

Improving Cross Layer Design for Multimedia Applications Over Distributed Radio Network using Adaptive Equalizer

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Keywords—adaptive equalizer, cross layer, multimedia application

Abstract—Delay in the passage of piece of information from the transmitting point to the receiving point has become a very big problem in our communication network. This can be overcome by improving cross layer design for multimedia applications over distributed radio network using adaptive equalizer. This is done in this manner by characterizing the network under study, determining the bit error rate and congestion from the characterized network that could cause the passage of information from sender to receiver difficult, determining the shortest route from the characterized network, designing a Simulink model that will reduce interference and congestion in improving cross layer design for multimedia applications over distributed radio network using adaptive equalizer and Comparing conventional and optimized adaptive equalizer. The result obtained from the analysis shows that using adaptive equalizer gives a better communication network than using conventional approach.

I. INTRODUCTION

Over the last years a number of new protocols have been developed for multimedia applications in the whole OSI layer's scale. The RTP and RTCP protocols (Schulzrinne, 2003), which operate on the transport layer usually on top of the UDP protocol, have been especially designed for multimedia data transmission. The RTSP (Schulzrinne, 1998) protocol offers control mechanisms over real time multimedia transmission whereas SIP (Schulzrinne, 2002) and H.323 are used in multimedia conferencing. Apart from the above developments there have been a number of proposals for improving QoS in multimedia applications through cross layer adaptation strategies. In Van der (Schaar, 2005) the need of a cross-layer optimization is examined and an adaptation framework is proposed amongst the APP, the MAC and the Physical (PHY) layers. In Shakkottai, 2003 the issue of cross-layer design

in wireless networks is addressed. The focus is on the way that higher layers share knowledge of the PHY and MAC layers conditions in order to provide efficient methods to allocate network resources over the Internet. In Van der Schaar, 2003 a joined APP and MAC adaptation is proposed with the use of MPEG-4 and the latest Fine Granularity Scalability (FGS) extension. In this work, packets containing multimedia data are classified into different classes and in the light of poor network conditions only packets with high value are transmitted. The network conditions are jointly measured by combining the information obtained by the retransmission number of a lost MAC frames (ARQ) and the information provided by the RTCP protocol. Signaling issues between the layers for cross-layer optimization over wireless networks are examined in Wang, 2003.

II. DESIGN METHODOLOGY

1. To characterize the network understudy.

Distributed Radio Systems include distributed antenna systems, distributed MIMO, distributed wireless networks and distributed spectrum sensing. ... a) is the traditional

tree structure of a cellular system. Mobile terminals or antennas send the signal to base transceiver station (BTS).

An hourly measured data of packet loss was collected from GLO network in Enugu metropolis for eight days as shown in table 1.

Table 1 Date of Data Collection: 1st TO 8th of February, 2018

Source; (Ngatek Global Services Limited)

TIME	DAY 1	DAY 2	DAY 3	DAY 4	DAY 5	DAY 6	DAY 7	Day 8
12.00 AM	5	8	4	8	7	6	5	8
1.00 AM	4	7	6	3	5	7	5	7
2.00 AM	6	5	8	7	5	4	6	5
3.00 AM	8	5	7	8	7	9	10	9
4.00 AM	6	10	8	11	9	12	11	8
5.00 AM	12	11	12	10	14	9	10	13
6.00 AM	18	15	17	19	15	17	18	16
7.00 AM	22	19	20	25	23	22	24	21
8.00 AM	30	35	33	30	40	42	39	37
9.00 AM	49	52	55	50	53	51	54	53
10.00 AM	33	38	40	37	35	40	43	39
11.00 AM	29	31	27	33	30	29	28	33
12.00 PM	22	26	21	23	25	22	23	25
1.00 PM	30	34	32	31	33	35	38	36
2.00 PM	45	40	50	55	49	53	48	52
3.00 PM	19	24	22	26	20	24	21	23
4.00 PM	28	27	30	29	33	28	31	32
5.00PM	55	50	53	57	51	49	52	56
6.00 PM	48	52	47	50	49	44	48	51
7.00 PM	30	28	33	29	31	35	32	31
8.00 PM	18	22	19	21	20	25	23	22
9.00 PM	14	12	15	18	16	13	15	14
10.00PM	12	9	11	13	11	9	10	11
11.00PM	8	7	6	5	7	9	8	6
TOTAL	452	595	576	734	548	594	602	578

The reason of collecting this packet loss data is to enable the researcher to analytically compute the congestion in the communication network where these packet losses are hourly experienced. The packet loss is used to develop a mathematical model as shown in equation 3.1

2. To determine the bit error rate and congestion from the characterized network that could cause the passage of information from sender to receiver difficult

Table 2: Total packet loss and congestion experienced for 8 Days

Total packet loss for eight days	Congestion experienced for the eight days
452	0.07681
595	0.06695
576	0.2111
734	0.06027
548	0.06976
594	0.21116
602	0.066555
578	0.06793

The mathematical model for congestion control in improving cross layer design for multimedia applications over distributed radio network using adaptive equalize is as shown in equation 3.2

$$L = 8/3W^2 \text{-----}1$$

Where L is packet loss

W is the network congestion

Then, make W the subject formula in equation 1

The mathematical model for congestion in the network is as shown in equation 2

$$W = \sqrt{8/3L} \text{-----}2$$

To find the network congestion in day one

$$W1 = \sqrt{8/3 \times 452}$$

$$W1 = \sqrt{8/1356} = 0.07681$$

Congestion in day two

$$W2 = \sqrt{8/3 \times 595} = \sqrt{8/1785} = 0.0044818$$

$$W2 = \sqrt{0.0044818}$$

$$W2 = 0.06695$$

Congestion in day three

$$W3 = \sqrt{8/3 \times 576}$$

$$W3 = \sqrt{8/1728} = 0.04456$$

$$W3 = \sqrt{0.04456} = 0.2111$$

Congestion in day four

$$W4 = \sqrt{8/3 \times 734}$$

$$W4 = \sqrt{8/2202}$$

$$W4 = \sqrt{0.003633}$$

$$W4 = 0.06027$$

Congestion in day five

$$W5 = \sqrt{8/3 \times 548}$$

$$W5 = \sqrt{8/1644}$$

$$W5 = \sqrt{0.004866}$$

$$W5 = 0.06976$$

Congestion in day six

$$W6 = \sqrt{8/3 \times 594}$$

$$W6 = \sqrt{8/1782}$$

$$W6 = \sqrt{0.04489}$$

$$W6 = 0.21116$$

Congestion in seventh day

$$W7 = \sqrt{8/3 \times 602}$$

$$W7 = \sqrt{8/1806}$$

$$W7 = \sqrt{0.0044296}$$

$$W7 = 0.066555$$

Congestion in day eight

$$W8 = \sqrt{8/3 \times 578}$$

$$W8 = \sqrt{8/1734}$$

$$W8 = \sqrt{0.004614}$$

$$W8 = 0.06793$$

3. To determine an ideal bit error rate convenient for the characterized network

The bit error rate that caused the collected packet loss in the communication network understudy is calculated with equation 3 Taking into consideration the worst-case scenario, the linear relationship between BER and packet error rate (PER) is expressed as:

$$PER = 8 \times BER \times MTU \times 66/64 \text{-----}3$$

Where the MTU is the maximum transmission unit, and using the Ethernet standards it is set to 1500 bytes for the simulations and then the MTU is increased to improve performance. A conversion from 8 bits to 1 byte is shown, Recall 1 byte = 8bits, 1500bytes = 8 x 1500 = 12000bits MTU = 12000bits

PER is packet loss and BER is bit error rate to evaluate the bit error rate in day one when the packet loss is 452.

Make BER the subject formula in equation 3

$$BER1 = PER/8 \times MTU \times 1.03125 \text{-----}4$$

$$BER1 = 452/8 \times 12000 \times 1.03125 = 452/9900 = 0.0457\text{bits}$$

To find the bit error rate in day two BER2 = 595/9900 = 0.0601

Bit error rate in day three BER3 = 576/9900 = 0.058

Bit error rate in day four, BER4 = 734/9900 = 0.0741bits

Bit error rate in day five BER5 = 548/9900 = 0.0554 bits

Bit error rate in day six BER6 = 594/9900 = 0.06 bits

Bit error rate in day seven BER7 = 602/9900 = 0.0608

Bit error rate in day eight BER8 = 578/9900 = 0.0584bits

Table3: Bit Error rate for the Characterized network

Total packet loss for eight days	Congestion experienced for the eight days	Bit error rate
452	0.07681	0.0457bits
595	0.06695	0.0601bits
576	0.2111	0.0582bits
734	0.06027	0.0741bits
548	0.06976	0.0554 bits
594	0.21116	0.06 bits
602	0.066555	0.0608bits
578	0.06793	0.0584bits

4. To determine the shortest route from the characterized network.

In graph theory, the shortest path problem is the problem of finding a path between two vertices (or nodes) in a graph such that the sum of the weights of its constituent edges is minimized.

The problem of finding the shortest path between two intersections on a road map (the graph's vertices correspond to intersections and the edges correspond to road segments, each weighted by the length of its road segment) may be modeled by a special case of the shortest path problem in graphs.

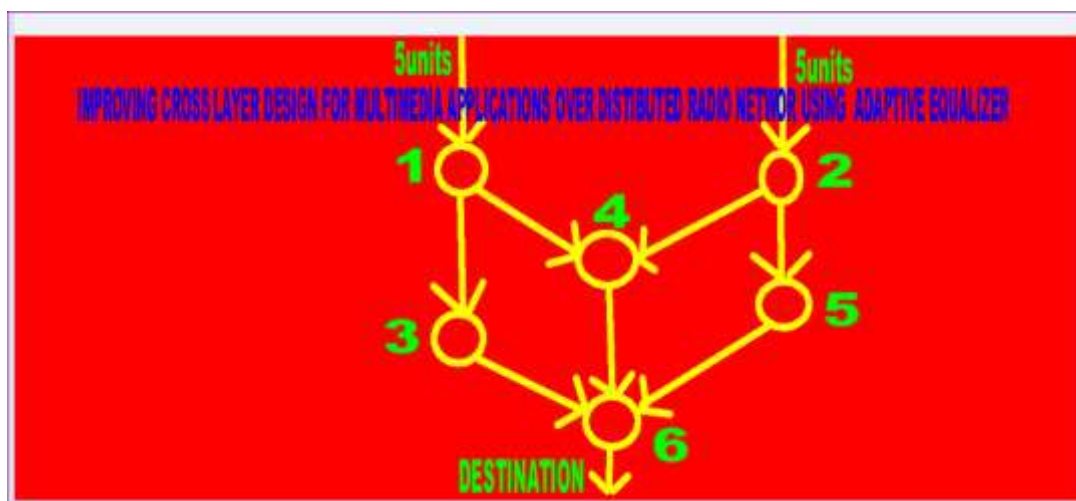


Fig.1 Network for shortest distance

Figure 1 Network for shortest distance. All links have a capacity of 10 units.

Traffic is routed through the middle link (4, 6), congestion occurs.

If, instead, paths (1 --> 3 --> 6) and (2 --> 5 --> 6) are used, the average delay is small. equal 10. Thus, the total throughput can be no more than 15 units.

The shortest distance gotten is 4 that is the distance when bit error rate reduces thereby minimizing congestion in improving cross layer design for multimedia applications over distributed radio network using adaptive equalizer.

5. To design a Simulink model that will reduce interference and congestion in improving cross layer design for multimedia applications over distributed radio network without using adaptive equalizer

The equalizer is a device that attempts to reverse the distortion incurred by a signal transmitted through a

channel. In digital communication its purpose is to reduce inter symbol interference to allow recovery of the transmit symbols. It can be a simple linear filter or a complex algorithm. The types of commonly used equalizers in digital communications are:

- Linear Equalizer: It processes the incoming signal with a linear filter.
- MSME equalizer: It designs the filter to minimize, where $E[|e|]$, where e is the error signal that is the filter output minus the transmitted signal.
- Zero forcing Equalizer: It approximates the inverse of the channel with a linear filter
- Decision feedback equalizer: It augments a linear equalizer by adding a filtered version of previous symbol estimates to the original filter output filter.
- Blind Equalizer: It estimates that the transmitted signal without knowledge of the channel statistics and uses only knowledge of the transmitted signal's statistics.

- vi. Adaptive Equalizer: It is typically a linear equalizer or a DFE, which updates the equalizer parameters (such as the filter coefficients) as it processes the data. It uses the MSE cost function and it assumes that it makes the correct symbol decisions and uses its estimate of the symbols to compute e which is defined above.
 - vii. Viterbi Equalizer: It Finds the optimal solution to the equalization problem. It is having a goal to minimize the probability of making an error over the entire sequence.
 - viii. BCJR Equalizer: It uses the BCJR algorithm whose goal is to minimize the probability that a given bit was incorrectly estimated.
 - ix. Turbo Equalizer: It applies turbo decoding while treating the channel as a convolutional code.
- The equalizer used in this work is an adaptive equalizer because it uses the MSE cost function and it assumes that it makes the correct symbol decisions.

The equalizer used in this work is an adaptive equalizer because it uses the MSE cost function and it assumes that it makes the correct symbol decisions.

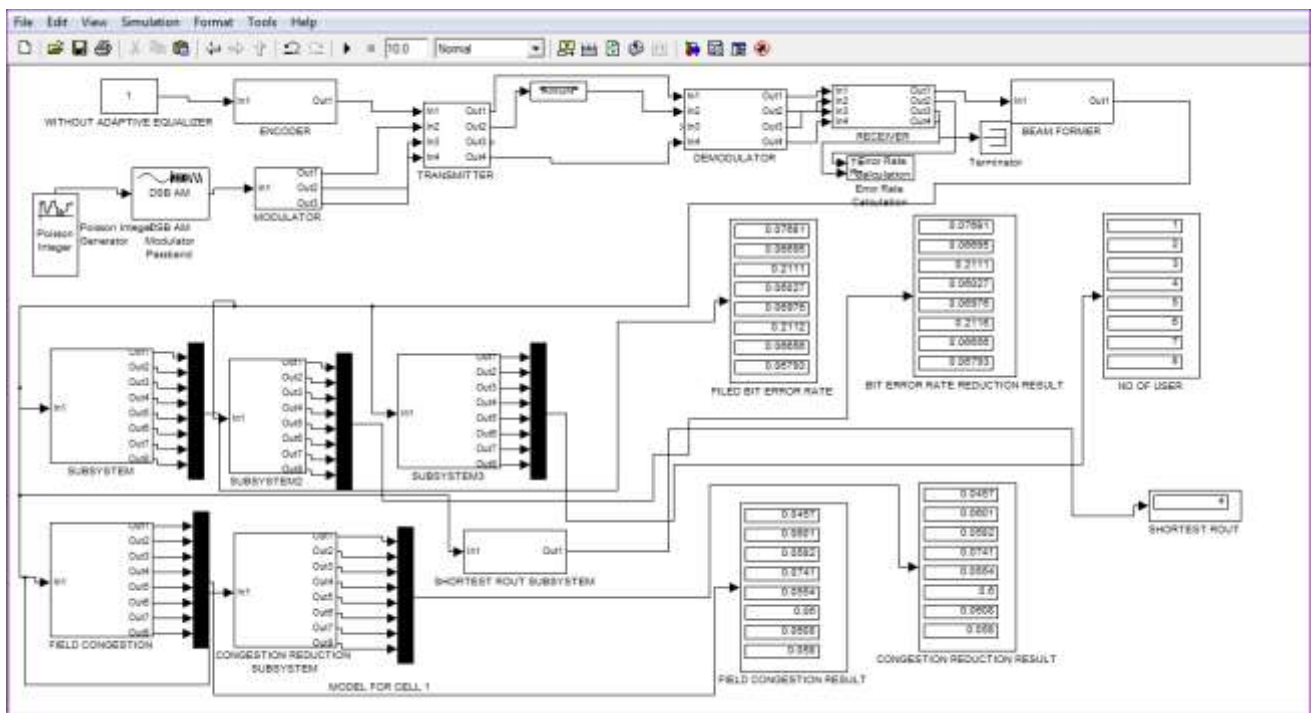


Fig.2: Designed Simulink Model in Improving Cross Layer Design for Multimedia Applications Over Distributed Radio Network Without Using Adaptive Equalizer

Figure 2 shows designed Simulink model in improving cross layer design for multimedia applications over distributed radio network without using adaptive equalizer.

The detailed result is as shown in tables 4, 5 and figures 4 and 5 respectively.

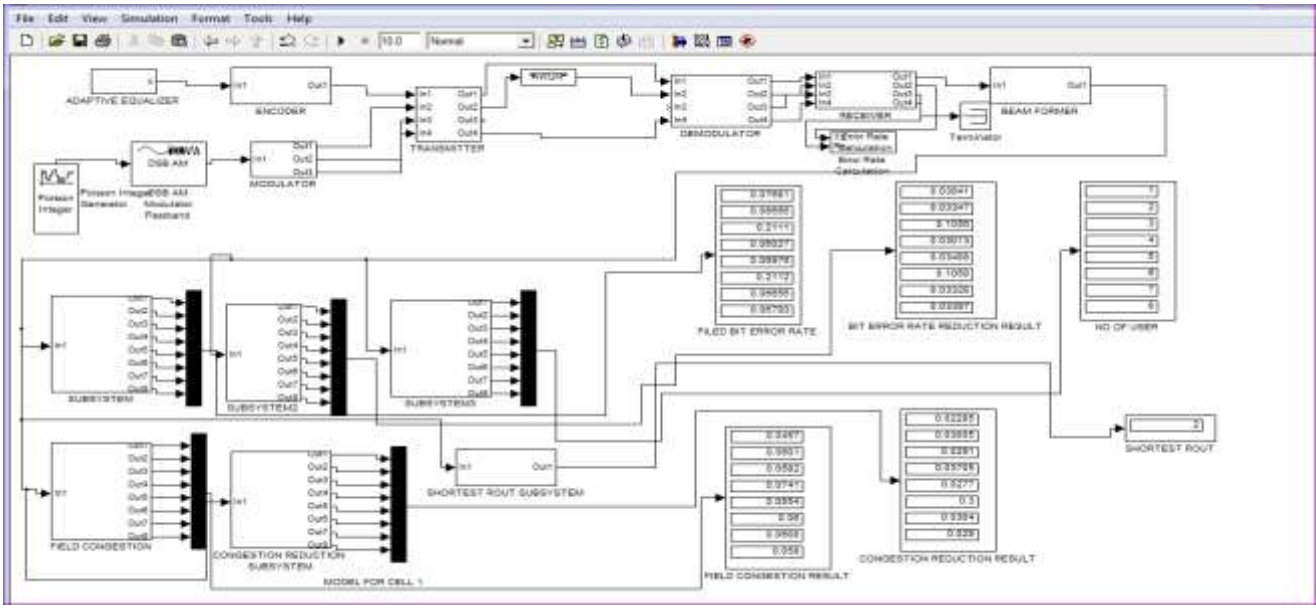


Fig.3: Designed Simulink Model That Will Reduce Interference and Congestion in Improving Cross Layer Design for Multimedia Applications Over Distributed Radio Network Using Adaptive Equalizer

Figure 3 shows designed Simulink model that will reduce interference and congestion in improving cross layer design for multimedia applications over distributed radio network using adaptive equalizer. Meanwhile the simulated results are shown in tables 6 and 7, figures 6 and 7 respectively.

III. RESULT ANALYSIS

Table 4: Conventional bit error rate in improving cross layer design for multimedia applications over distributed radio network without using adaptive equalizer

CONVENTIONAL BIT ERROR RATE	TIME (S)
0.07681	1
0.06695	2
0.2111	3
0.06027	4
0.06976	5
0.21116	6
0.066555	7
0.06793	8

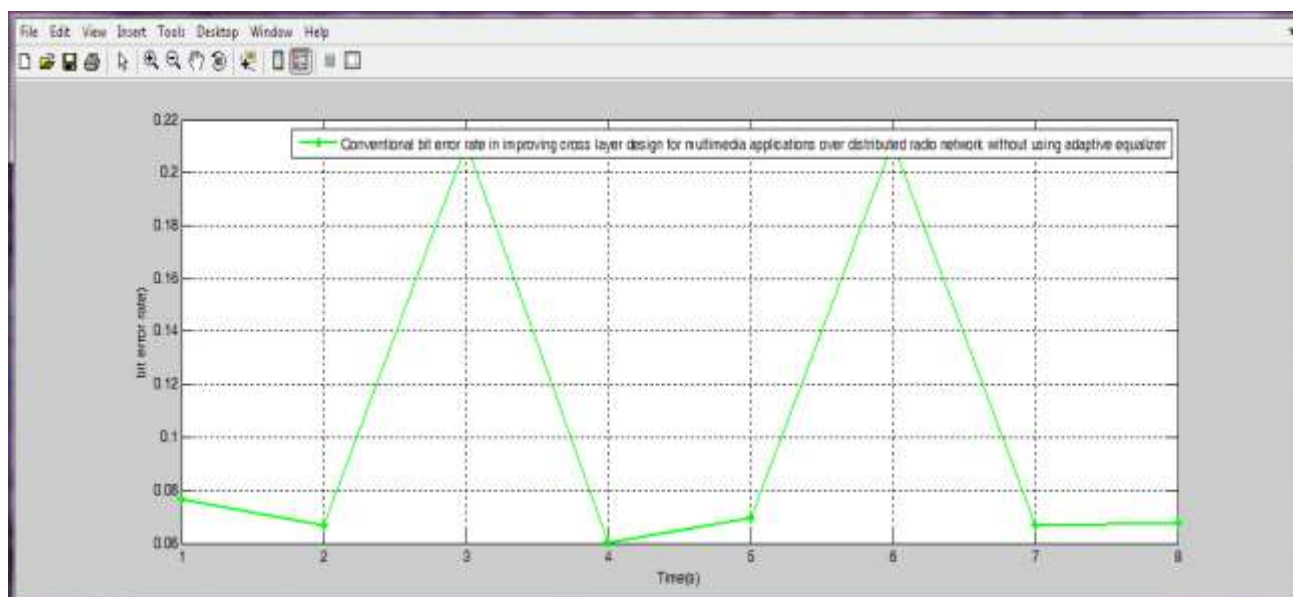


Fig.4: Result for conventional bit error rate in improving cross layer design for multimedia applications over distributed radio network without using adaptive equalizer

Figure 4 shows result for conventional bit error rate in improving cross layer design for multimedia applications over distributed radio network without using adaptive equalizer. Figure4 shows that the highest bit error rate

occurred at bit error rate and time coordination of (0.2116, 6) at this bit error rate the transmission of data from sender to receiver will become apparently impossible.

Table 5: Conventional congestion in improving cross layer design for multimedia applications over distributed radio network without using adaptive equalizer

Conventional congestion	Time(s)
0.0457	1
0.0601	2
0.0582	3
0.0741	4
0.0554	5
0.06	6
0.0608	7
0.058	8

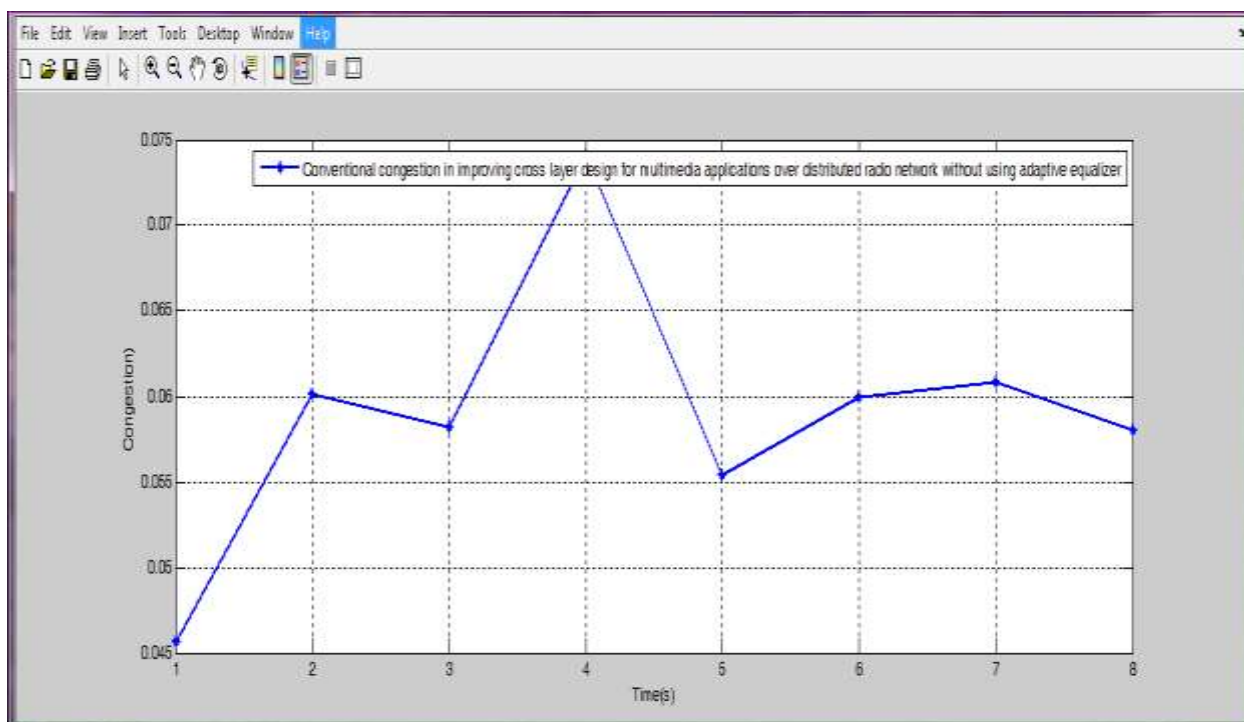


Fig.5: Result for conventional congestion in improving cross layer design for multimedia applications over distributed radio network without using adaptive equalizer

Figure5 shows result for conventional congestion in improving cross layer design for multimedia applications over distributed radio network without using adaptive equalizer. In figure5, the highest congestion occurred at

coordination of congestion and time of (0.0741, 4). At this congestion stage data will be delayed to reach its destination in time.

Table 6: Bit error rate in improving cross layer design for multimedia applications over distributed radio network using adaptive equalizer

Bit error rate when adaptive equalizer is used	Time(s)
0.03841	1
0.03347	2
0.1056	3
0.03013	4
0.03488	5
0.1058	6
0.03328	7
0.03397	8

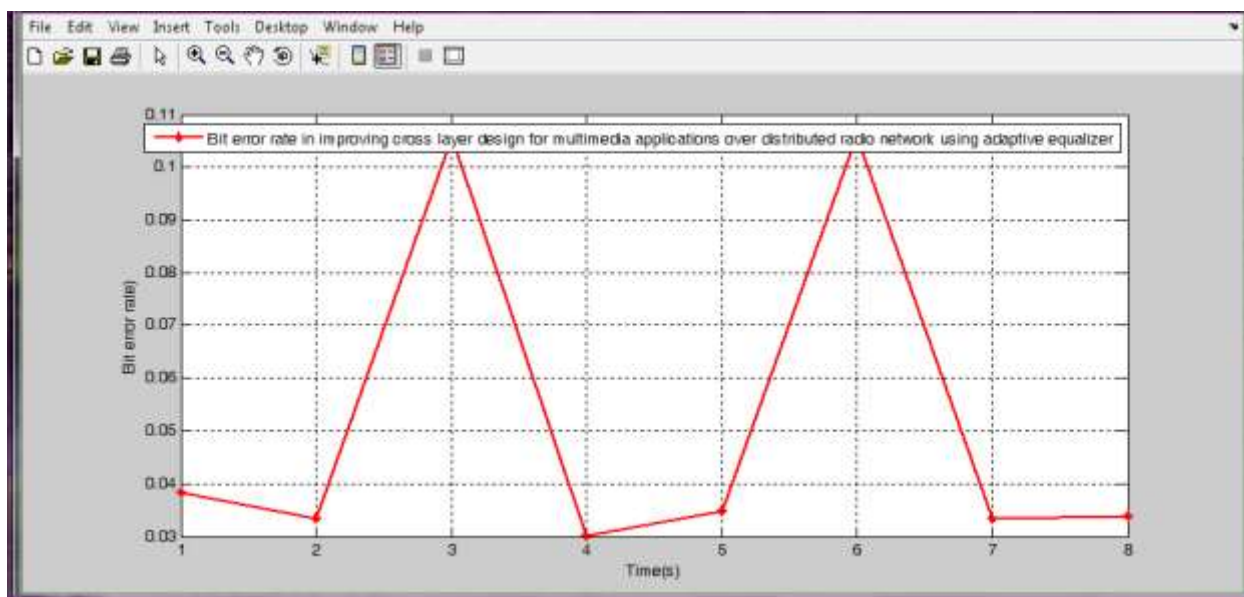


Fig.6: Result for bit error rate in improving cross layer design for multimedia applications over distributed radio network using adaptive equalizer

Figure 6 shows result for bit error rate in improving cross layer design for multimedia applications over distributed radio network using adaptive equalizer. Figure 6 shows

that the highest bit error rate to time coordination occurred at (0.1058,6). At this point the passage of data from sender to receiver is fast.

Table 7 congestion in improving cross layer design for multimedia applications over distributed radio network using adaptive equalizer

Congestion when adaptive equalizer is incorporated	Time(s)
0.02285	1
0.03005	2
0.0291	3
0.03705	4
0.0277	5
0.03	6
0.0304	7
0.029	8

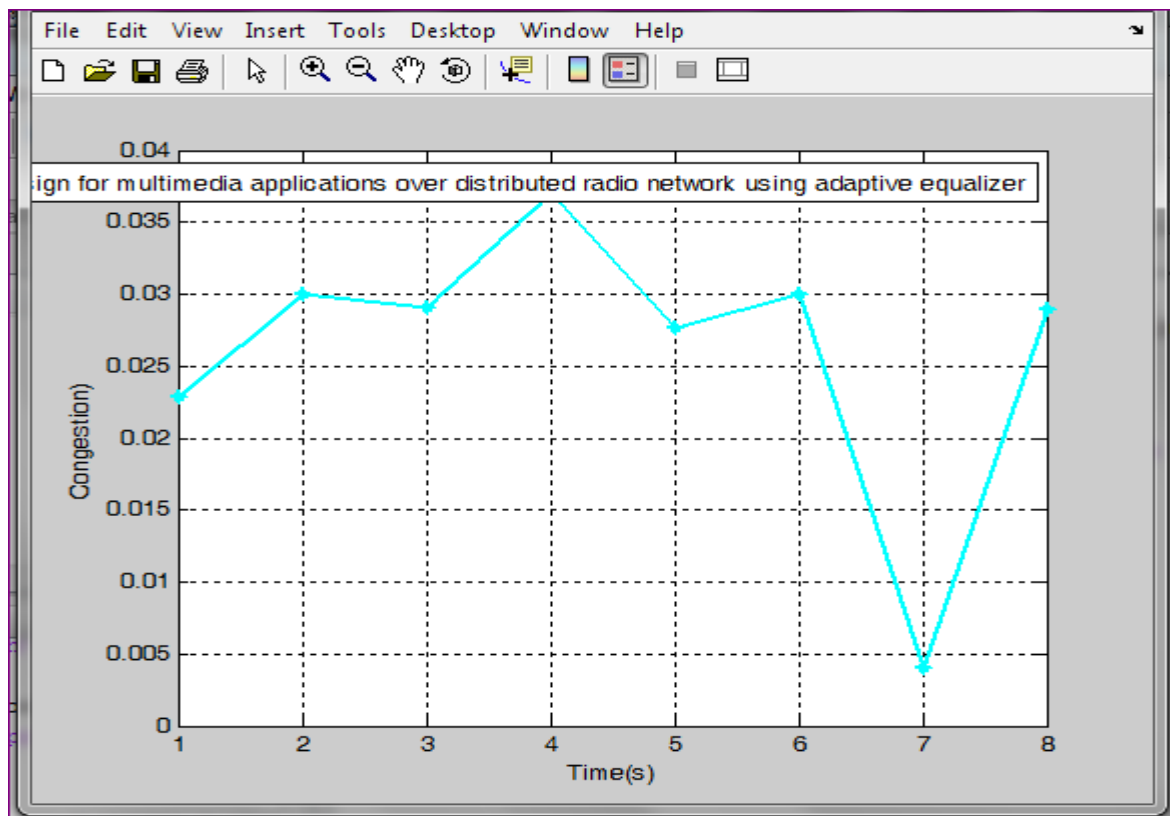


Fig.7: Congestion in improving cross layer design for multimedia applications over distributed radio network using adaptive equalizer

Figure7 shows that the lowest congestion verse time coordination is at (0.0228, 1). This shows that the passage of piece of information from source to sink in cross layer

design for multimedia applications over distributed radio network using adaptive equalizer is fast and reliable.

Table 8: Comparing conventional bit error rate with bit error rate when adaptive equalizer is used

Conventional Bit Error Rate	Bit error rate when adaptive equalizer is used	Time(s)
0.07681	0.03841	1
0.06695	0.03347	2
0.2111	0.1056	3
0.06027	0.03013	4
0.06976	0.03488	5
0.021116	0.1058	6
0.066555	0.03328	7
0.06793	0.03397	8

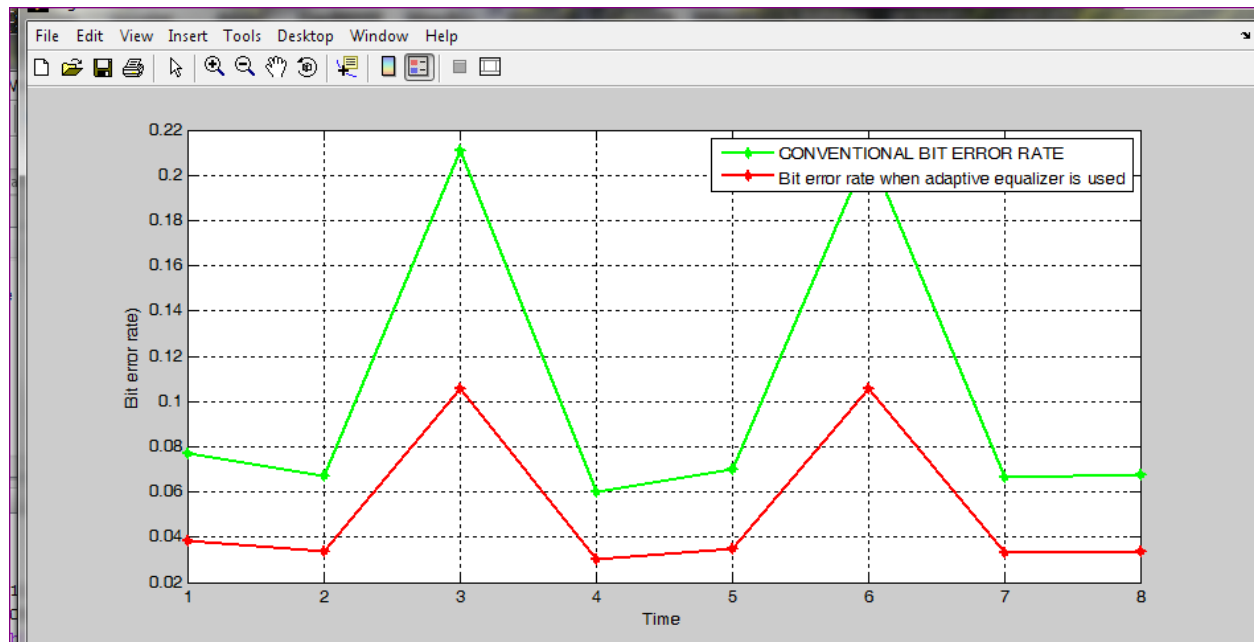


Fig.8: Comparing the result of conventional bit error rate with bit error rate when adaptive equalizer is used

Figure 8 shows that the highest bit error rate verse time without using and using adaptive equalizer (0.07681, 1). On the other hand, the highest bit error rate coordination with time using adaptive equalizer falls at (0.03841, 1). With these results, it shows that without having adaptive

equalizer has high bit error rate which equally means that it has an interference that make it not to transfer data from source to sink. While the one that adaptive equalizer was incorporated in it has reduced bit error rate that does not contain interference thereby passes data conveniently.

Table 9: Comparing conventional congestion with congestion when adaptive equalizer is used

Conventional congestion	Congestion when adaptive equalizer is used	Time(s)
0.0457	0.02285	1
0.0601	0.03005	2
0.0582	0.0291	3
0.0741	0.03705	4
0.0554	0.0277	5
0.06	0.03	6
0.0608	0.0304	7
0.058	0.029	8

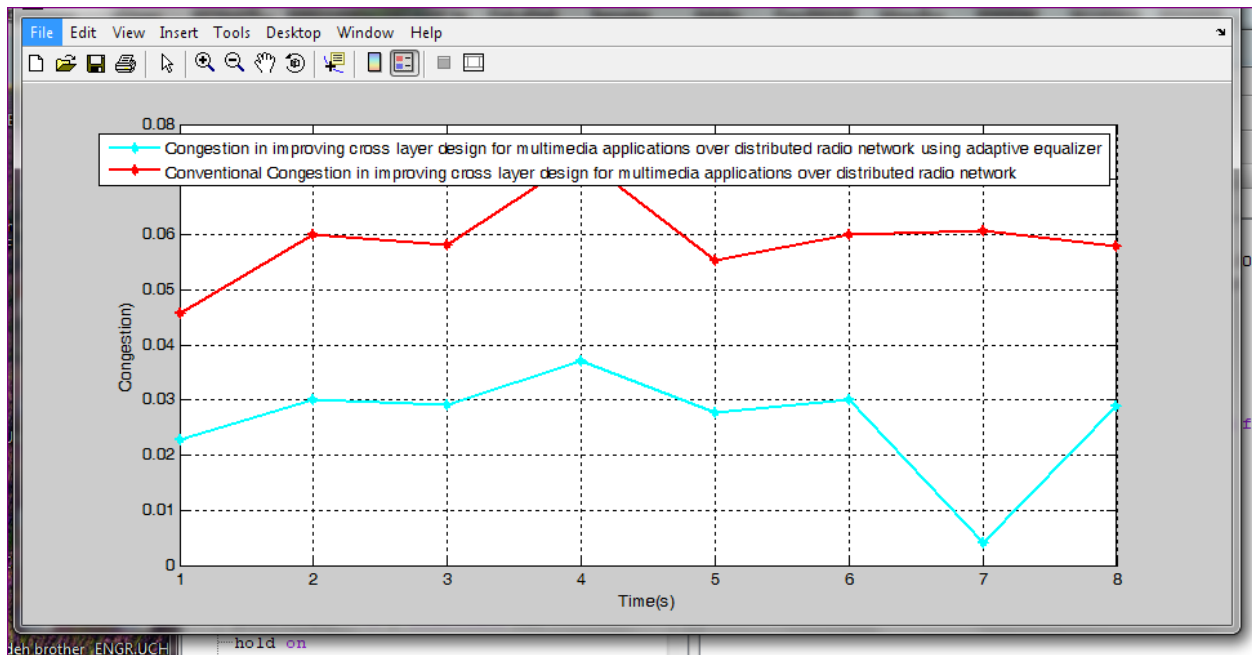


Fig.9: Comparing conventional congestion with congestion when adaptive equalizer is used

Figure 9 shows the comparing conventional congestion with congestion when adaptive equalizer is used. It shows that in the congestion verse time coordinate the highest congestion when adaptive equalizer is used occurred at (0.0741, 4) while that when adaptive equalizer is used occurred at (0.03705, 4). With these results it shows that with congestion in improving cross layer design for multimedia applications over distributed radionetwork without using adaptive equalizer the transmitting of data from one point to the other become practically impossible while when adaptive equalizer is used the congestion is reduced with quick transmission of information.

IV. CONCLUSION

The difficulty of transmitting data from one point to the other or passing piece of information from source to sink is caused by high bit error rate which constitutes interference and congestion in the communication network. The difficulty of passing piece of information in communication network is overcome by improving cross layer design for multimedia applications over distributed radio network using adaptive equalizer. This is done in this manner, by characterizing the network under study, determining the bit error rate and congestion from the characterized network that could cause the passage of information from sender to receiver difficult, determining the shortest route from the characterized network, designing a Simulink model that will reduce interference and congestion in improving cross layer design for multimedia applications over distributed radio network

using adaptive equalizer and Comparing conventional and optimized adaptive equalizer

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