professor in Periyar University, Salem Tamil Nadu. He has completed MCA., PhD. He has 20 years of experience in teaching and research. He guided 22 PhD students. His area of interest is wireless and Mobile Computing and published research 137 papers