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Development of Hybrid Scheduling in WiMAX using Intelligent Neural Network

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Abstract: *Worldwide Interoperability for Microwave Access (WiMAX) networks were expected to be the main Broadband Wireless Access (BWA) technology that provided several services such as data, voice, and video services including different classes of Quality of Services (QoS), which in turn were defined by IEEE 802.16 standard. The main objective of the broadband wireless technologies is to ensure the end to end Quality of Service (QoS) for service classes. WiMAX is a revolution in wireless networks which could support real time multimedia services. In order to provide QoS support and efficient usage of system resources an intelligent scheduling algorithm is needed. The design of detailed scheduling algorithm is a major focus for researchers and service providers. In this paper, we discuss various types of Scheduling algorithms and Compare their performance in terms of Average Waiting Time (AWT) and Average Turnaround Time (ATT) and we propose a scheduling algorithm that is the combination of the Shortest Job First (SJF) scheduling algorithm, Priority based scheduling algorithm and neural network which improve the performance of the system.*

Keywords: *WiMAX, IEEE 802.16, Scheduling, First Come First Serve (FCFS), Shortest Job First (SJF), Priority based Scheduling and Neural Network.*

I. INTRODUCTION

Worldwide Interoperability for Microwave Access (WiMAX) or IEEE 802.16d/e is typically considered as the most reliable wireless access technology. Getting High bit rate and reaching large area in a single base station is possible in this technology. So the subscriber station can extend up to 30 miles. Hence connectivity to end users becomes cost-effective. Installation of wired infrastructure can become cost-effective or technically achievable when the qualities like low cost, high speed, rapid and easy deployment in Wireless Metropolitan Area Network (WMAN) is combined with the last-mile access. WiMAX technology based on the IEEE 802.16 standard has a very rich set of features. Indeed, it is a very promising Broadband Wireless Access (BWA) technology. The main objective is to have a highly efficient use of radio resources while transmitting different types of services. These services can have different constraints such as the traffic rate, maximum latency, and tolerated jitter. IEEE 802.16 power control and other capacity estimations were studied in. IEEE 802.16 defines the layer 1 (Physical (PHY)) and layer 2 (Data link or Media Access Control (MAC)) of the Open System Interconnection (OSI) seven layer network model. The different types of standards for PHY supports are Single Carrier (SC), Single Carrier Access (SCA), Orthogonal Frequency Division Multiplexing (OFDM) and Orthogonal Frequency Division Multiple Access (OFDMA). Recent researches focus mainly on the OFDM and OFDMA PHY supports. These standards define two operational modes for communication namely: mesh mode and point-to-multipoint mode. In mesh mode, the SSs can communicate with each other and also with the BS. In point-to-multipoint mode, SSs are supposed to communicate only through BS. BS has dedicated buffers and slots for downlink connection. During uplink, slots are allotted per SS and not per connection. Uplink channel is shared by all SSs, whereas downlink channel is used only by BS. The MAC layer functions of IEEE 802.16e are described in Fig. 1. Internet Protocol (IP), Ethernet and Asynchronous Transfer Mode (ATM) traffic are supported by convergence sub-layer. This layer converts the traffic into MAC data units. WiMAX network provides broadband access for services having different QoS requirements and different traffic priorities. It is the responsibility of the MAC layer to schedule the traffic flows and to allocate the bandwidth such that QoS requirements of each flow are satisfied. IEEE 802.16e is expected to provide QoS for fixed and mobile users. QoS depends upon a number of implementation details like scheduling, buffer management and traffic shaping. The responsibility of scheduling and BW management is to allocate the resources efficiently based on the QoS requirement of the services.

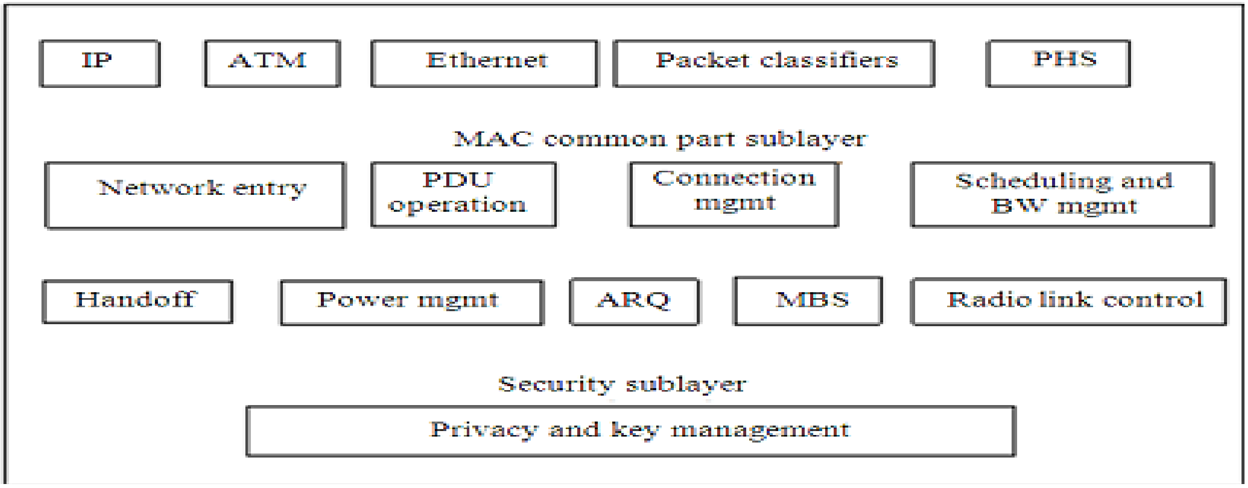

Fig. (a) MAC Layer

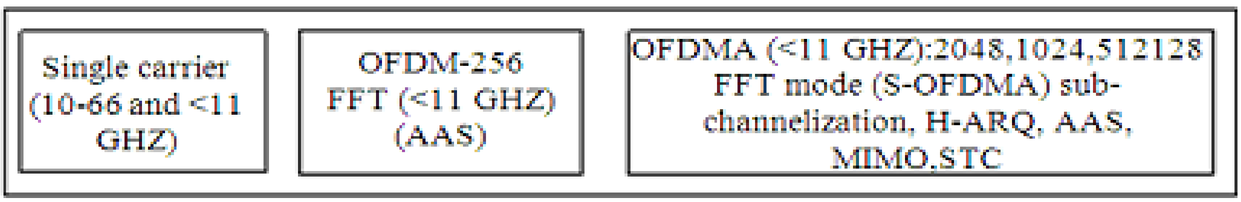

Fig. (b) PHY Layer
Fig. 1 IEEE 802.16e-2005 protocol stack (a) MAC Layer and (b) PHY Layer

II. ARCHITECTURE OF WIMAX

WiMAX based on the standard IEEE 802.16, which consist of one Base Station (BS) and one or more Subscriber Stations (SSs), as shown in Fig. 1, the BS is responsible for data transmission from SSs through two operational modes: Mesh and Point-to-multipoint (PMP), this transmission can be done through two independent channels: the Downlink Channel (from BS to SS) which is used only by the BS, and the Uplink Channel (from SS to BS) which is shared between all SSs, in Mesh mode, SS can communicate by either the BS or other SSs, in this mechanism the traffic can be routed not only by the BS but also by other SSs in the network, this means that the uplink and downlink channels are defined as traffic in both directions; to and from the BS. In the PMP mode, SSs can only communicate through the BS, which makes the provider capable of monitor the network environment to guarantee the Quality of Service QoS to the customers.

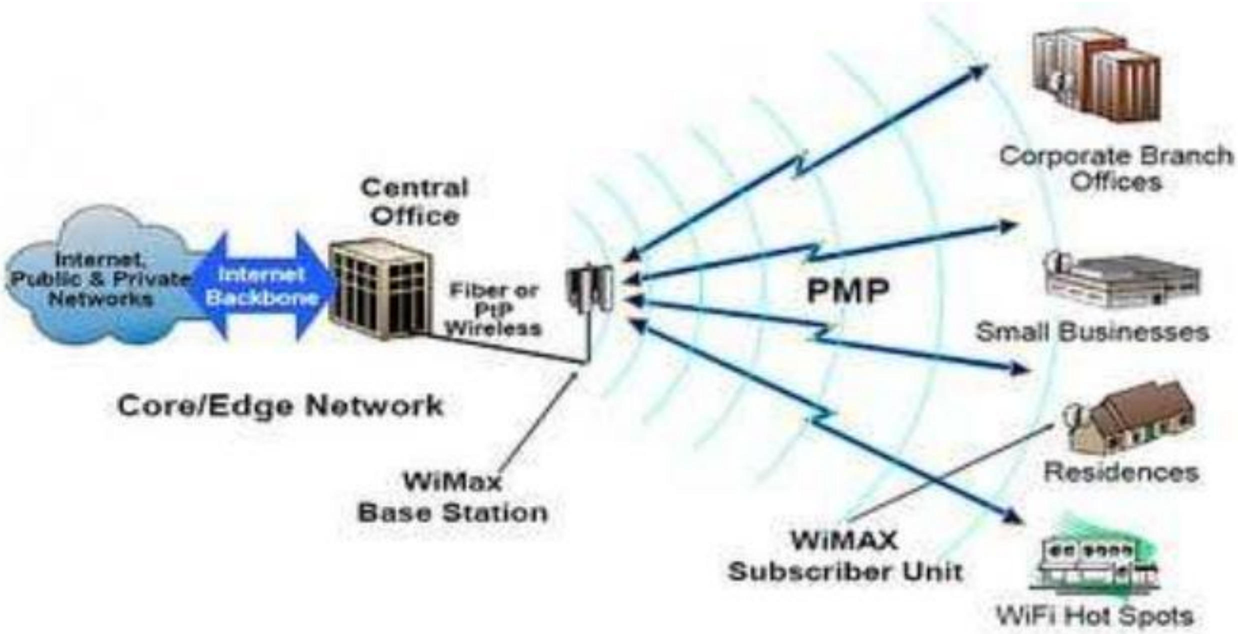

Fig. (a) Point-to-Multipoint (PMP) WiMAX Network

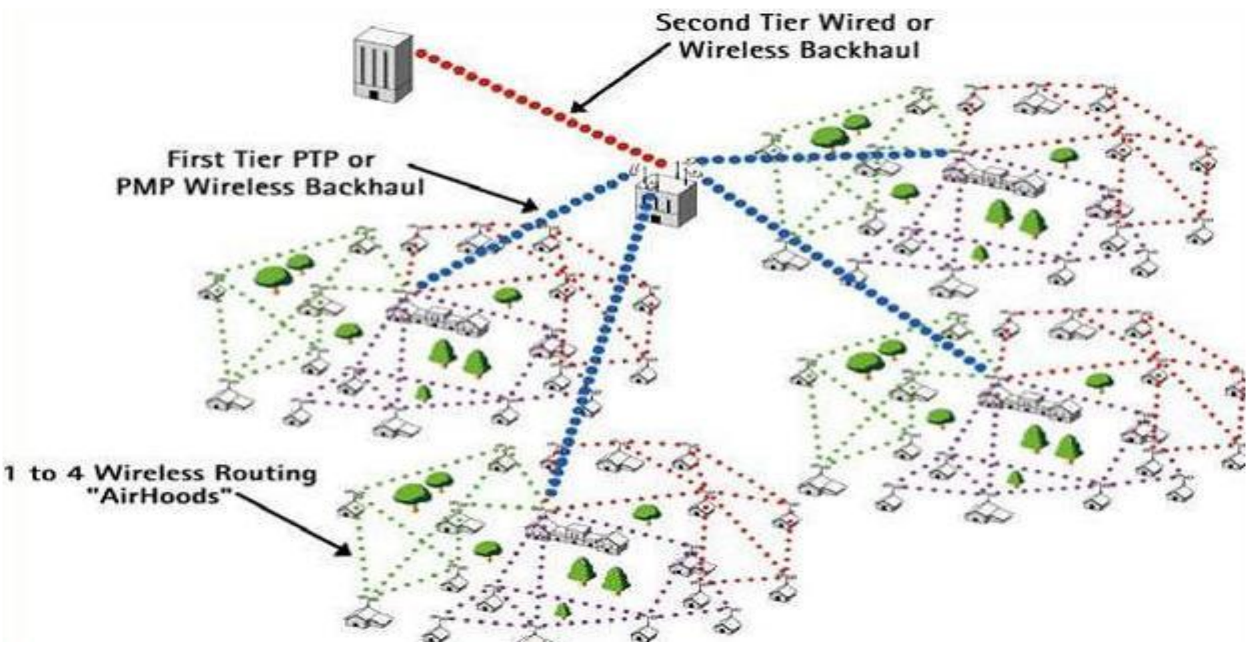

Fig. (b) Mesh WiMAX Network.

Fig.2 WiMAX Architecture (a) Point-to-Multipoint and (b) Mesh WiMAX Networks.

III. SCHEDULING

IEEE 802.16 MAC layer adopts a connection oriented architecture in which a connection must be established before data communications. Each connection is assigned a unique identifier (connection IDI) and it is associated with a service flow which defines the desired QoS level of the connection. In a standard scheduling framework, data packets arriving at the BS are classified into connections which are then classified into service flows. Packets of same service flow are placed in a queue and then further classified based on their service priorities of the connection. For packets in multiple queues with different service requirements, a packet scheduler is employed to decide the service order of the packets from the queues. If properly designed a scheduling algorithm may provide the desired service guarantees. The scheduler should consider the following important parameters:

- The traffic service type.
- The set of QoS requirements of the connections.
- The capacity of bandwidth for data transmission.
- The bandwidth requirements from the connections.
- Waiting time of bandwidth request in the system.

The main focus of the scheduling is to provide best possible end-to-end performance for the applications. The objective is to maximize the total throughput, reduce the packet loss rate, delay and power consumption and to improve the efficiency when satisfying the QoS requirements of different service classes. The SS with highest priority is selected to transmit in the frame. The priority of the SS is calculated based on the traffic class it belongs to.

IV. SERVICES AND CLASSES IN WIMAX

4.1. Services

- **UGS (Unsolicited Grant Service):** This service support real time packets with fixed size. In this service, the BS periodically allocates a fixed amount of bandwidth resources to the subscriber station and the SS does not need to send bandwidth request.
- **rtPS (Real Time Polling Service):** This service support real time packets with variable size. In this service, the BS periodically polls the SS about its uplink bandwidth request and allocates bandwidth to it in the next uplink sub-frame.
- **ertPS (Extended Real Time Polling Service):** It basically works similarly to UGS but the SS has the opportunity to request the BS to allocate different amount of bandwidth whenever the SS needs to change the transmission rate.
- **nrtPS (Non-Real Time Polling Service):** This service is designed to support non real time and delay tolerant services that require variable size data grant burst types on a regular basis such as File Transfer Protocol (FTP).
- **BE (Best Effort):** This service is designed to support data streams that do not require any guarantee in QoS such as Hyper Text Transfer Protocol (HTTP).

4.2. Classes

- **Class 1** (UGS, rtPS, ertPS).
- **Class 2** (nrtPS).
- **Class 3** (BE).

We have taken 10 processes that are arrived in the order given below in Table 1 and analysis their performance by various scheduling algorithms with given time quantum and priority.

Processes	Burst Time (in ms)	Priority
P1	34	9
P2	23	10
P3	11	8
P4	66	6
P5	21	7
P6	56	5
P7	16	4
P8	09	1
P9	17	3

P10	29	2

Table 1 List of Processes with Burst Time and Priority

When we take these 10 processes to generate the data for analysis, these processes are shown in the given Fig. 3 as nodes and priorities assigned to them as shown in the Fig. 4.

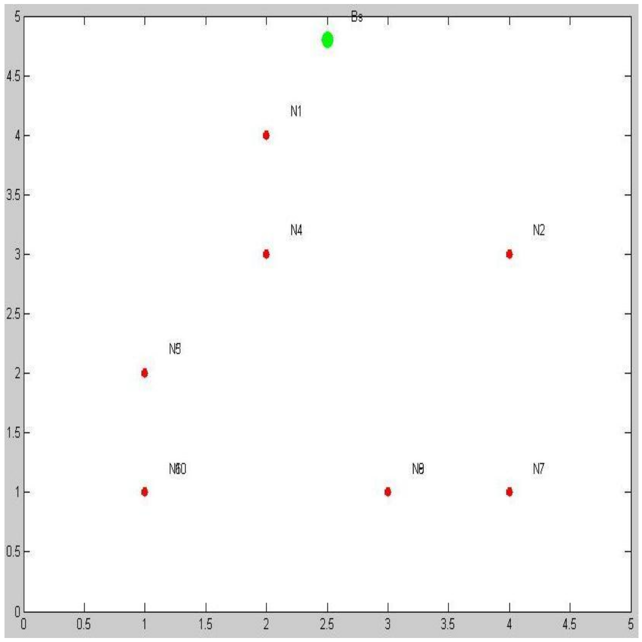

Fig. 3 Processes or Nodes for analysis

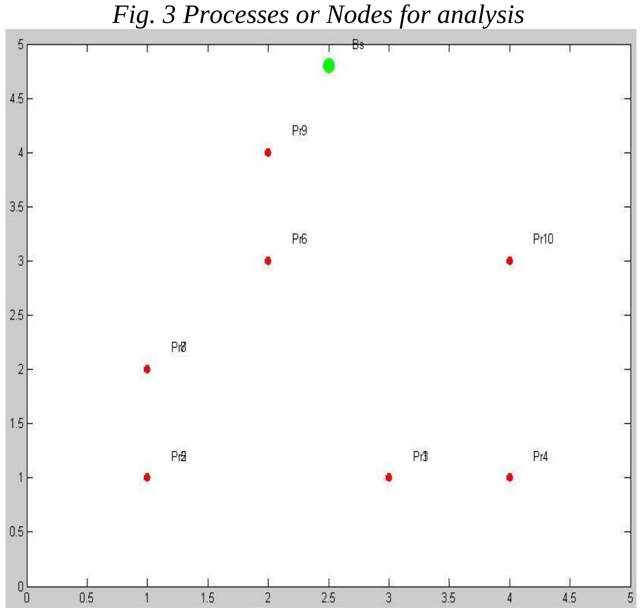

Fig. 4 Priorities assigned to the nodes

V. WIMAX SCHEDULING ALGORITHMS

Scheduling algorithms are responsible for Distributing resources among all users in the network, and provide them with a higher QoS. Users request different classes of service that may have different requirements such as bandwidth and delay, so the main goal of any scheduling algorithm is to maximize the network utilization and achieve fairness among all users.

5.1. First Come First Served (FCFS)

The simplest scheduling algorithm is the First Come First Served (FCFS) scheduling algorithm. With this algorithm, processes are assigned to the main unit in the order they request it or the process or job that requests the system first is executed and other process if in the queue has to wait until the system is free. The implementation of the FCFS algorithm is easily managed with a FIFO queue. There is a single queue of ready processes and new processes or requests are added to the tail of the ready queue. This algorithm executes the processes from the ready queue one by one. FCFS algorithm is shown in the Fig. 5.

Fig. 5 FCFS Scheduling Algorithm

Gantt chart for above process as per FCFS is:

	P1	P2	P3	P4	P5	P6	P7	P8	P9	P10
0	34	57	68	134	155	211	227	236	253	282

Average Waiting Time = 1375/10 = 137.5ms
Turnaround Time = Burst Time + Waiting Time
Average Turnaround Time = 1657/10 = 165.7ms

5.1.1 Output Graphs for FCFS Scheduling Algorithm

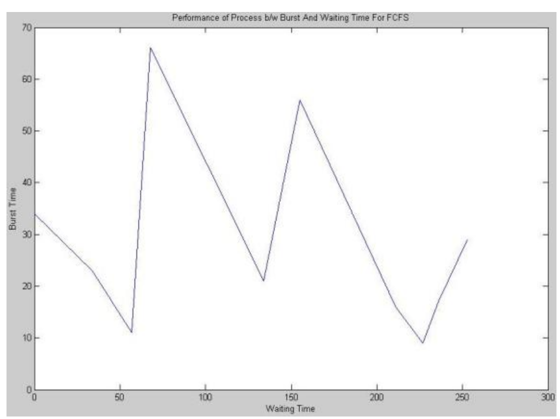

Fig. 6 Performance of the Processes between Burst Time and Waiting Time for FCFS

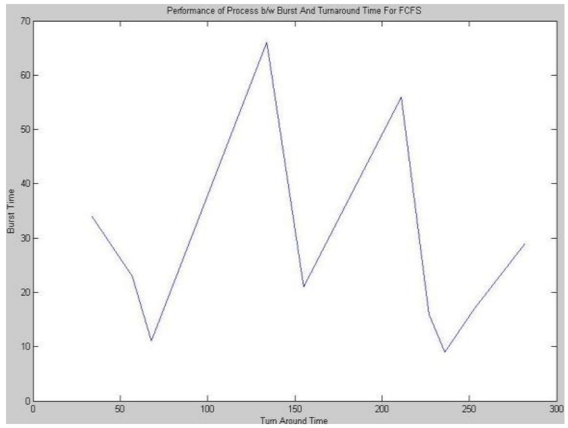

Fig. 7 Performance of the Processes between Burst Time and Turnaround Time for FCFS

From the output graphs we can observed that the average time for waiting for FCFS system is very poor and also a process with 9ms as burst time has waiting time of 230ms, especially for low burst time.

5.2. Shortest Job First (SJF)

A different approach to scheduling is the Shortest Job First (SJF) scheduling algorithm. This algorithm associates with burst time of each process. This algorithm makes the queue of the incoming processes according to their burst time (i.e. from lower to higher) and executes them one by one. So the process having lowest burst time executes first. If the next burst time of two processes are the same, FCFS scheduling is used. SJF algorithm is shown in the Fig. 8.

Process	Arrival Time	Execute Time	Service Time
P0	0	5	0
P1	1	3	3
P2	2	8	8
P3	3	6	16

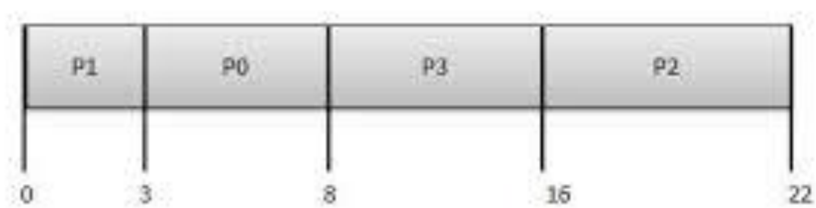

Fig. 8 SJF Scheduling Algorithm

Gantt chart for above process as per SJF is:

P8	P3	P7	P9	P5	P2	P10	P1	P6	P4

0 9 20 36 53 74 97 126 160 216 282

Average Waiting Time = 791/10 = 79.1ms
Average Turnaround Time = 1082/10 = 108.2ms

5.2.1. Output Graphs for SJF Scheduling Algorithm

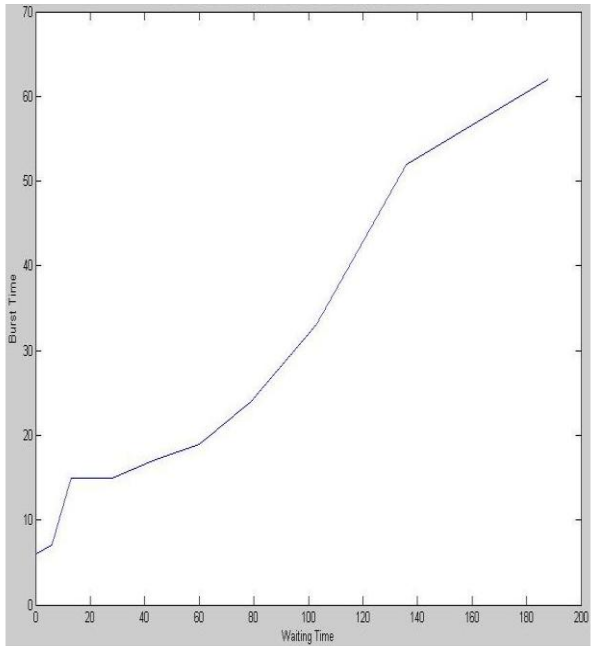

Fig. 9 Performance of the Processes between Burst Time and Waiting Time for SJF

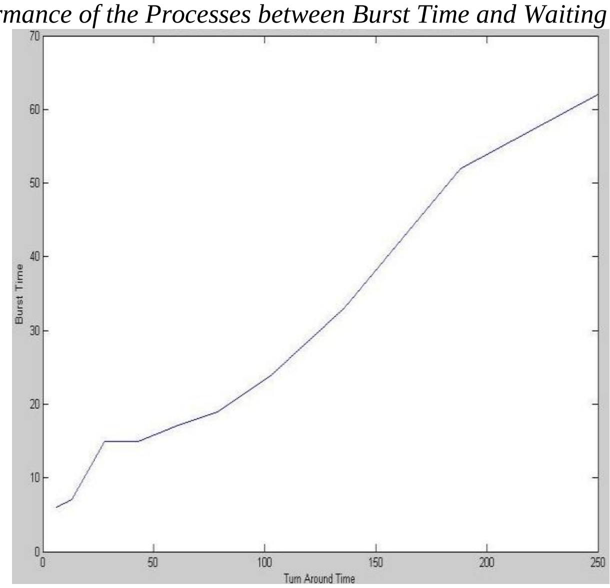

Fig. 10 Performance of the Processes between Burst Time and Turnaround Time for SJF

5.3. Priority Based Scheduling

The SJF algorithm is a special case of the general priority scheduling algorithm. In Priority scheduling algorithm, packets are represented by the scheduler depending on the QoS class and then they are assigned into different priority queues, these queues are served or executed according to their priority from the highest to the lowest as shown in Fig. 11.

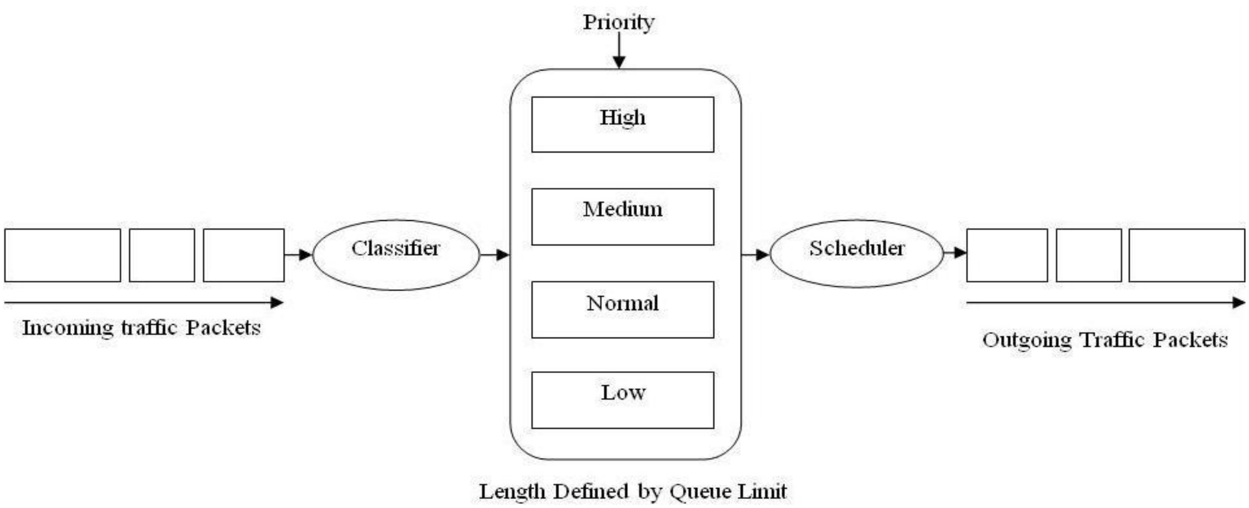

Fig. 11 Priority based Scheduling Algorithm

Gantt chart for above process as per Priority is:

P8	P10	P9	P7	P6	P4	P5	P3	P1	P2

0 9 38 55 71 127 193 214 225 259 282

Average Waiting Time = 1191/10 = 119.1ms
Average Turnaround Time = 1473/10 = 147.3ms

5.3.1. Output Graphs for Priority based Scheduling Algorithm

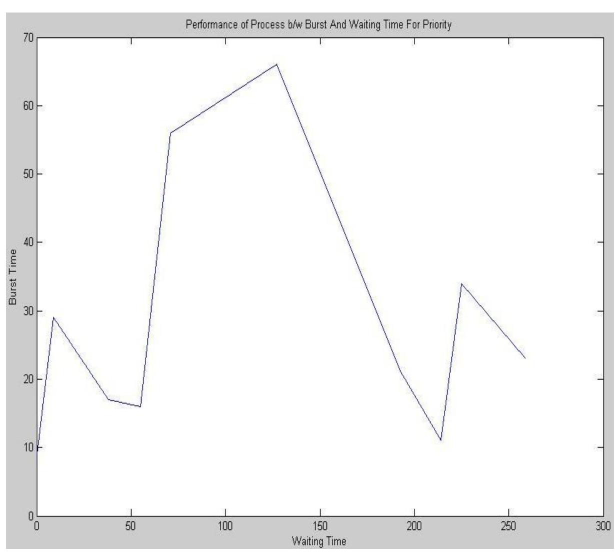

Fig. 12 Performance of the Processes between Burst Time and Waiting Time for Priority

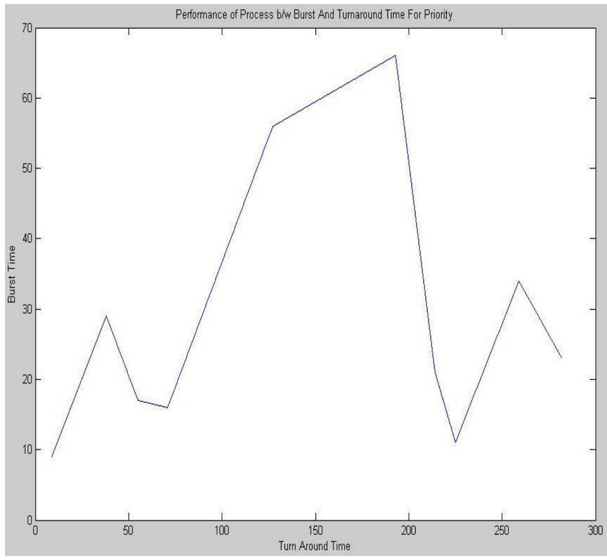

Fig. 13 Performance of the Processes between Burst Time and Turnaround Time for Priority

5.4. Proposed Scheduling Algorithm

In a proposed scheduling algorithm a hybrid structure of Shortest Job First (SJF), Priority based Scheduling Algorithm and Intelligent Neural Network has been used to improve the performance of the system.
Gantt chart for above process as per Proposed Scheduling Algorithm is:

P8	P3	P7	P9	P5	P2	P10	P1	P6	P4

0 8 17 30 45 65 86 113 142 193 255

Average Waiting Time = 699/10 = 69.9ms
Average Turnaround Time = 954/10 = 95.4ms

5.4.1. Output Graphs for Proposed Scheduling Algorithm

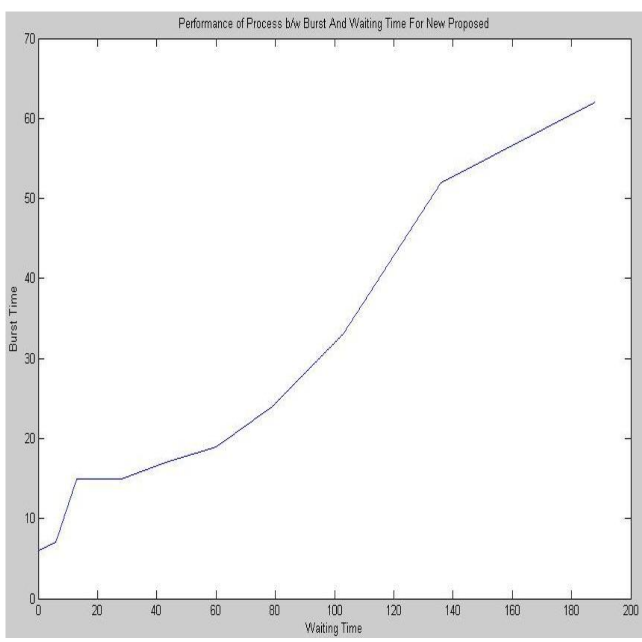

Fig. 14 Performance of the Processes between Burst Time and Waiting Time for Proposed Scheduling Algorithm

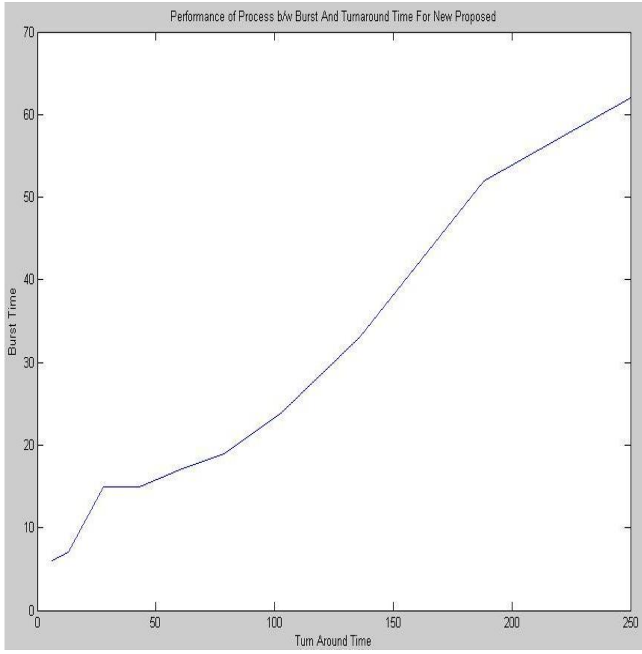

Fig. 15 Performance of the Processes between Burst Time and Turnaround Time for Proposed Scheduling Algorithm

For training of the data, neural network tool is there which is inbuilt in MATLAB 7.10.0. Neural Network tool and training of the data is shown in the given Fig. 16 and Fig. 17 respectively.

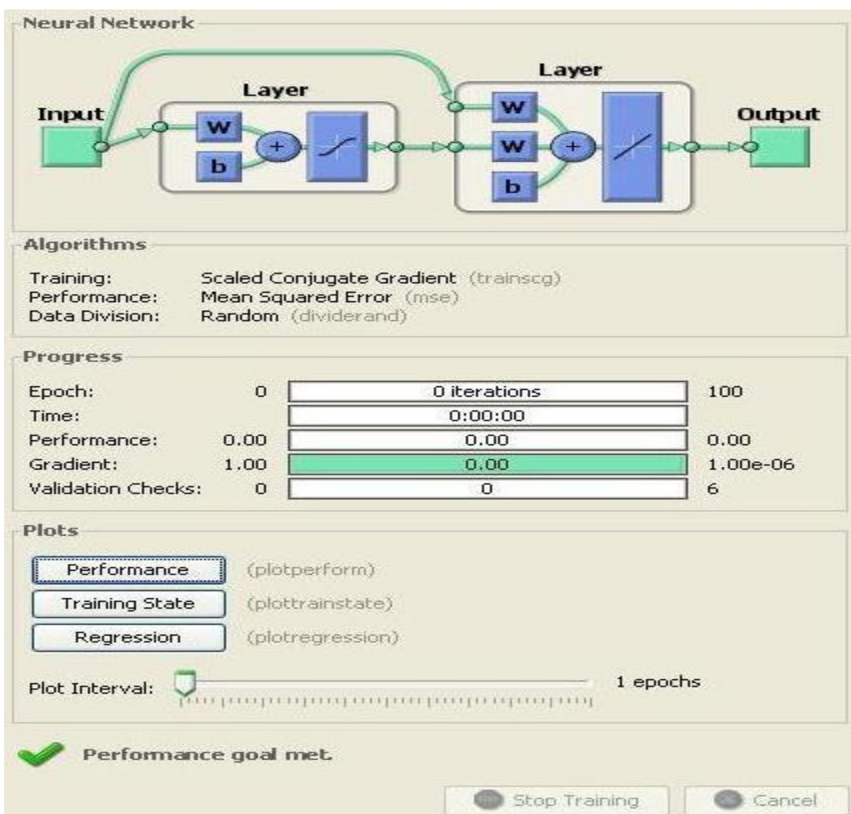

Fig. 16 Neural Network Tool in MATLAB

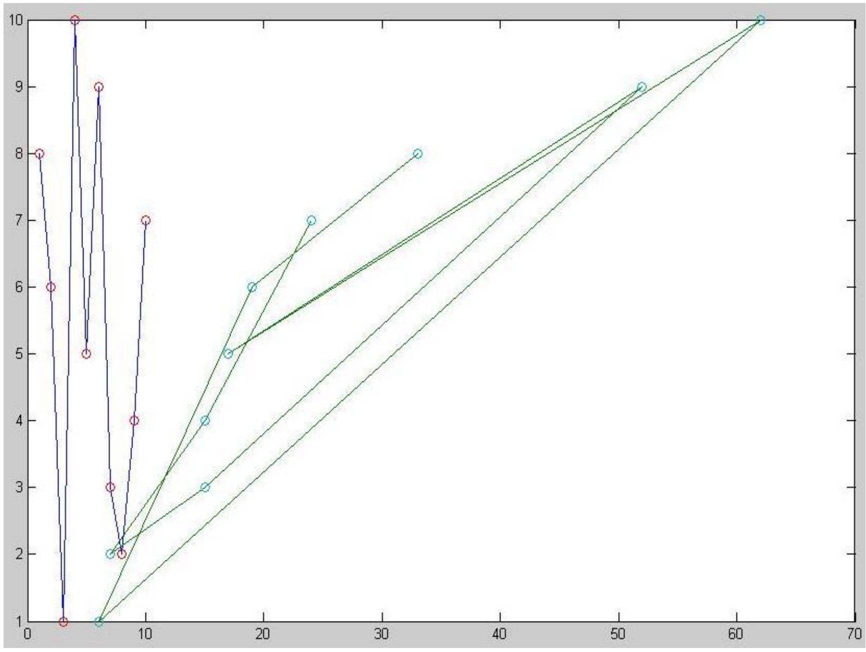

Fig. 17 Training of the data in Neural Network

5.4.2. Comparison Output Graphs for FCFS, Priority and Proposed Scheduling Algorithm

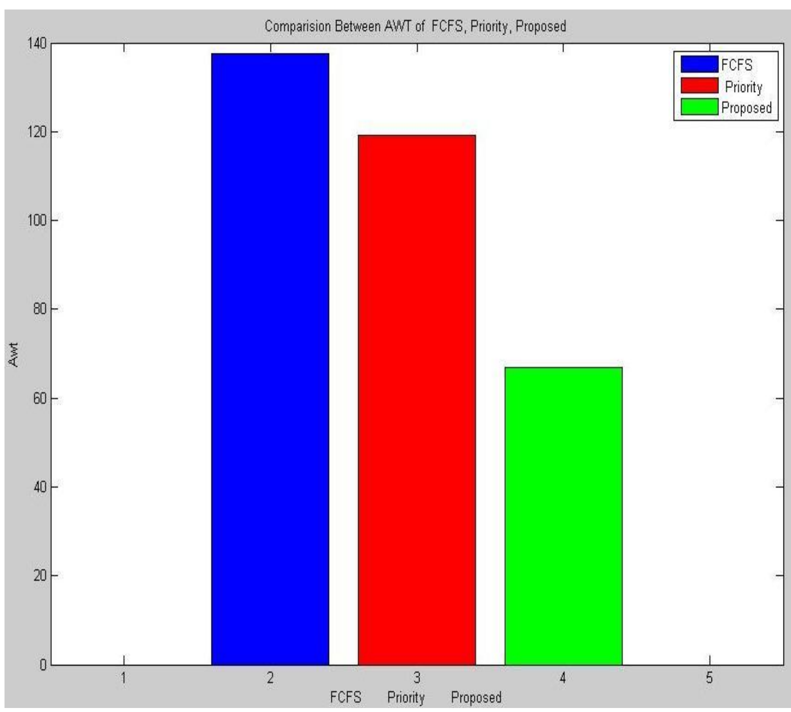

Fig. 18 Comparison output graph for Average Waiting Time

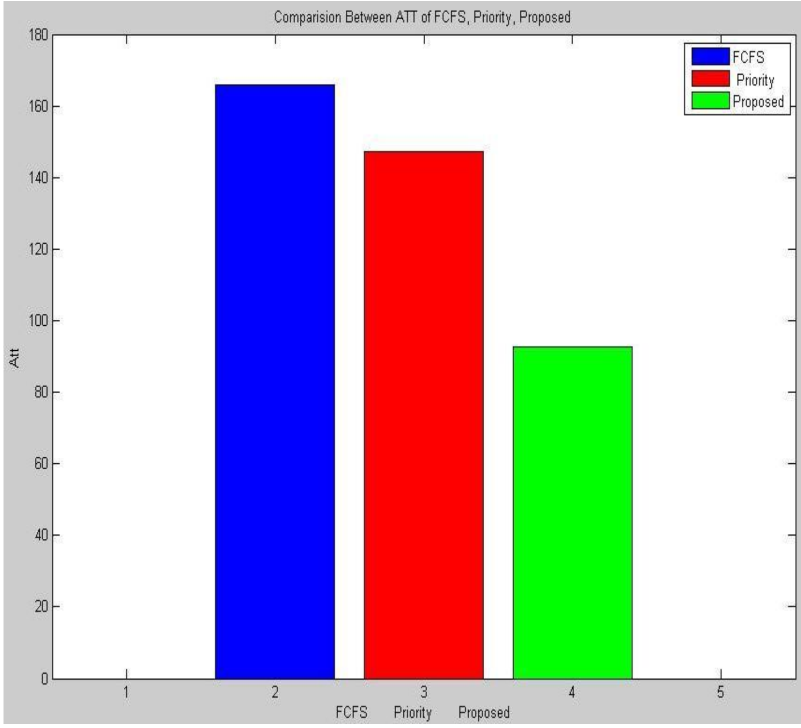

Fig. 19 Comparison output graph for Average Turnaround Time

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Scheduling Algorithms	Average Waiting Time	Average Turnaround Time
FCFS	137.5ms	165.7ms
Priority	119.1ms	147.3ms
SJF	79.1ms	108.2ms
Proposed	69.9ms	95.4ms

Table 2 Comparison Table for Scheduling algorithms

VIII. CONCLUSION

In this paper, we have presented a hybrid scheduling in WiMAX using intelligent neural network. This proposal is the combination of the Shortest Job First (SJF) scheduling algorithm, Priority based scheduling algorithm and neural network which improve the performance of the system. We have proved that using this scheduling algorithm, there is improvement in Average Waiting Time and Average Turnaround Time, we can see in the comparison output graphs and Table 2. The improved Average Waiting Time is 69.9ms and Average Turnaround Time is 95.4ms.

REFERENCES

[1] R. Nandini and N. Devarajan, “Comparison For WiMAX Scheduling Algorithms And Proposal Quality of Services Improvement In WiMAX Network”, American Journal of Applied Sciences 11 (1): 8-16, 2014.

[2] Raja Murali Prasad and Pentamsetty Satish Kumar, “Joint Routing, Scheduling and Admission Control Protocol for WiMAX Networks”, The International Arab Journal of Information Technology, Vol. 10, No. 1, January 2013.

[3] Lalit Kishor and Dinesh Goyal, “Time Quantum Based Improved Scheduling Algorithm”, International Journal of Advanced Research in Computer Science and Software Engineering, Volume 3, Issue 4, April 2013.

[4] Akashdeep and Dr K S Kahlon, “A Neural Based Proposal For Scheduling of IEEE 802.16 Networks”, International Journal of Engineering and Technology (IJET), Vol 4 No 5 Oct-Nov 2012.

[5] Łukasz Chróst and Agnieszka Brachman, “Towards a Common Benchmark in WiMAX Environment”, 978-1-4244-4067-2/09/$25.00 ©2009 IEEE.

[6] Ehsan Haghani and Nirwan Ansari, “VoIP Traffic Scheduling in WiMAX Networks”, 978-1-4244-2324-8/08/$25.00 © 2008 IEEE.

[7] Yan Wang∗, Sammy Chan†, Moshe Zukerman‡and Richard J. Harris§, “Priority-based Fair Scheduling for Multimedia WiMAX Uplink Traffic”, 978-1-4244-2075-9/08/$25.00 ©2008 IEEE.

[8] Wang H. and Jia W., “Scalable and Adaptive Resource Scheduling in IEEE 802.16 WiMAX Networks,” in Proceedings of IEEE Global Telecommunications Conference, New Orleans, pp. 1-5, 2008.

[9] L. Andrew, C. Marcondes, S. Floyd, L. Dunn, R. Guillier, W. Gang, L. Eggert, S. Ha, and I. Rhee, “Towards a common tcp evaluation suite,” in PFLDnet 2008, March 2008.

[10] E. Halepovic, Q. Wu, C. Williamson, and M. Ghaderi, “TCP over WiMAX: A measurement study,”Proc. MASCOTS, to appear, 2008.

[11] J. Sun, S. Chan, K. Ko, G. Chen, and M. Zukerman, “Instability effects of two-way traffic in a TCP/AQM system,”Computer Communications, vol. 30, no. 10, pp. 2172–2179, 2007.

[12] J. Lakkakorpi, A. Sayenko, J. Karhula, O. Alanen, and J. Moilanen, “Active queue management for reducing downlink delays in WiMAX,” Vehicular Technology Conference, 2007. VTC-2007 Fall. 2007 IEEE 66th, pp. 326–330, 30 2007-Oct. 3 2007.

[13] E. Haghani, S. De, and N. Ansari, “On modeling VoIP traffic in broadband networks,” in Proc. IEEE Global Telecommunications Conference (Globecom’07), Washington DC, pp. 1922–1926, Nov. 2007.

[14] D. Bonfiglio, M. Mellia, M. Meo, D. Rossi, and P. Tofanelli, “Revealing skype traffic: when randomness plays with you,” inProceedings ACM SIGCOMM 2007, Aug. 2007.

[15] M. Menth, A. Binzenhfer, and S. M¨ uhleck, “Source models for speech traffic revisited,” University of W¨ uzburg, Germany, Tech. Rep. 426, May 2007.

[16] D. Zhao and X. Shen, “Performance of packet voice transmission using IEEE 802.16 protocol,” IEEE Wireless Communications, vol. 14, pp. 44–51, 2007.

[17] N. Scalabrino, F. D. Pellegrini, R. Riggio, A. Maestrini, C. Costa, and I. Chlamtac, “Measuring the quality of VoIP traffic on a WiMAX testbed,” in Proceedings TRIDENTCOM 2007, May 2007.

[18] G. Yanfeng and H. Aiqun, “Bandwidth allocation algorithm of VoIP based on the adaptive linear prediction in the IEEE 802.16 system,” in Proceedings of 6th International Conference on ITS Telecommunications, June. 2006, pp. 16–19.[3] J. Chen, C. Wang, F. Chee-Da Tsai, C. Chang, S. Liu, J. Guo, W. Lien, J. Sum, and C. Hung, “The design and implementation of WiMAX module for ns-2 simulator,” inACM International Conference Proceeding Series; Vol. 202. ACM New York, NY, USA, 2006.

[19] Lin C., Chen Y., and Pang A., “A New Resource Allocation Scheme for IEEE 802.16-based Networks,” in Proceeding of the 3rd IEEE VTS Asia Pacific Wireless Communications Symposium, Korea, 2006.

[20] H. Lee, T. Kwon, and D. H. Cho, “An enhanced uplink scheduling algorithm based on voice activity for VoIP services in IEEE 802.16d/e system,”IEEE Communications Letters, vol. 9, pp. 44–51, 2005.

[21] H. Toral-Cruz and D. Torres-Roman, “Traffic analysis for IP telephony,” in Proceeding 2nd International Conference on Electrical and Electronics Engineering, pp. 136 – 139, Sept. 2005.

[22] A. Sukhov, P. Calyam, W. Daly, and A. Illin, “Towards an analytical model for characterizing behavior of high-speed VVoIP applications,” in TERENA Networking Conference (TNC), Jun. 2005.

[23] IEEE Std. 802.16-2004, “IEEE standard for local and metropolitan area networks- part 16: Air interface for fixed broadband wireless access systems,” 2004.

[24] Korf., R. E., “Optimal rectangle packing: New results. In Shlomo Zilberstein, Jana Koehler, and Sven Koenig, editors”, ICAPS, pp. 142–149, AAAI, 2004.