Mixed Approach Development in WiMAX Scheduling using Intelligent Neural Network to Improve Time Quantum

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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 scheduling algorithms and Compare their performance in terms of Average Waiting Time (AWT) and Average Turnaround Time (ATT) by taking the random number of processes 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.

1. 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.

2. 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.

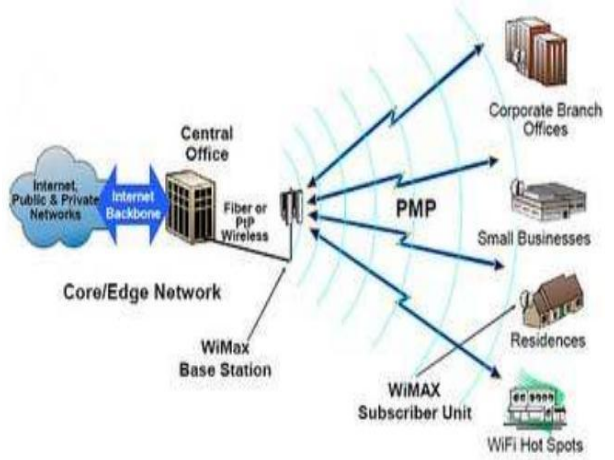

Figure 1(a): Testing Point-to-Multipoint (PMP) WiMAX Network

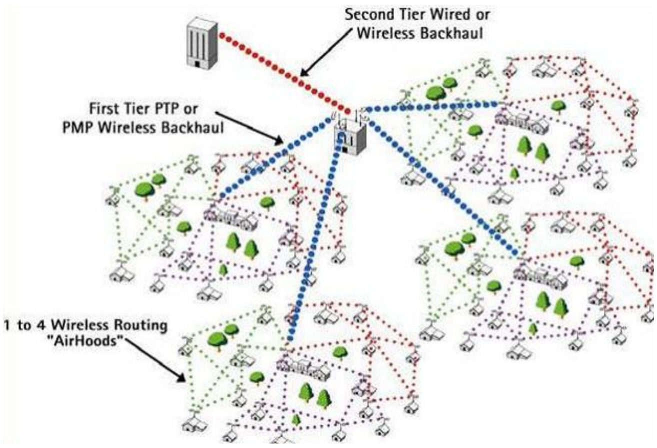

Figure 1(b): Mesh WiMAX Network

Figure 1: WiMAX Architecture (a) Point-to-Multipoint and (b) Mesh WiMAX Networks

3. Scheduling

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 main focus of the scheduling is to provide best possible end-to-end performance for the applications i.e. 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.

4. 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 A (UGC, rtPS, ertPS)
- Class B (nrtPS)
- Class C (BE)

The MATLAB software tool is used for this analysis. We have taken 20 random number of processes that are arrived in the order given below in Table 1 and analysis their performance by various scheduling algorithms with randomly generated time quantum and priority.

Table 1: List of Processes with Burst Time and Priority

Processes	*Burst Time (in ms)*	*Priority*
P1	82	8
P2	91	9
P3	13	17
P4	92	14
P5	64	18
P6	10	12
P7	28	2
P8	55	10
P9	96	16
P10	97	20
P11	16	3
P12	98	7
P13	96	19
P14	49	4
P15	81	1
P16	15	13
P17	43	11
P18	92	5
P19	80	15
P20	96	6

When we take these 20 random processes to generate the data for analysis, these processes are shown in the given Figure 2 as nodes and priorities assigned to them as shown in the Figure 3.

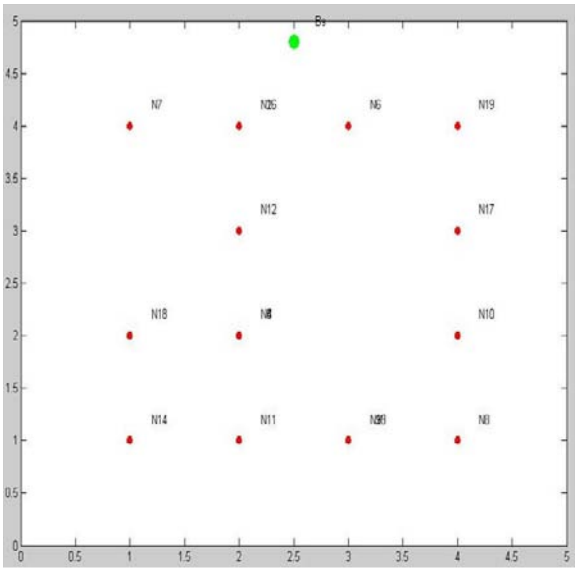

Figure 2: Processes or Nodes for analysis

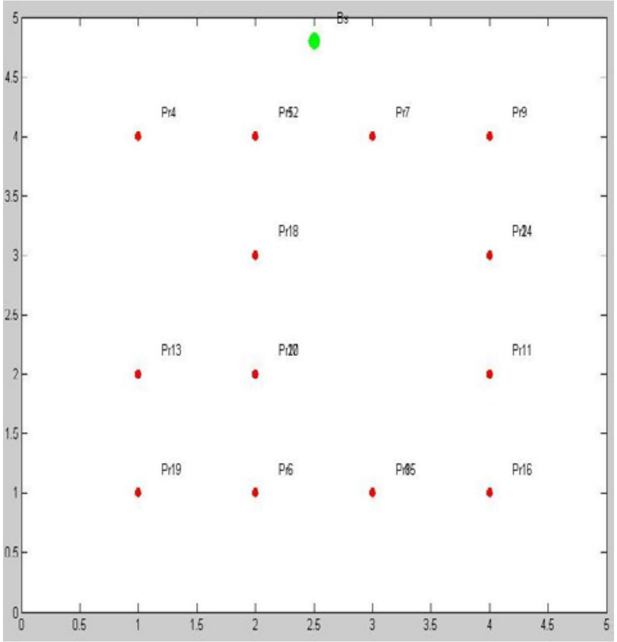

Figure 3: Priorities assigned to the nodes

5. 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)

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.

Gantt chart for above process as per FCFS is:

P1	P2	P3	P4	P5	P6	P7	P8	P9	P10
0 82	173	186	278	342	352	380	435	531	628

P11	P12	P13	P14	P15	P16	P17	P18	P19	P20
644	742	838	887	968	983	1026	1118	1198	1294

Average Waiting Time = 11791/20 = 589.55ms
Turnaround Time = Burst Time + Waiting Time
Average Turnaround Time = 13085/20 = 654.25ms

5.1.1 Output Graphs for FCFS Scheduling Algorithm

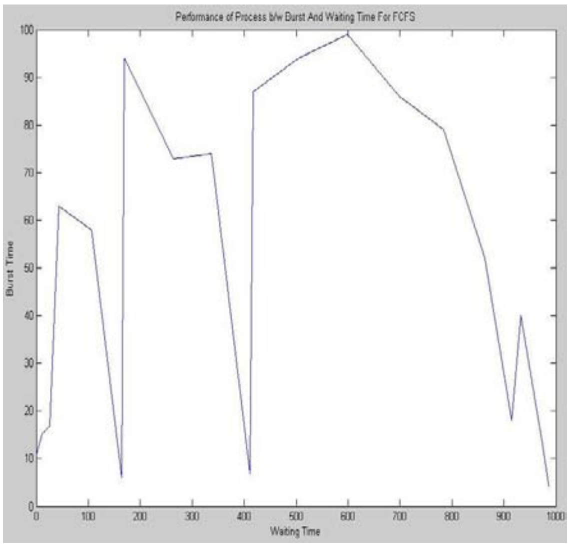

Figure 4: Performance of the Processes between Burst Time and Waiting Time for FCFS

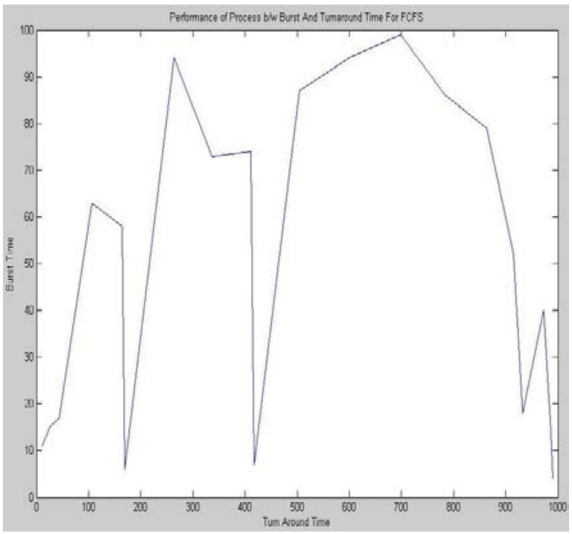

Figure 5: Performance of the Processes between Burst Time and Turnaround Time for FCFS

5.2 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.

Gantt chart for above process as per Priority is:

P15	P7	P11	P14	P18	P20	P12	P1	P2	P8
0 81	109	125	174	266	362	460	542	633	688

P17	P6	P16	P4	P19	P9	P3	P5	P13	P10
731	741	756	848	928	1024	1037	1101	1197	1294

Average Waiting Time = 11803/20 = 590.15ms
Average Turnaround Time = 13097/20 = 654.85ms

5.2.1 Output Graphs for Priority based Scheduling Algorithm

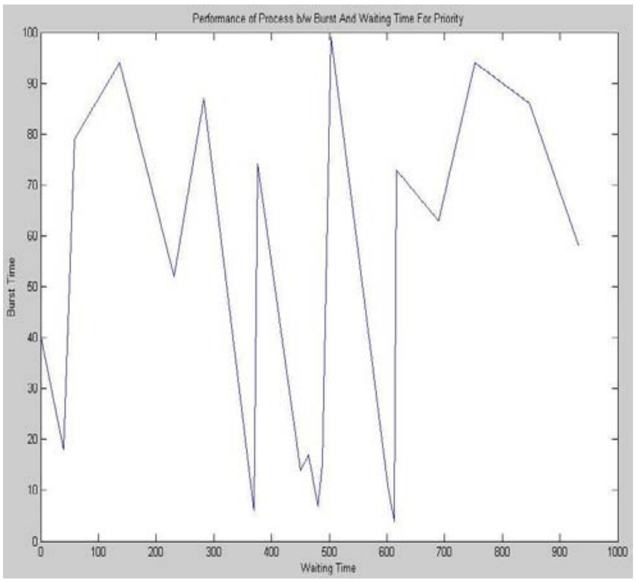

Figure 6: Performance of the Processes between Burst Time and Waiting Time for Priority

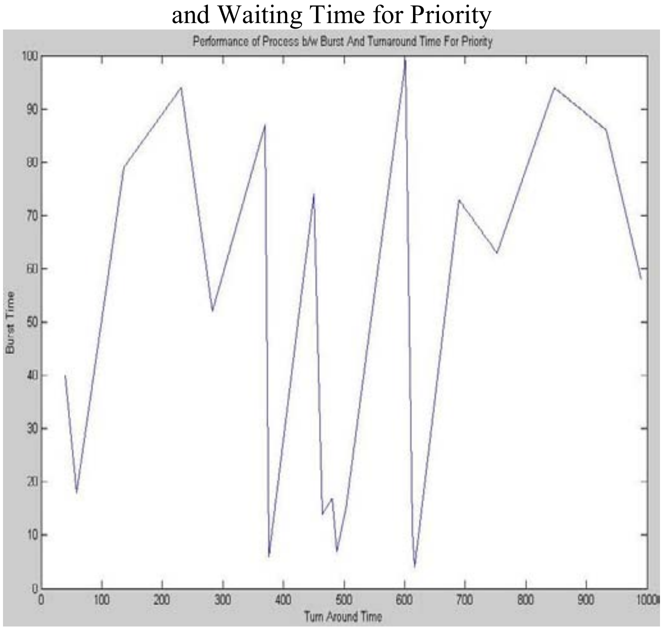

Figure 7: Performance of the Processes between Burst Time and Turnaround Time for Priority

5.3 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:

P6	P3	P16	P11	P7	P17	P14	P8	P5	P15

0 6 17 28 41 66 108 152 205 265 341

P19	P1	P2	P18	P4	P20	P9	P13	P10	P12

418 497 584 673 763 854 948 1042 1137 1232

Average Waiting Time = 8145/20 = 407.25ms

Average Turnaround Time = 9377/20 = 468.85ms

5.3.1 Output Graphs for Proposed Scheduling Algorithm

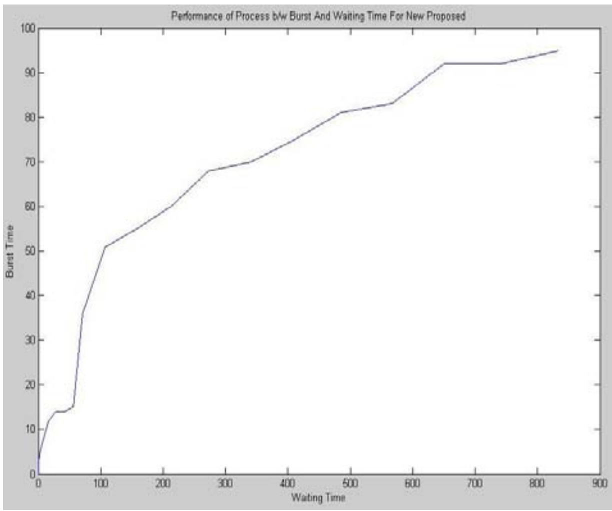

Figure 8: Performance of the Processes between Burst Time and Waiting Time for Proposed Scheduling Algorithm

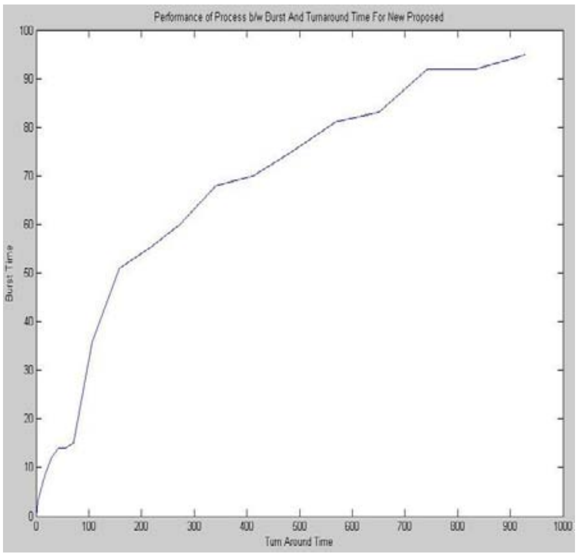

Figure 9: Performance of the Processes between Burst Time and Turnaround Time for Proposed Scheduling Algorithm

5.3.2 Comparison Output Graphs for Proposed Scheduling Algorithm

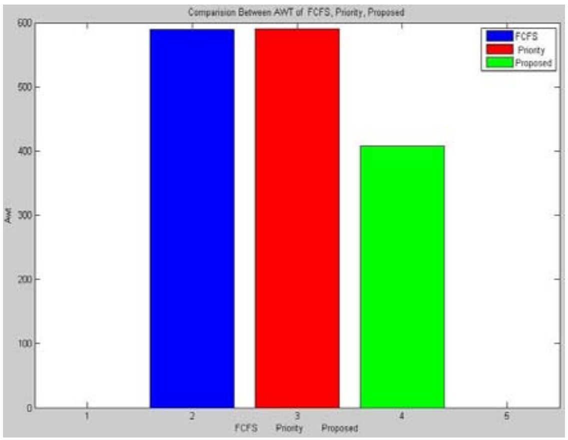

Figure 10: Comparison output graph for Average Waiting Time

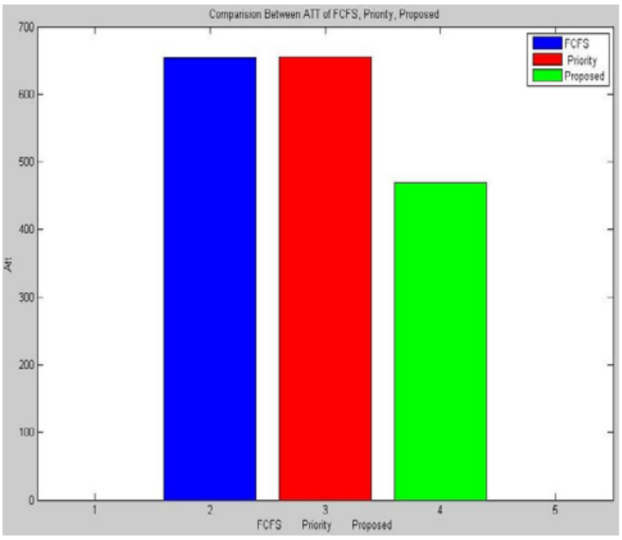

Figure 11: Comparison output graph for Average Turnaround Time

Table 2: Comparison Table for Scheduling algorithms

Scheduling Algorithms	*Average Waiting Time*	*Average Turnaround Time*
FCFS	589.55ms	654.25ms
Priority	590.15ms	654.85ms
Proposed	407.25ms	468.85ms

6. Conclusion

If In this paper, we have presented a mixed approach 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 407.25ms and Average Turnaround Time is 468.85ms.

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