BSS vs Combiner BER Comparison

This tech note compares the BER improvement for various combining algorithms. The classic Optimal Ratio Combiner (ORC) is compared to a best source selector picking the Best Source (BS) and a best source selector using straight Majority Vote (MV), GDP Bit-by-Bit (BBB) Weighted Majority Vote (WMV) and RCC/IRIG Frame-by-Frame (FBF) WMV. The comparison is done with 2 signals and with 3 signals, the most common operational scenario, for various combinations of relative signal levels. From a BER perspective the optimal ratio combiner provides the best performance followed by GDP BBB WMV then IRIG FBF WMV. Straight MV is sometimes better than the BS and sometimes worse.

2 Signal tests

The BERs for two signals with relative power levels of 0dB, 3dB, and 6dB are compared for the ORC, GDP WMV, IRIG WMV and BS. For 2 signals there is no MV, ORC provides the most gain, GDP WMV is almost as good as ORC and IRIG WMV provides no gain over the BS.

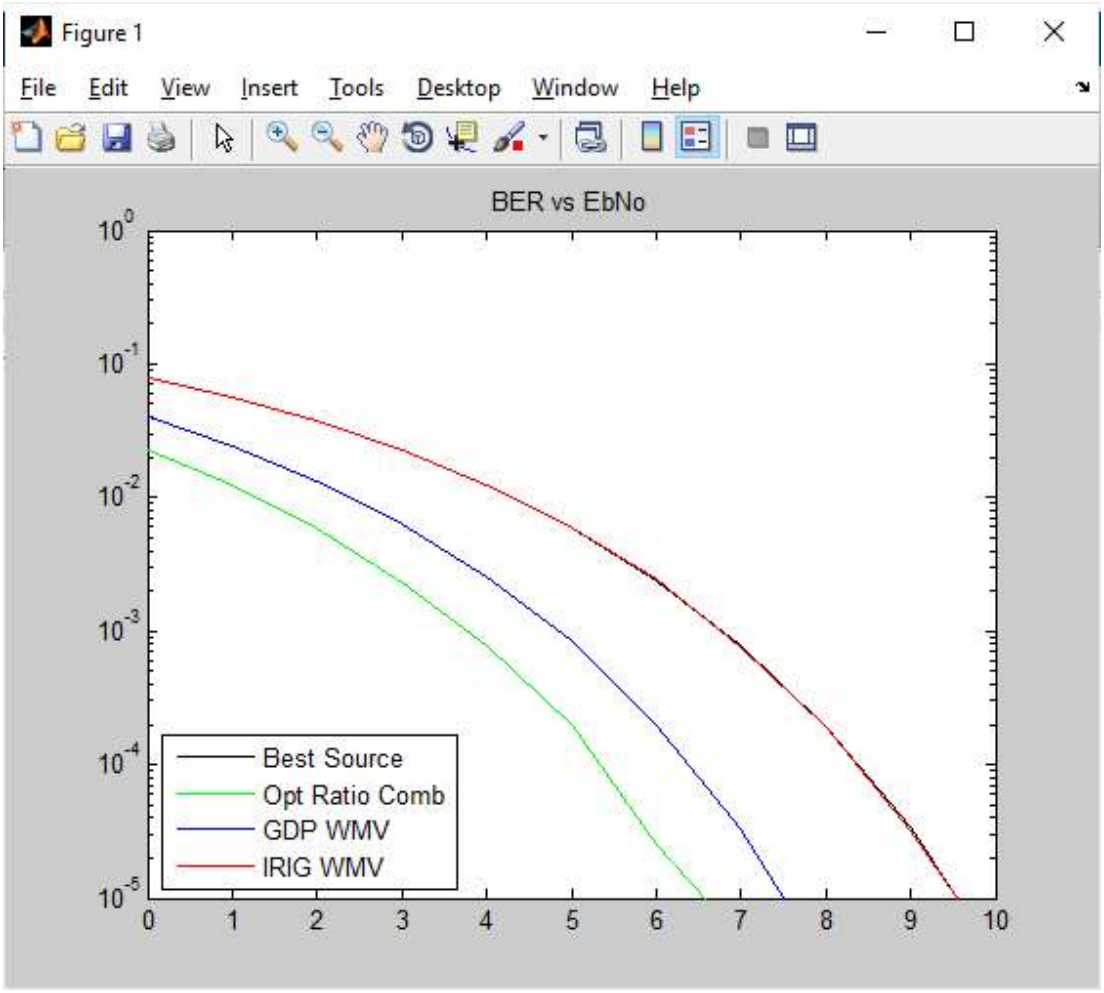

Figure 1, BER for 2 Equal Signals

For the case of 2 equal power signals, Figure 1, ORC provides 3dB of combining gain, as expected, GDP WMV provides 2 dB of gain and IRIG WMV is equal to the BS.

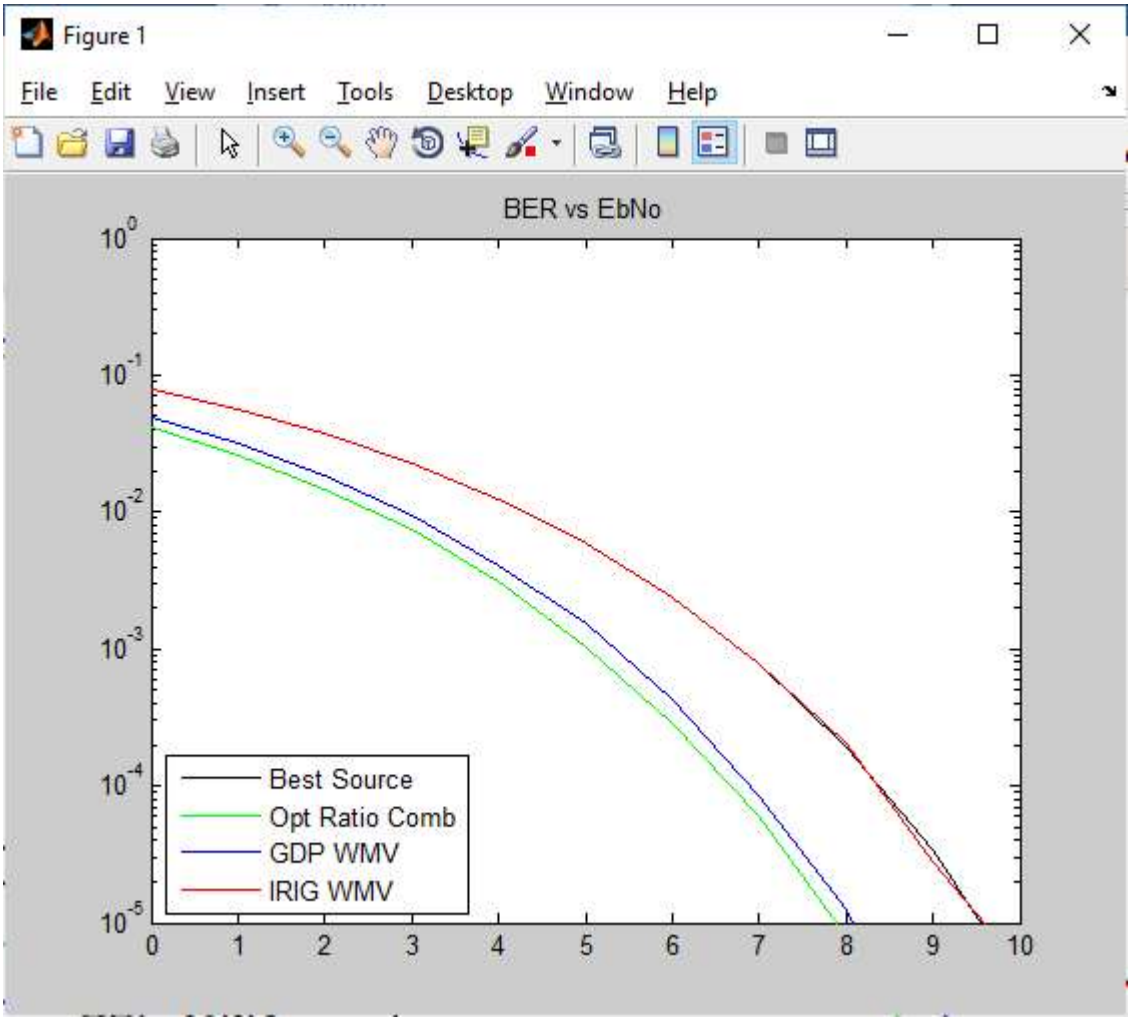

Figure 2, BER for 2 Signals, EbNo1-EbNo2 = 3dB

For 2 signals, one signal with a 3dB worse EbNo that the other, Figure 2, ORC provides over 1.5dB of combining gain, GDP WMV provides nearly 1.5dB and IRIG WMV is equal to the BS.

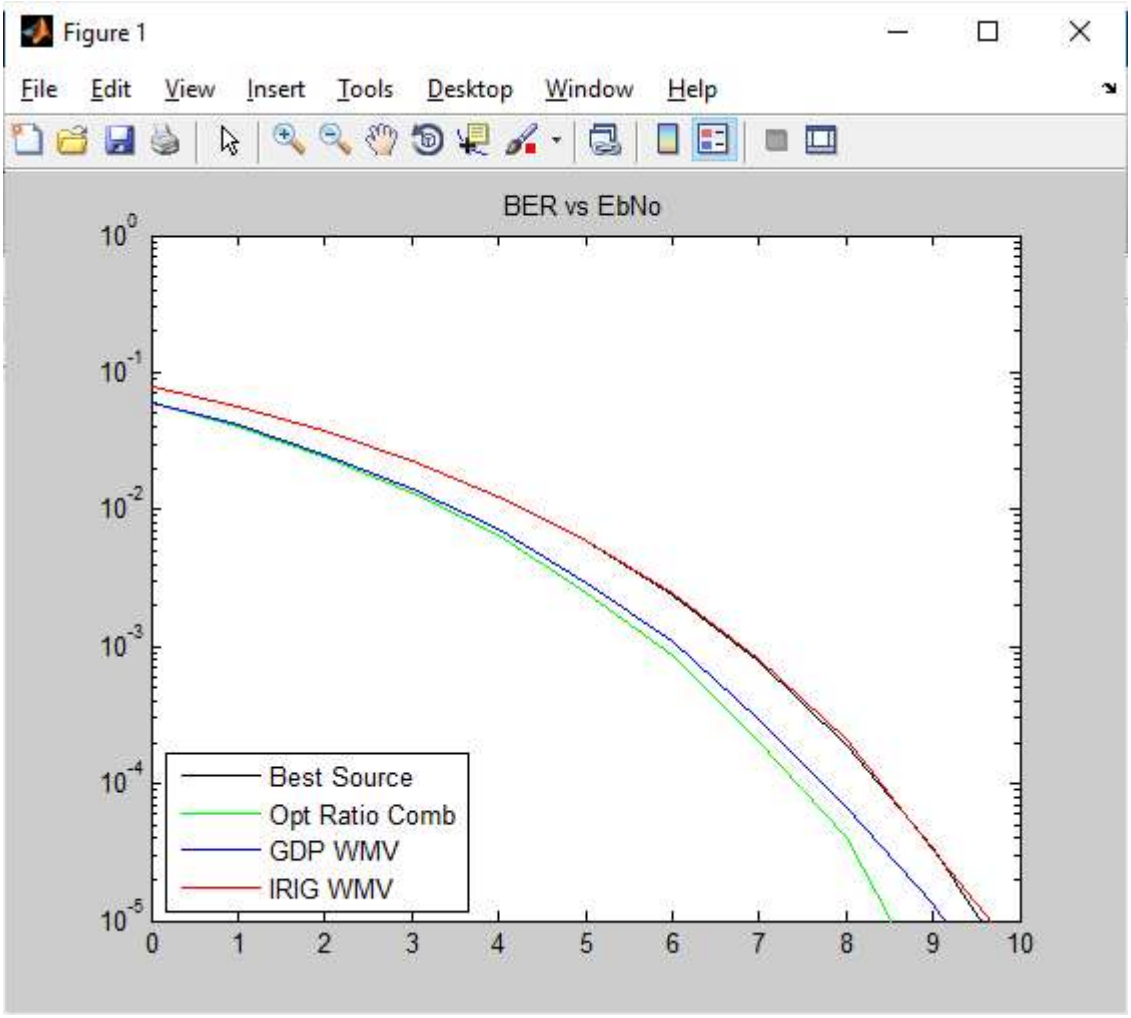

Figure 3, BER for 2 Signals, EbNo1-EbNo2 = 6dB

For 2 signals, one signal with a 6dB worse EbNo that the other, Figure 3, ORC provides around 1dB of combining gain, GDP WMV provides around .5dB and IRIG WMV is equal to the BS.

3 Signal Tests

The BERs for three signals with various relative power levels are compared for the ORC, GDP BBB WMV, IRIG FBF WMV and BS. The comparison is made for equal power levels, two of the 3 signals with equal lower power levels, one of the 3 signals with a lower power level, and all 3 signals with different power levels. As for 2 signals, ORC provides the most gain. GDP BBB WMV is almost as good as ORC, and IRIG FBF WMV ranks 3rd being better than or equal to the BS.

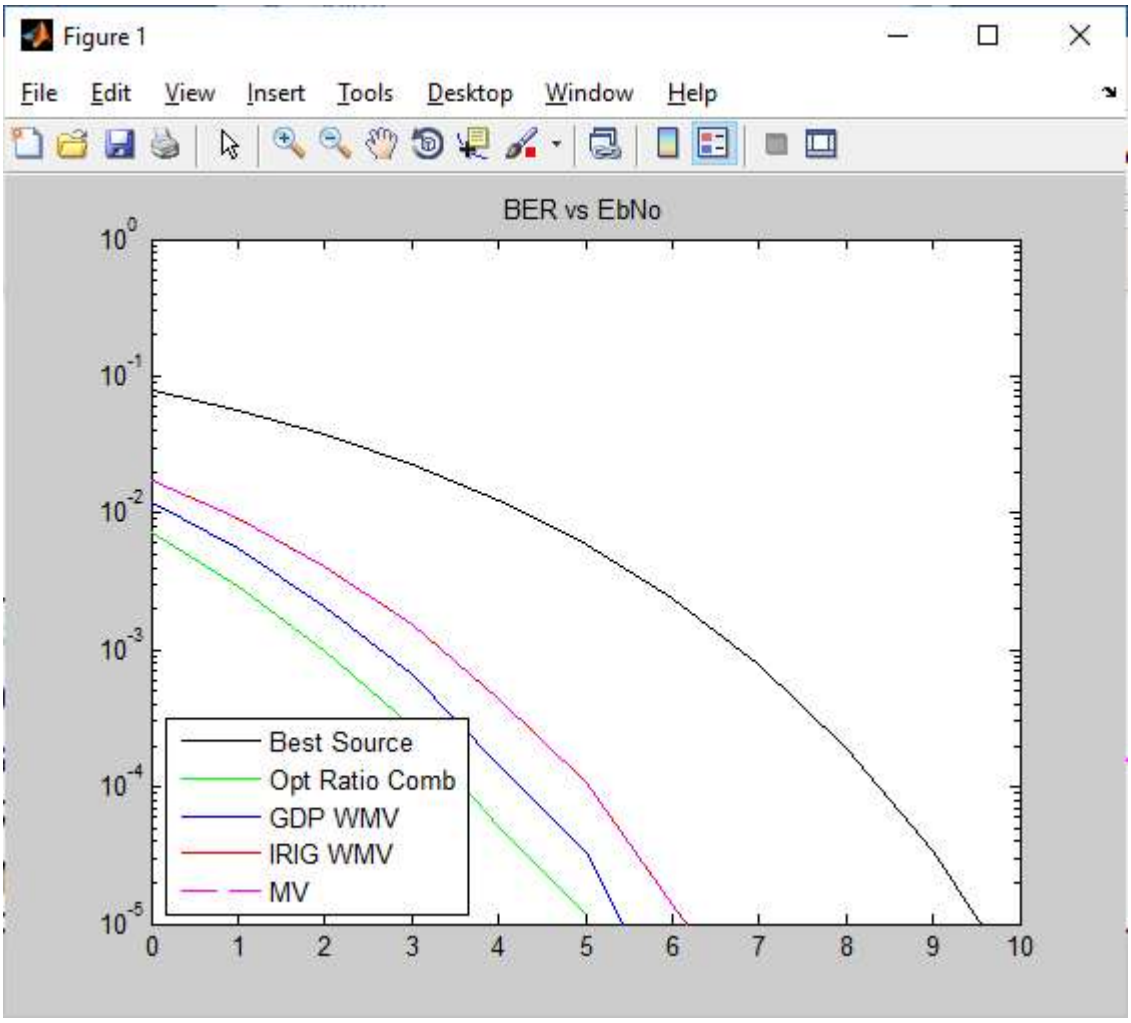

Figure 4, BER for 3 Equal Signals

For 3 signals with equal power, ORC provides over 4.5dB of combining gain, as expected. GDP WMV provides 4dB and IRIG WMV is equal to MV providing about 3.5dB gain over the BS.

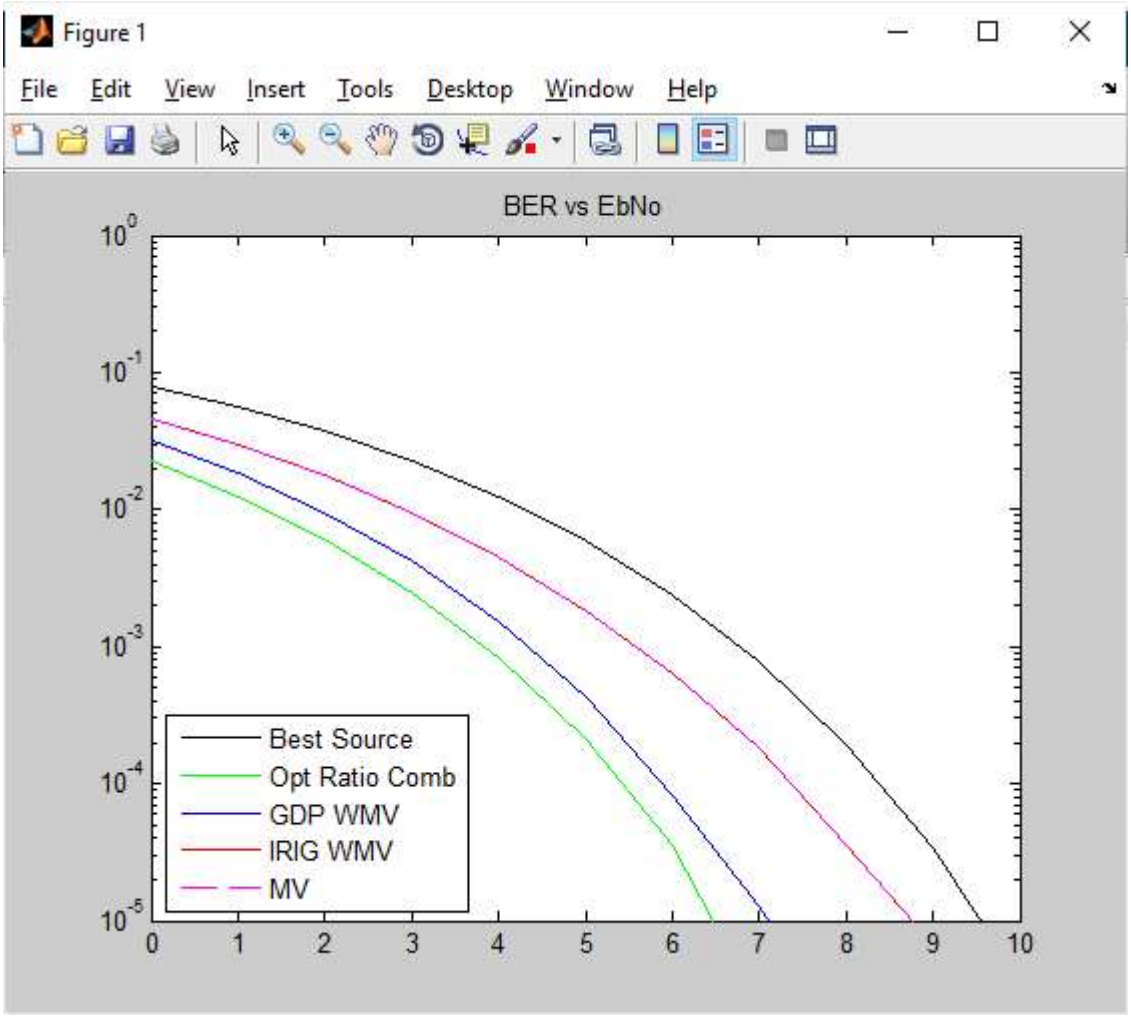

Figure 5, BER for 3 Signals, EbNo1-EbNo2 = 3dB, EbNo1-EbNo3 = 3dB

For 3 signals, two of the signals with 3dB worse EbNo that the first signal, Figure 5, ORC provides around 3dB of combining gain, GDP WMV provides around 2.5dB and IRIG WMV is equal to MV providing nearly 1dB gain over the BS.

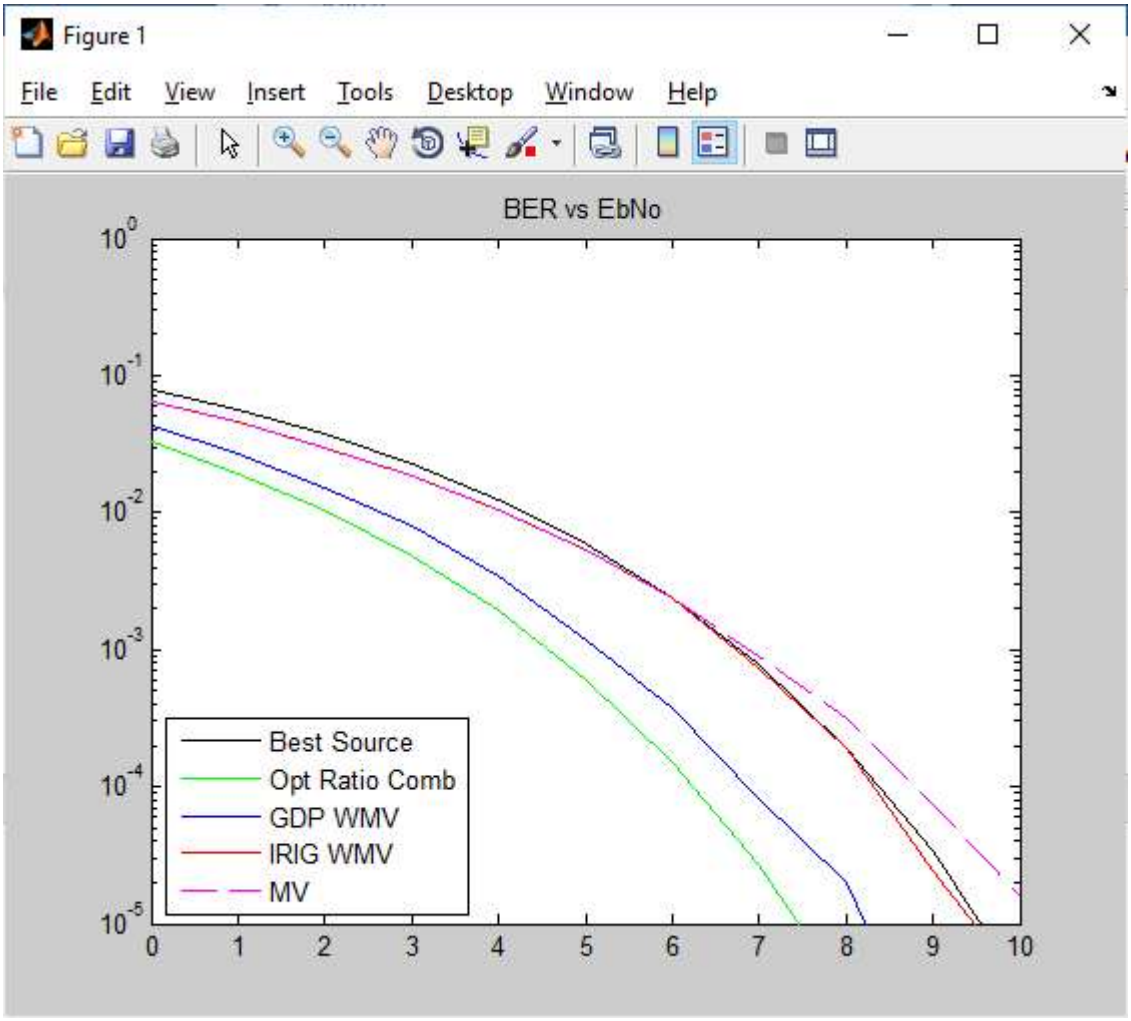

Figure 6, BER for 3 Signals, EbNo1-EbNo2 = 4.5dB, EbNo1-EbNo3 = 4.5dB

For 3 signals, two of the signals with 4.5dB worse EbNo than the first signal, Figure 6, ORC provides around 2dB of combining gain and GDP WMV provides around 1dB. IRIG WMV is equal to and provides no gain over the BS. MV is worse than the BS.

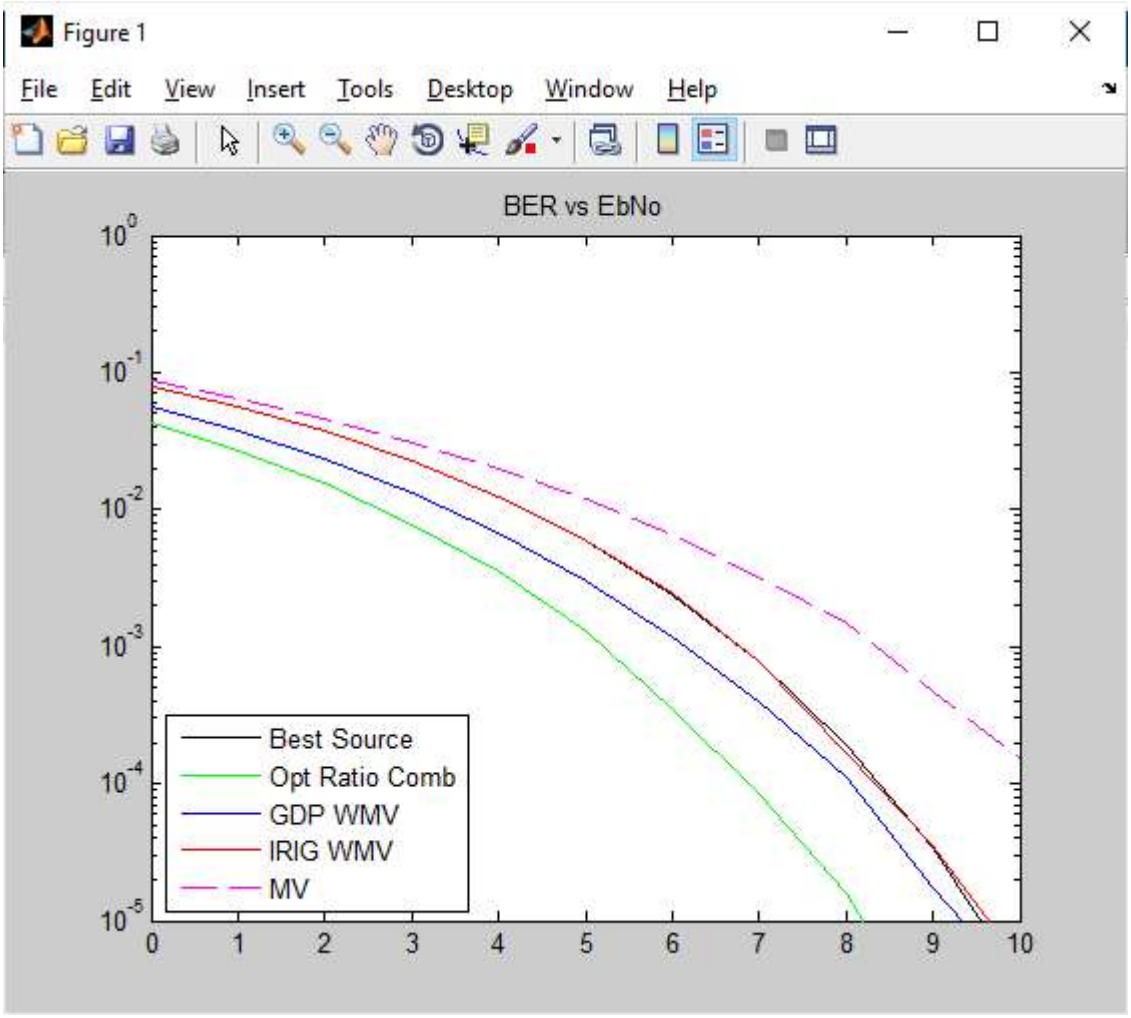

Figure 7, BER for 3 Signals, EbNo1-EbNo2 = 6dB, EbNo1-EbNo3 = 6dB

For 3 signals, two of the signals with 6dB worse EbNo than the first signal, Figure7, ORC provides over 1dB of combining gain and GDP WMV provides around .5dB. IRIG WMV is equal to and provides no gain over the BS. In this case MV is about 2dB worse that the BS.

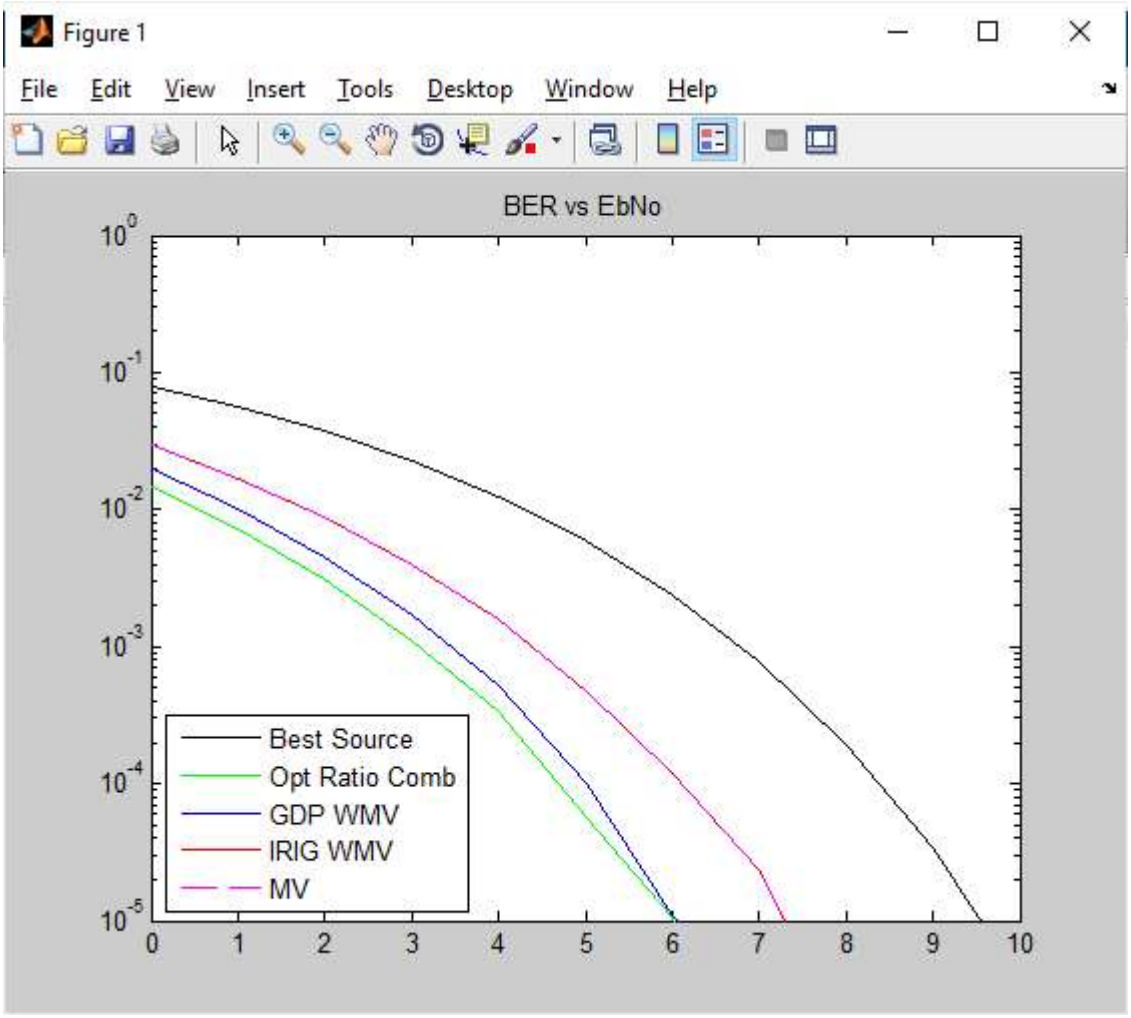

Figure 8, BER for 3 Signals, EbNo1=EbNo2, EbNo1-EbNo3 = 3dB

For 3 signals, one of the signals with 3dB worse EbNo that the other 2, Figure 8, ORC provides around 3.5dB of combining gain, GDP WMV provides around 3dB and IRIG WMV is equal to MV providing around 2dB gain over the BS.

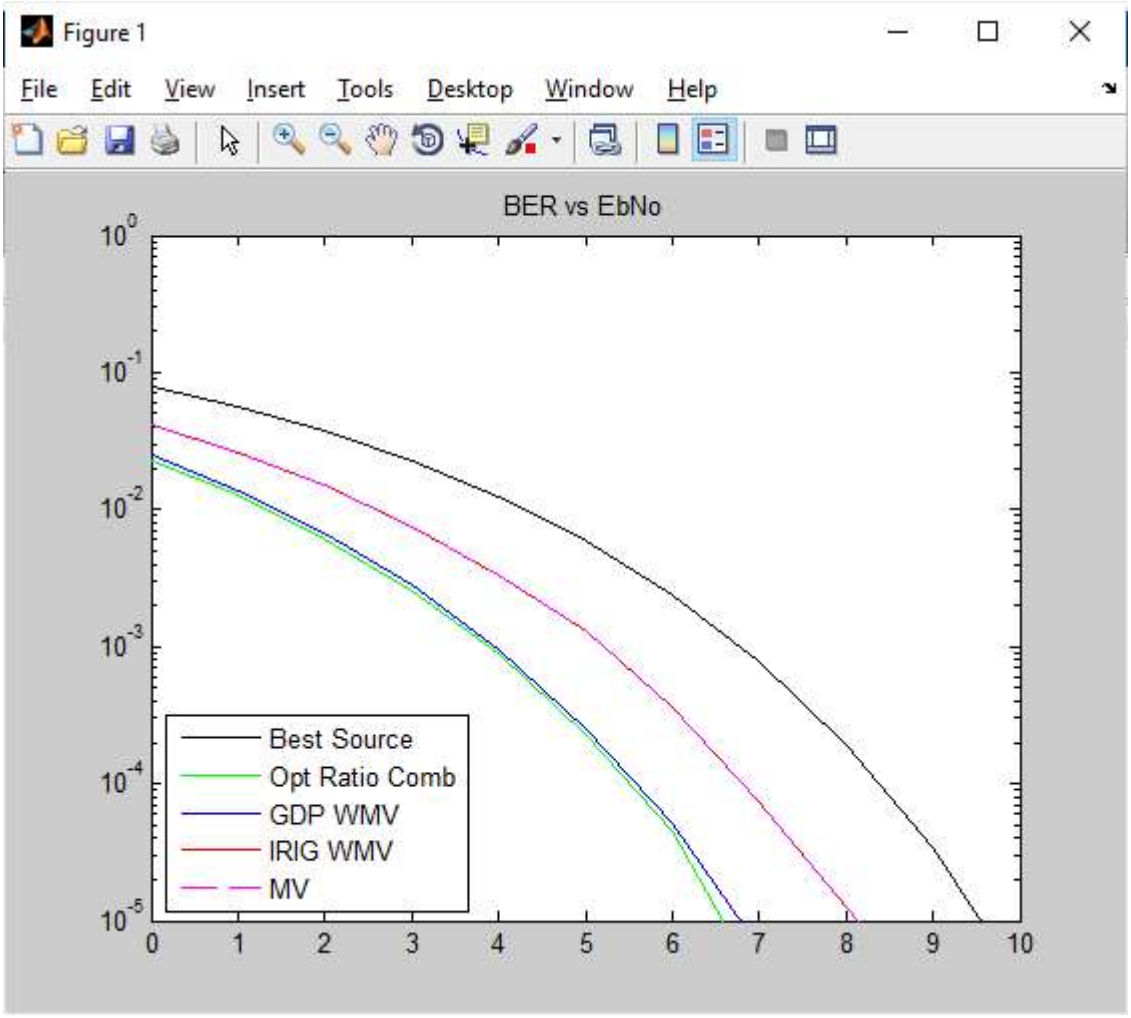

Figure 9, BER for 3 Signals, EbNo=EbNo2, EbNo1-EbNo3 = 6dB

For 3 signals, one of the signals with 6dB worse EbNo than the other 2, Figure 9, ORC and GDP WMV provide almost 3dB of combining gain. IRIG WMV is equal to MV providing around 1.5dB gain over the BS.

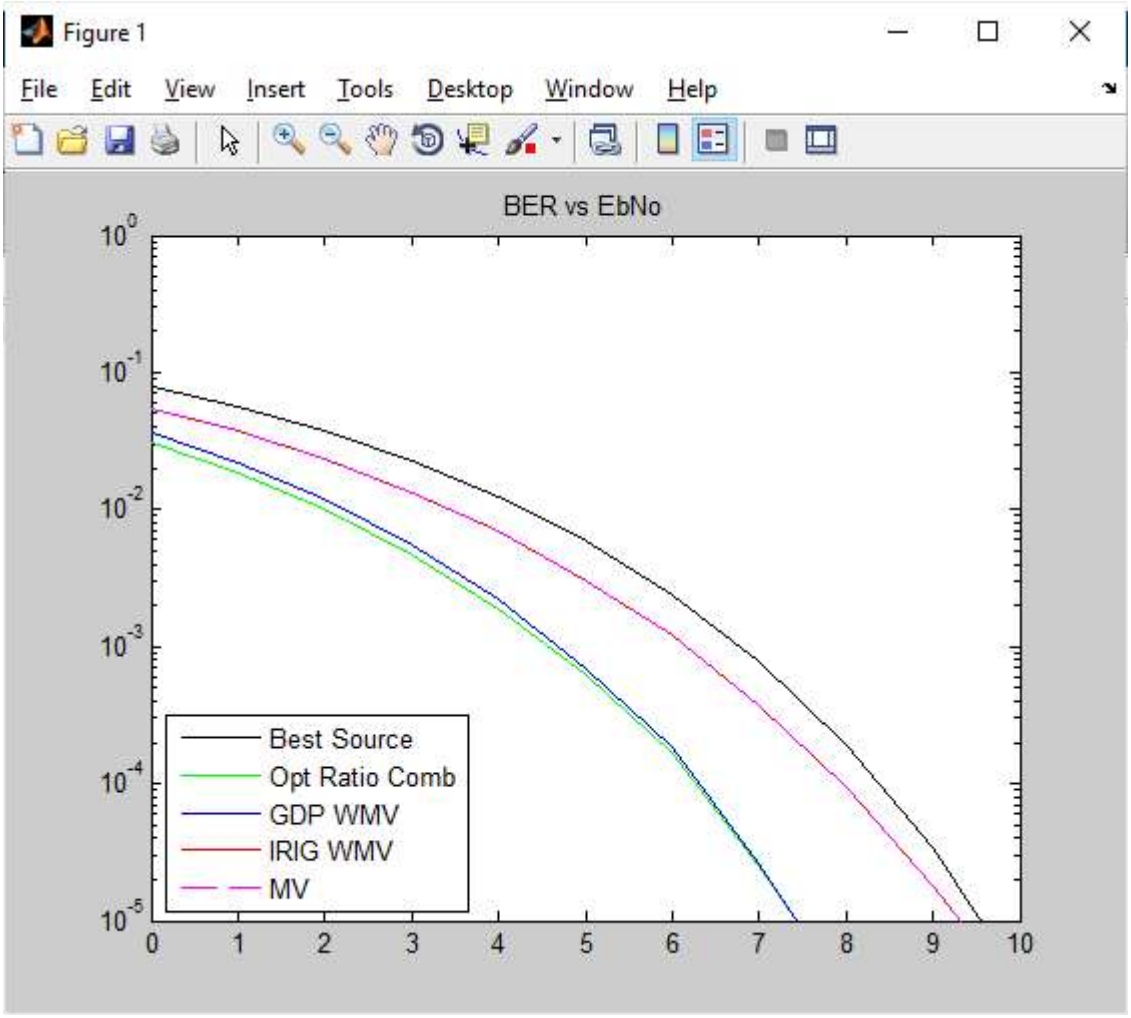

Figure 10, BER for 3 Signals, EbNo1-EbNo2 = 2dB, EbNo1-EbNo3 =6dB

For 3 signals, the second signal with 2dB worse EbNo, and the third signal with 6dB worse EbNo, than the first signal, Figure 10, ORC and GDP WMV provide over 2dB of combining gain. IRIG WMV is equal to MV and provides about .5dB gain over the BS.

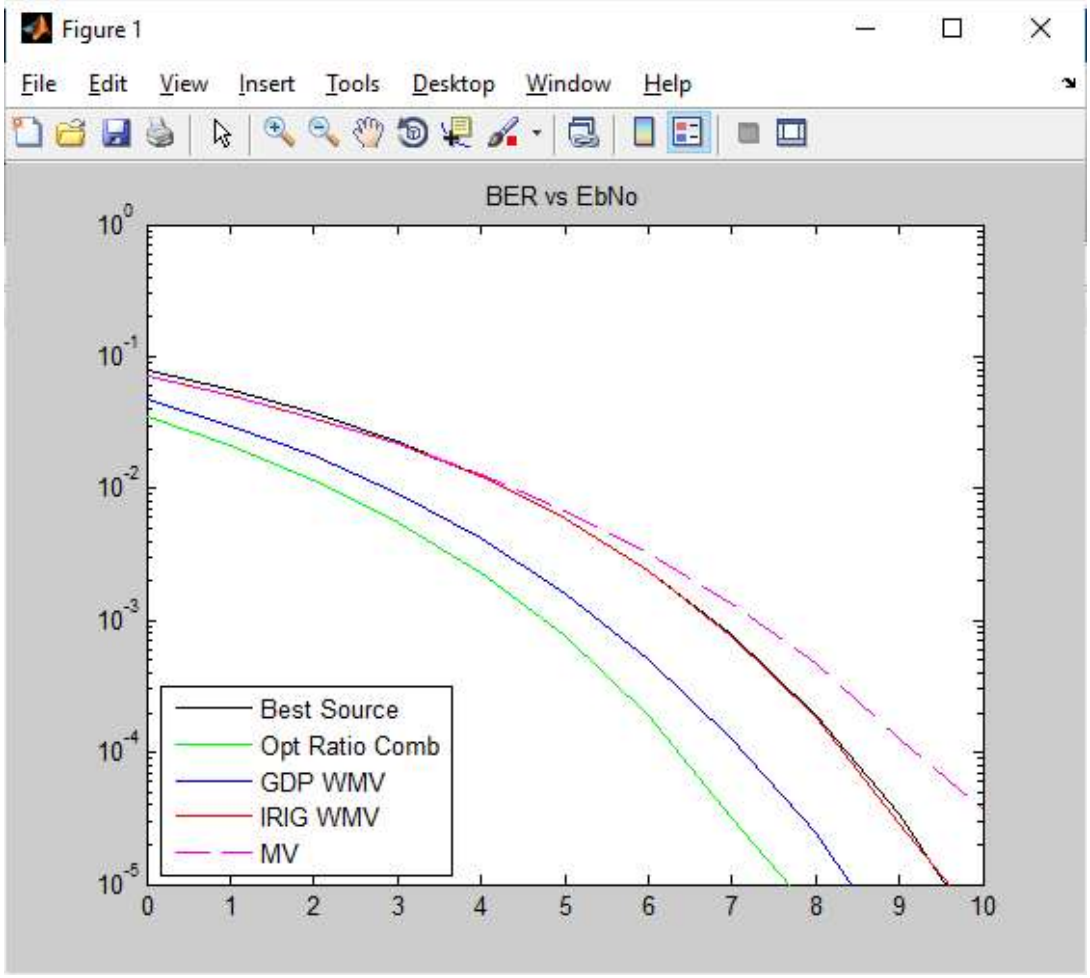

Figure 11, BER for 3 Signals, EbNo1-EbNo2 = 4dB, EbNo1-EbNo3 = 6dB

For 3 signals, the second signal with 4dB worse EbNo, and the third signal with 6dB worse EbNo than the first signal, Figure 11, ORC provides around 2dB of combining gain and GDP WMV provides around 1dB. IRIG WMV is equal to and provides no gain over the BS. In this case MV is about 1dB worse that the BS

Summary

The both the 2 signal and the 3 signal case the ORC provides the best performance relative to the BS; for 3 equal signal over 4.5 dB better. The performance of GDP BBB WMV is typically within 1dB of the ORC; for 3 equal signal over 4 dB better than the BS. For 2 signals, both ORC and GDP BBB WMV provide gain over the BS; for equal signals the gain is 3dB and 2dB respectively. For 2 signals, IRIG FBF WMV is always equal to the BS. For 3 signals IRIG FBF WMV is equal to or better than the BS and always worse that GDP BBB WMV, typically by more than 1dB. Straight MV is either equal to IRIG FBF WMV or worse than the BS.

For 3 signals, IRIG FBF WMV is better than the BS, and MV is equal to the BS, if two of the signals have EbNos worse than the third by less than around 4dB. IRIG FBF WMV is equal to the BS, and MV is worse than the BS, if two of the signals have EbNos worse than the third by more than around 4dB. ORC and GDP BBB WMV are always better than the BS.