10

# COMPARISION OF GA WITH ZF & MMSE FOR MUD FOR CDMA BASED SYSTEMS

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## 10.1 INTRODUCTION

CDMA is a multiplexing technique whereby several independent users simultaneously access a multi-point-to-point channel by modulating pre-assigned signature waveforms. One of the key problems in CDMA systems is the detrimental effect of MAI to the performance of the receivers and the overall communication system. The problem is particularly severe in mobile communications. Multi-user detection techniques can be used to alleviate the performance degradations due to MAI.

## 10.1 ZF-PREVIOUS RESULTS

A ZF linear MUD or simply ZF MUD, attempts to completely eliminate the MAI in a DS-CDMA system without regard 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.

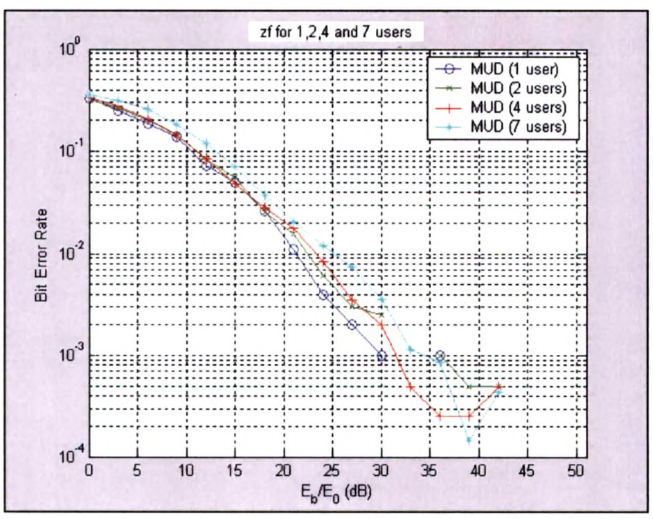


Figure 10.1(a): ZF Performance of the BER versus $E_b/E_0$ (dB) for 1,2, 4 and 7 users

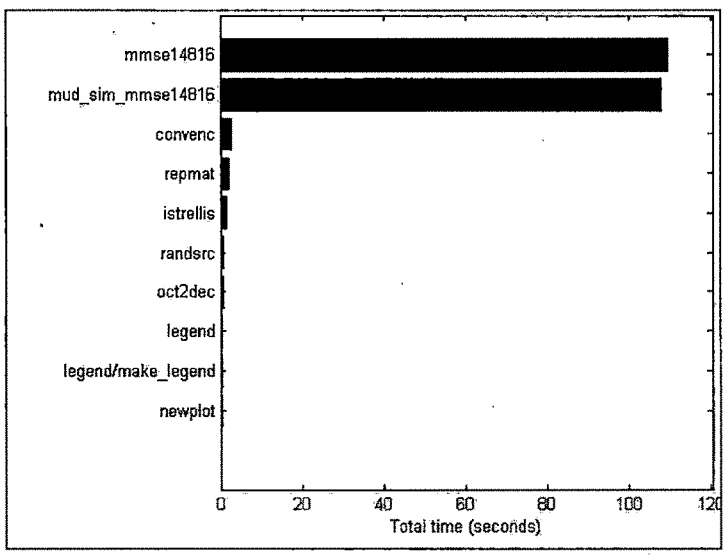


Figure 10.1(b): ZF Profile Plot for the 1,4,8 and 16 users

**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 10.1(c): ZF Profile Report summary for 1,4,8 and 16 users

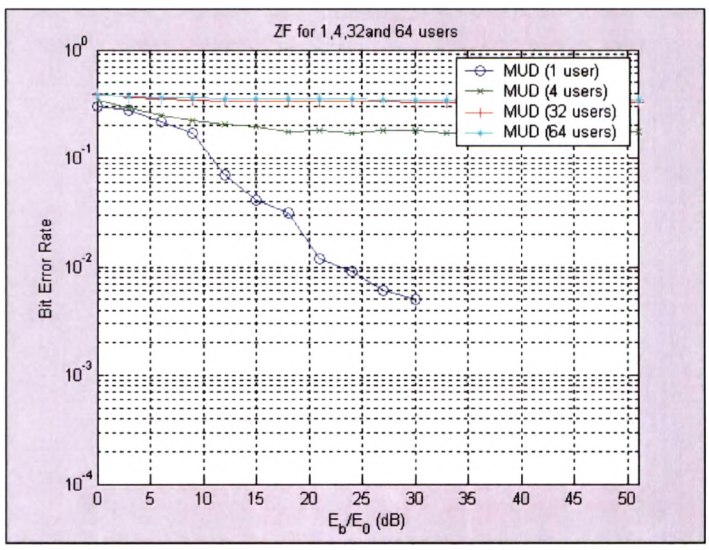


Figure 10.2(a): ZF Performance of the BER versus $E_b/E_0$ (dB) for 1,4,32 and 64 users

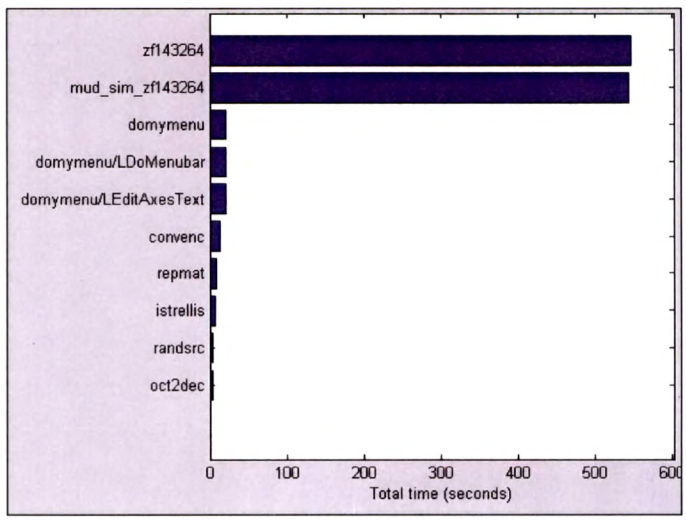


Figure 10.2(b): ZF Profile Plot for the 1,4,32 and 64 users

**MATLAB Profile Report: Summary**

*Report generated 26-Mar-2006 02:38:23*

| | |
|---|---|
| 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 10.2(c): ZF Profile Report summary for 1,4,32 and 64 users

## 10.3 MMSE-PREVIOUS 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.

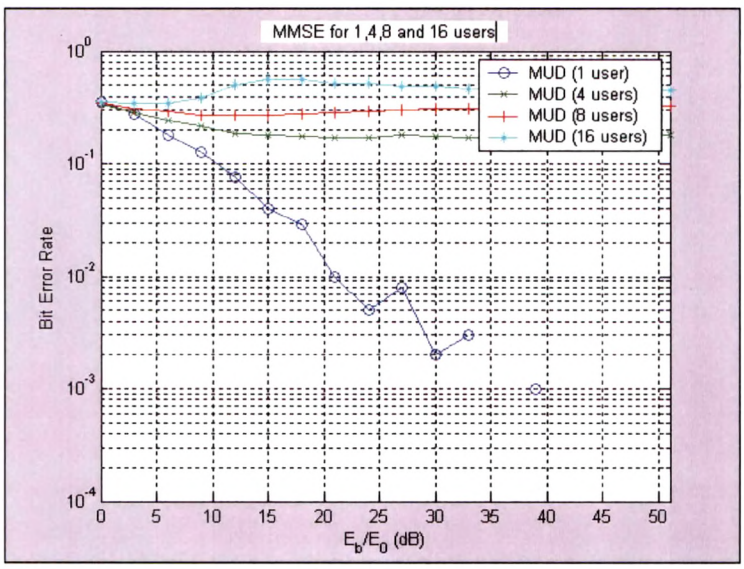


Figure 10.3(a):MMSE Performance of the BER versus $E_b/E_0$ (dB) for 1,4,8 and 16 users

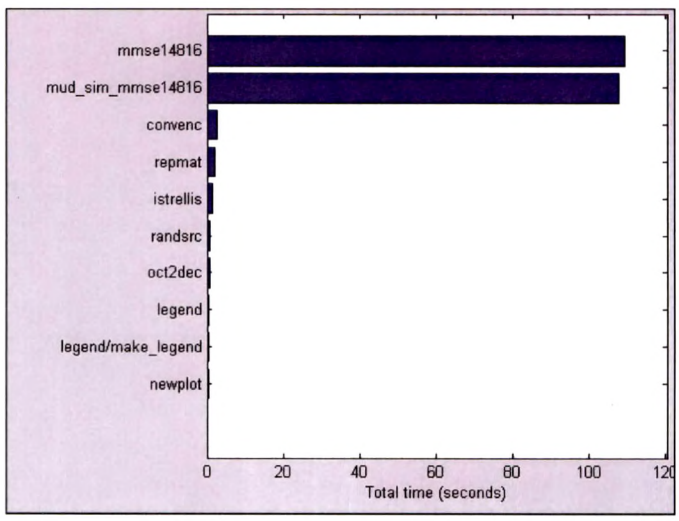


Figure 10.3(b):MMSE Profile Plot for the 1,4,8 and 16 users

**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 10.3(c): MMSE Profile Report summary for 1,4,8 and 16 users

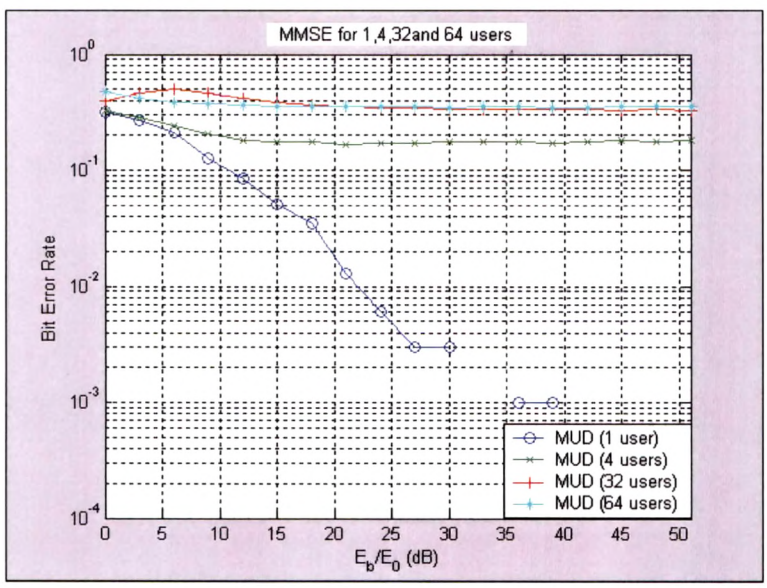


Figure 10.4(a): MMSE Performance of the BER versus $E_b/E_0$ (dB) for 1,4,32 and 64 users

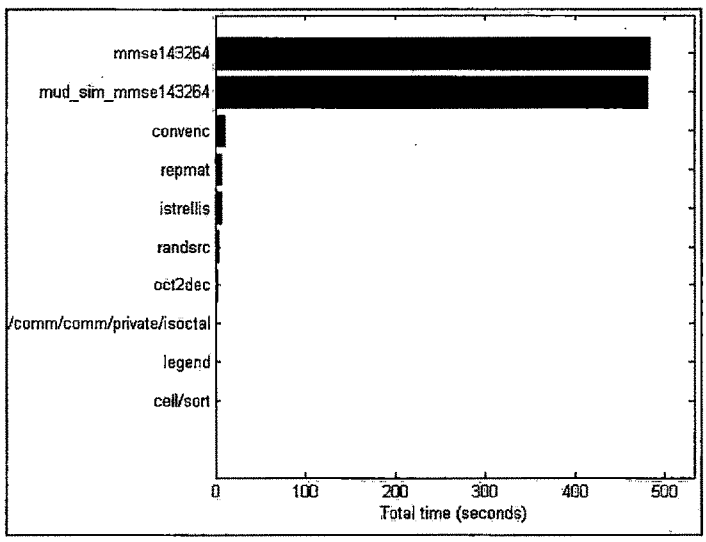


Figure 10.4(b):MMSE Profile Plot for the 1,4,32 and 64 users

**MATLAB Profile Report: Summary**

*Report generated 26-Mar-2006 10:52:52*

| | |
|---|---|
| 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 10.4(c): MMSE Profile Report summary for 1,4,32 and 64 users

## 10.4 GENETIC ALGORITHMS RESULTS

Basic approach of a Genetic Algorithm (GA) employed in optimizing a specific problem defined by an objective function. Implementation of GA is thought to be done for Multi-user detection in CDMA. BER Performance of the system for different number of Users and Modulation techniques for two types of channels AWGN and Raleigh Fading is compared.

Here simulation Results for 16-QAM under influence of AWGN and Rayleigh using Walsh code is shown for comparison.

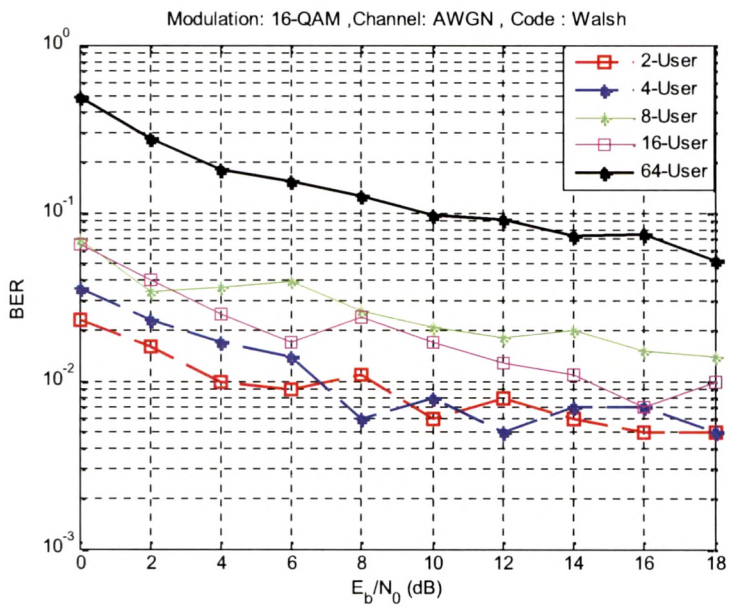


Figure 10.5(a): BER for Walsh Code : AWGN

| Function name | Calls | **Total Time** | Self Time* | Total Time Plot (dark band = self time) |
|---|---|---|---|---|
| awgn | 320 | 7.359 s | 1.094 s | |
| wgn | 320 | 6.266 s | 6.266 s | |
| legend | 1 | 0.844 s | 0.016 s | |
| legend>make_legend | 1 | 0.828 s | 0.000 s | |
| newplot>ObserveAxesNextPlot | 5 | 0.219 s | 0.016 s | |
| graphics\private\clo | 1 | 0.172 s | 0.016 s | |
| gcf | 19 | 0.063 s | 0.063 s | |

Figure 10.5(b): Profile Summary *Generated 03-May-2007 14:57:53: AWGN*

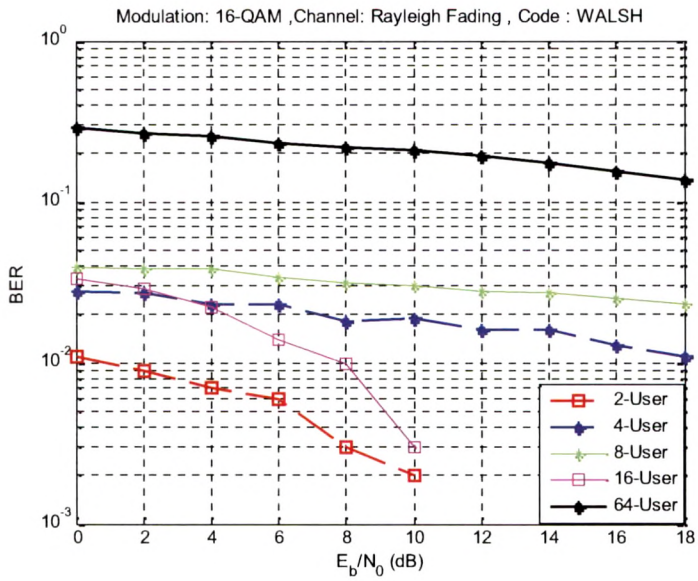


Figure 10.6(a): BER for Walsh Code : Rayleigh

| Function name | Calls | **Total Time** | Self Time* | Total Time Plot (dark band = self time) |
|---|---|---|---|---|
| channel.rayleigh (Opaque-function) | 1560 | 1099.016s | function is recursive | |
| channel.multipath.filter | 320 | 1097.21 s | function is recursive | |
| channel.multipath.filterblock | 680 | 1071.734 s | 8.469 s | |
| channel.channelfilter.filter | 680 | 975.484 s | 975.359 s | |
| channel.interpfilter.filter | 680 | 86.625 s | 0.109 s | |
| ...l.interpfilter.filter>polyphaseFilter | 680 | 86.484 s | 73.109 s | |
| ...el.multipath.filter>ComputeStatistics | 320 | 15.297 s | 2.938 s | |

Figure 10.6(b): Profile Summary *Generated 11-May-2007 16:16:16 : Rayleigh*

## 10.5 SUMMARY

From the simulation results of BER V/S Eb/No for different users(2,4,8,16,64) we have seen that the Performance of the Genetic 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 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 GA = 0.04 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 GA = 0.65 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 GA 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. So we can say that Genetic Algorithms converges easily and is less complex.

So we can say that the Performance of the Genetic Algorithm is considerably better than other currently available algorithms such as Zero Forcing, MMSE for MUD in CDMA based wireless communication systems.