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# COMPARISON & PERFORMANCE OF PDA ALGORITHM WITH ZF & MMSE

## 12. 1 INTRODUCTION

The wireless communication is the current area of interest but the growing number of users cannot afford to cause hindrance for others. Multi-user Detection technique (MUD) is going to be the key to this problem.

Also, in wireless systems, DS-CDMA is a popular multiple access technology however its performance is limited by MAI and multi-path faded environment. The MAI occurs in multi-access communication systems is unavoidable because receiver's deal with information interferes with each other.

A MUD technique is employed to improve the performance of DS-CDMA system. MUD is basically the design of signal processing algorithms that algorithms take into account the correlative structure of the MAI.

To improve the system capacity, MUD techniques such as ZF, MMSE, PDA is used. Specially, in this chapter we can compare the performance and analysis of PDA algorithm with Zero Forcing and Minimum mean square error algorithms.

## 12.2 ZERO FORCING – RESULTS

A ZF linear MUD or simply ZF MUD, attempts to completely eliminate the MAI in a DS-CDMA system regardless to AWGN. For the purpose of this section we consider a synchronous CDMA system. Simulation Results for ZF (Zero Forcing) algorithm for various numbers of users is shown below.

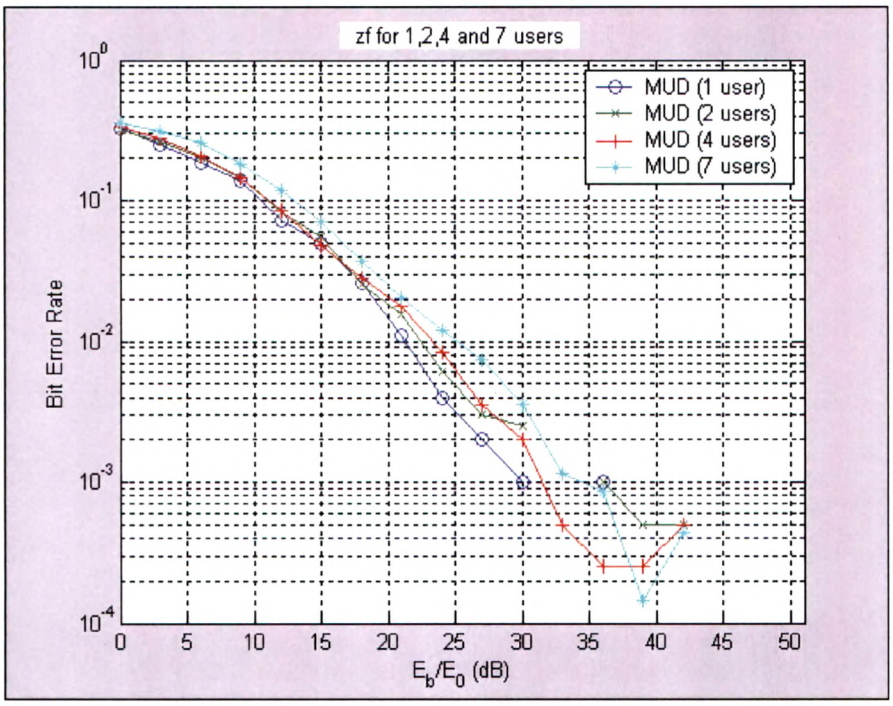


Figure. 12.1(a) ZF Performance of the BER versus $E_b/E_0$ (dB) for 1, 2, 4 and 7 users.

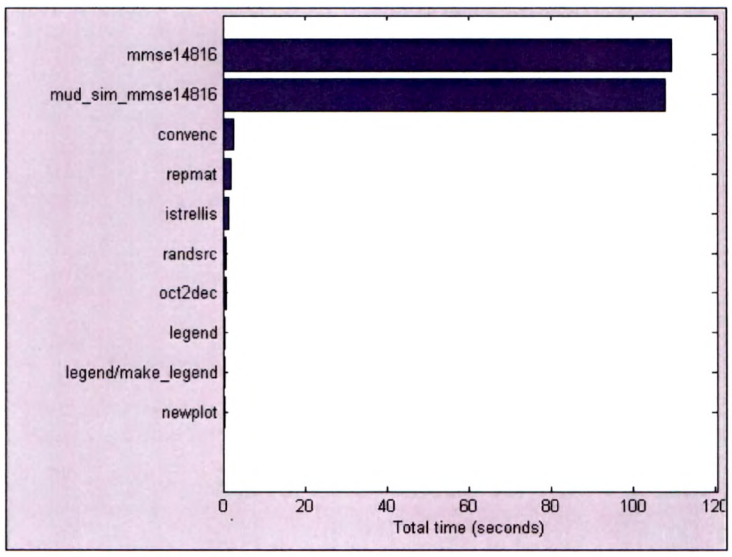


Figure. 12.1(b) ZF Profile Plot for 1, 4, 8 and 16 users.

**MATLAB Profile Report: Summary**

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| | |
|---|---|
| Total recorded time: | 109.51 s |
| Number of M-functions: | 39 |
| Number of M-scripts: | 1 |
| Number of M-subfunctions: | 29 |
| Number of MEX-functions: | 6 |
| Clock precision: | 0.00000006 s |
| Clock Speed: | 1716 Mhz |

Figure. 12.1(c) ZF Profile Plot Summary for 1, 4, 8, and 16 users

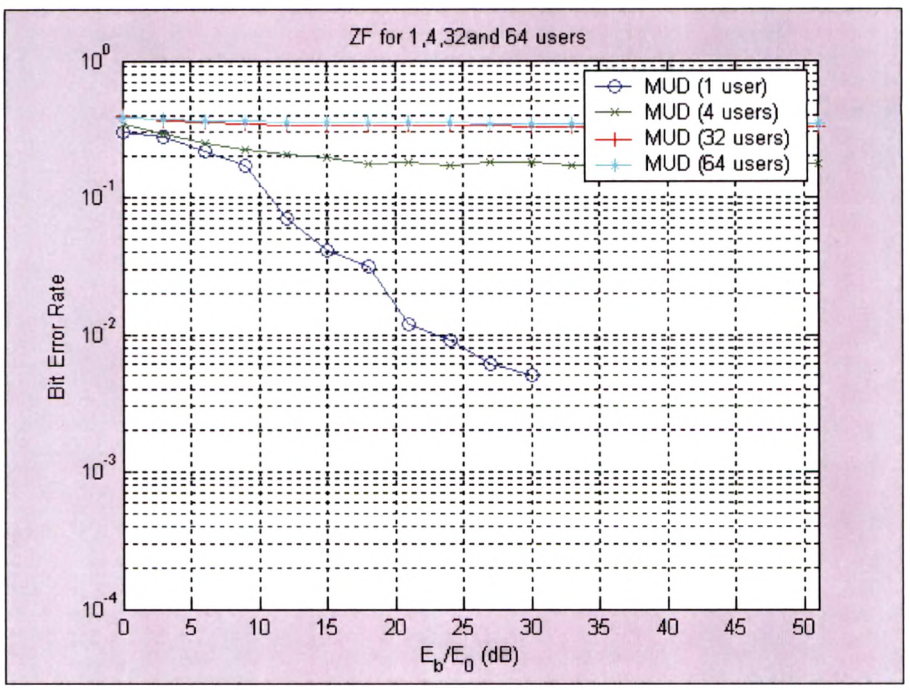


Figure.12.2(a) ZF Performance of the BER versus $E_b/E_0$ (dB) for 1,4,32 and 64 users.

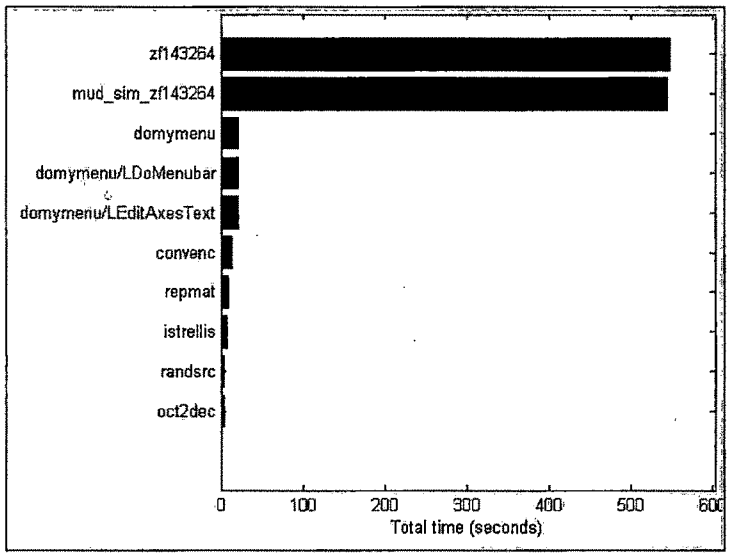


Figure. 12.2(b) ZF Profile Plot for 1, 4, 32 and 64 users

**MATLAB Profile Report: Summary**

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| | |
|---|---|
| Total recorded time: | 569.72 s |
| Number of M-functions: | 92 |
| Number of M-scripts: | 1 |
| Number of M-subfunctions: | 49 |
| Number of MEX-functions: | 6 |
| Clock precision: | 0.00000006 s |
| Clock Speed: | 1700 Mhz |

Figure. 12.2(c) ZF Profile Plot Summary for 1, 4, 32, and 64 users

## 12.3 MINIMUM MEAN SQUARE ERROR – RESULTS

A receiver structure can be obtained if the linear trans-formation is sought which minimizes the mean square error between the transmitted bits and the outputs of the transformation. It takes the background noise into account and utilizes the knowledge of the received signal powers. It implements a linear mapping which minimizes E[ |d -Ly|2], mean squared error between the actual data and the soft output of the conventional detector. Simulation Results for MMSE (Minimum Mean Square Error) Algorithm for various numbers of users.

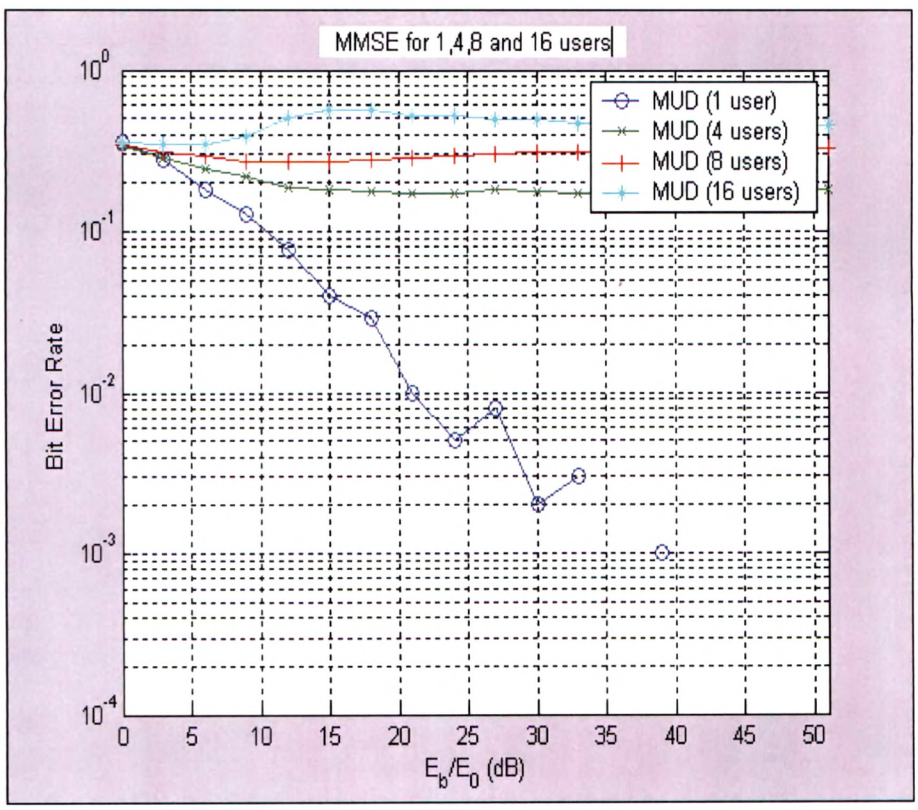


Figure 12.3(a) MMSE Performance : BER versus $E_b/E_0$(dB) for 1,4,8 and 16 users.

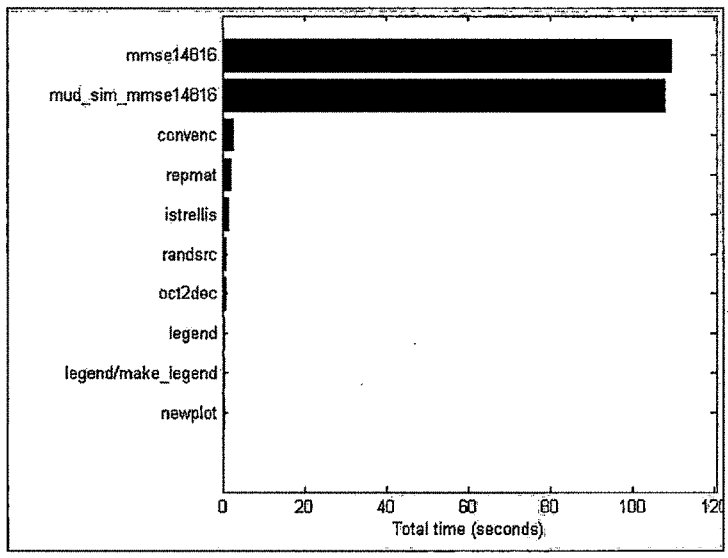


Figure. 12.3(b) MMSE : Profile Plot for 1, 4, 8 and 16 users

**MATLAB Profile Report: Summary**

*Report generated 26-Mar-2006 10:36:41*

| | |
|---|---|
| Total recorded time: | 109.51 s |
| Number of M-functions: | 39 |
| Number of M-scripts: | 1 |
| Number of M-subfunctions: | 29 |
| Number of MEX-functions: | 6 |
| Clock precision: | 0.00000006 s |
| Clock Speed: | 1716 Mhz |

Figure. 12.3(c) MMSE Profile Plot Summary for 1, 4, 8, and 16 users

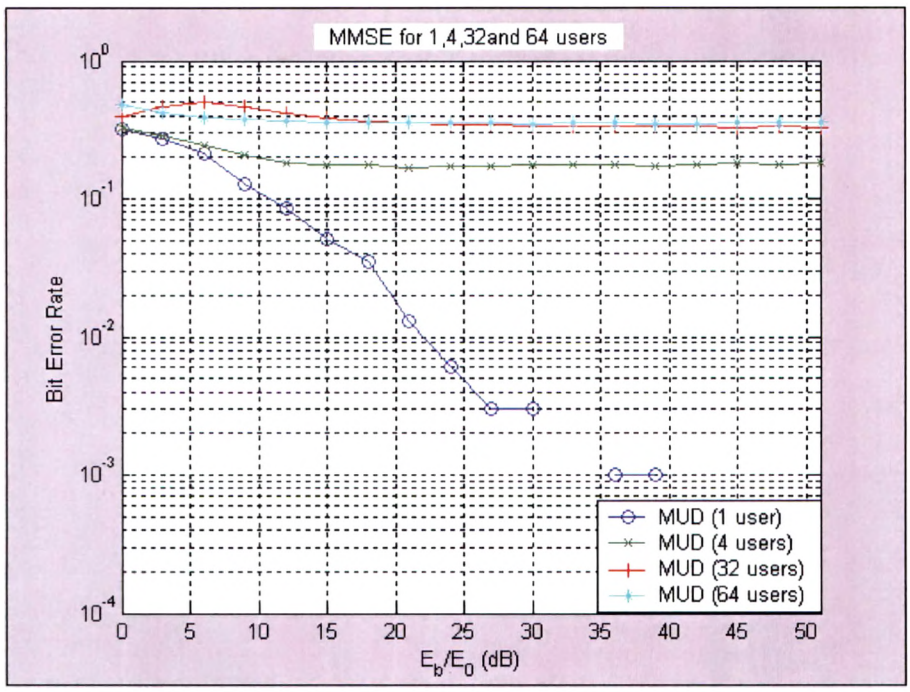


Figure. 12.4(a) MMSE :Performance : BER versus $E_b/E_0$ (dB) for 1,4,32 and 64 users.

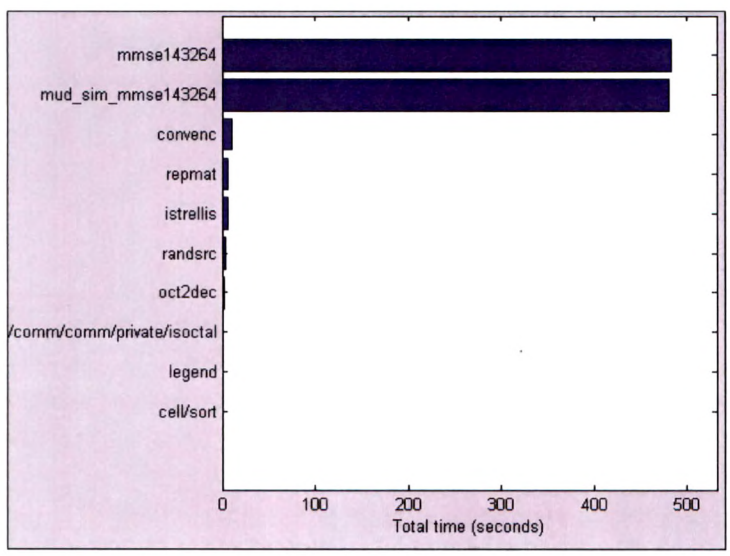


Figure. 12.4(b) MMSE Profile Plot for 1, 4, 32 and 64 users

**MATLAB Profile Report: Summary**

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| | |
|---|---|
| Total recorded time: | 483.67 s |
| Number of M-functions: | 43 |
| Number of M-scripts: | 1 |
| Number of M-subfunctions: | 29 |
| Number of MEX-functions: | 6 |
| Clock precision: | 0.00000006 s |
| Clock Speed: | 1683 Mhz |

Figure. 12.4(c) MMSE Profile Plot Summary for 1, 4, 32, and 64 users

## 12.4 PROBABILITY DATA ASSOCIATION – RESULTS

Basic approach of a Probability Data Association Algorithm (PDA) employed in optimizing a specific problem defined by an objective function. Implementation of PDA is thought to be done for Multi-user detection in synchronous CDMA. Bit Error Rate performance of the system for different number of users and various number of modulation techniques like QPSK, 16-QAM, 64-QAM, GMSK etc. along with AWGN channel and Raleigh Faded environment is compared.

Here simulation Results for 16-QAM under influence of AWGN and Rayleigh faded environment using Walsh code is shown for comparison with ZF and MMSE mentioned above.

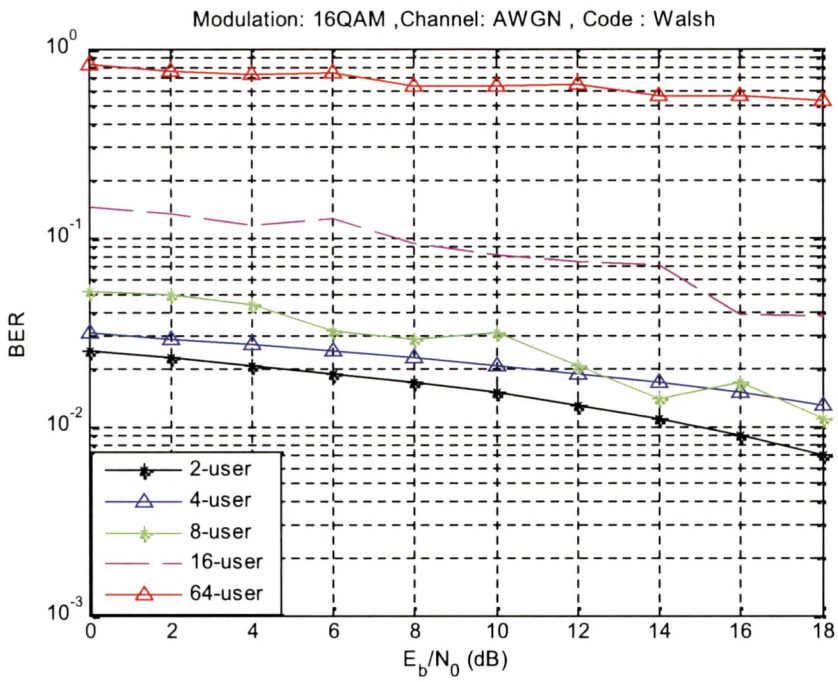


Figure. 12.5(a) Performance of the BER versus Eb/E0 (dB) for AWGN

| Function name | Calls | Total Time | Self Time* | Total Time Plot (dark b and = self time) |
|---|---|---|---|---|
| qamdemod | 940 | 22.469 s | 0.078 s | |
| genqamdemod | 940 | 21.297 s | 21.297 s | |
| de2bi | 940 | 2.313 s | 2.313 s | |
| comm\private\squareqamconst | 1880 | 2.219 s | 2.047 s | |
| awgn | 940 | 1.594 s | 0.328 s | |
| qammod | 940 | 1.578 s | 0.250 s | |
| wgn | 940 | 1.266 s | 1.266 s | |

Figure. 12.5(b) Profile Plot for 16-QAM - AWGN

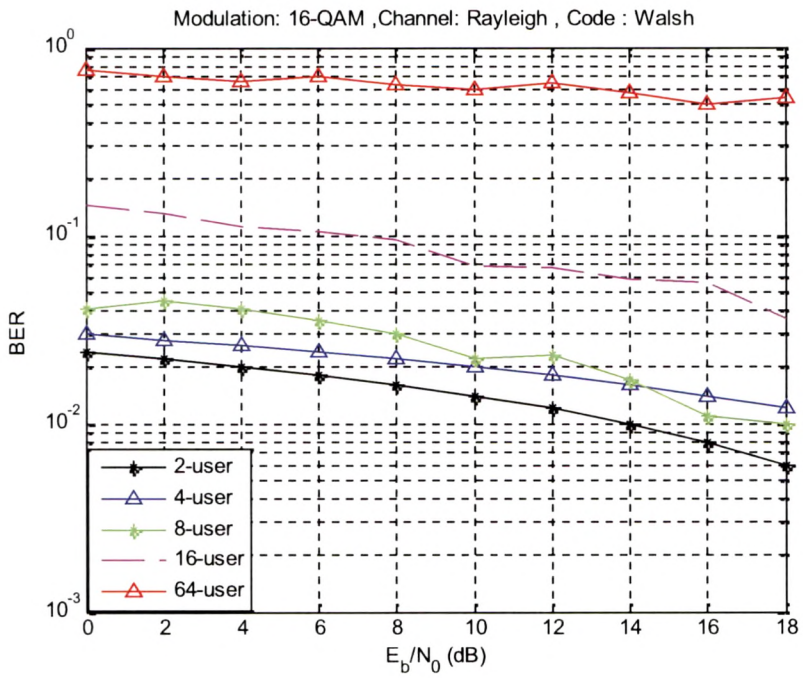


Figure. 12.6(a) Performance of the BER versus Eb/E0 (dB) for RAYLEIGH

| Function name | Calls | Total Time | Self Time* | Total Time Plot (dark band = self time) |
|---|---|---|---|---|
| channel.rayleigh (Opaque-function) | 10340 | 41.875 s | function is recursive | |
| channel.multipath.filter | 940 | 23.172 s | function is recursive | |
| channel.multipath.filterblock | 2820 | 22.328 s | 0.734 s | |
| rayleighchan | 940 | 18.688 s | 0.047 s | |
| channel.channelfilter.filter | 2820 | 14.063 s | 13.906 s | |
| qamdemod | 940 | 10.766 s | 0.047 s | |
| channel.multipath.reset | 1880 | 10.109 s | function is recursive | |

Figure. 12.6(b) Profile Plot for 16-QAM - RAYLEIGH

## 12.5 PDA PERFORMANCE

Based on the above simulation results of BER V/S Eb/No for different number of users ( 2,4,8,16, and 64 users), we have seen that the Performance of the Probability Data Association Algorithm is considerably better than counter algorithms discussed (Zero Forcing, MMSE) because of its powerful principle of estimating the best solution to given problem.

As seen from BER v/s Eb/No results obtained for different algorithms we have observe that,

- BER for ZF = 0.6 for 16-users at 0 dB Eb/Eo value.
- BER for MMSE = 0.2 for 16-users at 0 dB Eb/Eo value
- BER for PDA = 0.145 for 16-users at 0 dB Eb/Eo value using 16-QAM modulation technique and under influence of AWGN channel using Walsh code.
- BER for PDA = 0.146 for 16-users at 0 dB Eb/Eo value using 16-QAM modulation technique and under influence of Rayleigh fading channel using Walsh code.
- We also observe that BER performance of the PDA algorithm for 16-user is comparatively better at higher values of Eb/Eo then ZF and MMSE algorithms.

From the timing diagram performance of the system model introduced for different parameters is better compared to ZF and MMSE algorithms.

## 12.6 SUMMARY

This chapter explores the performance of PDA algorithm in comparison with ZF and MMSE algorithm. It also shows that the BER curve for 16-QAM modulation technique gives better Eb/Eo as compared to ZF & MMSE algorithm which incorporates the system capacity requirements.