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Title: Further Results on CPICH Interference Cancellation as A Means for Increasing DL Capacity
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1. Introduction

This contribution presents further results on the proposal described in [1] for the UE to cancel multiple access interference (MAI) associated with the pilot channels of the active and neighboring base stations. The results in [1] and in the current contribution indicate that CPICH cancellation can increase capacity by 10% or more. In addition, the price in computational complexity for this procedure is relatively small, (see Appendix in [1]). Other advantages of pilot MAI cancellation are listed in the conclusion. The current contribution considers the ITU Vehicular and Pedestrian channel models proposed in [2] for the evaluation of 3G proposals, as well as two 4-base station configurations.

2. Simulation Assumptions

The channel models used for the simulations presented here are the ITU Channel A and B models for Vehicular and Pedestrian environments described in [2]. The tapped-delay-line parameters for each channel are described in Tables 1 and 2 in the Appendix. As in [2], we assume 3 km/hr UE velocity for the Pedestrian models, and 120 km/hr UE velocity for the Vehicular models. The number of RAKE fingers used in the receiver is recorded in Table 3. Note that the difference in results between using 1 and 2 fingers for the Pedestrian Channel A environment was negligible. Also note that we assume that the channel taps are not known a priori at the receiver, and thus, a channel tap estimator was used in all simulation examples.

We consider two configurations of four base stations, as defined in Tables 4 and 5, with all users having equal power. In [1] we considered a 1-base station configuration (e.g., all users near the center of the cell), and a 2-base station configuration, where the interfering base station was strongest. Here we consider two 4-base station configurations, where (1) all users are significantly to moderately interfered with by the four base stations, (Table 4), and (2) all users are moderately to lightly interfered with by the four base stations, (Table 5). The data rates for the voice and data users are 12.2 kbps and 64 kbps, respectively [3]. The forward error correction coding used is Convolutional for the voice users and Turbo for the data users [3]. The delay profiles used for each base station are identical (see Tables 1 and 2), but shifted in time by 10 chip periods (2604 ns, see also [3, Section 8.6.3]). The Ec/Ior values for the P-CCPCH, SCH, and PICH channels were set as described in [3, Annex 3 C.3.2], and a noise figure of 8.0 dB was assumed.

For both base station configurations, we assume that the three neighboring base stations are not maximally loaded, and thus, the pilot power allocation will be larger. It is in fact unlikely that all base stations would be transmitting at peak power at the same time. We assume a P-CPICH_Ec/Ior value of –8.5 dB for the pilots of the neighboring base stations, which corresponds to approximately a 71% load. The target base station is assumed to be transmitting at peak capacity with P-CPICH_Ec/Ior set at –10 dB in accordance with [3, Annex C.3.2].

3. Simulation Results

Results are plotted for the BLER performance as a function of the number of equal power users for each simulation environment defined in Section 2. Curves are provided for performance both with and without pilot MAI cancellation. In all figures, the pilot MAI cancellation method provided approximately 10%-15% improvement in capacity. Note that the capacity results for the slow fading Pedestrian channels are particularly low, since for purposes of clarity and comparability the simulations do not incorporate downlink power control.

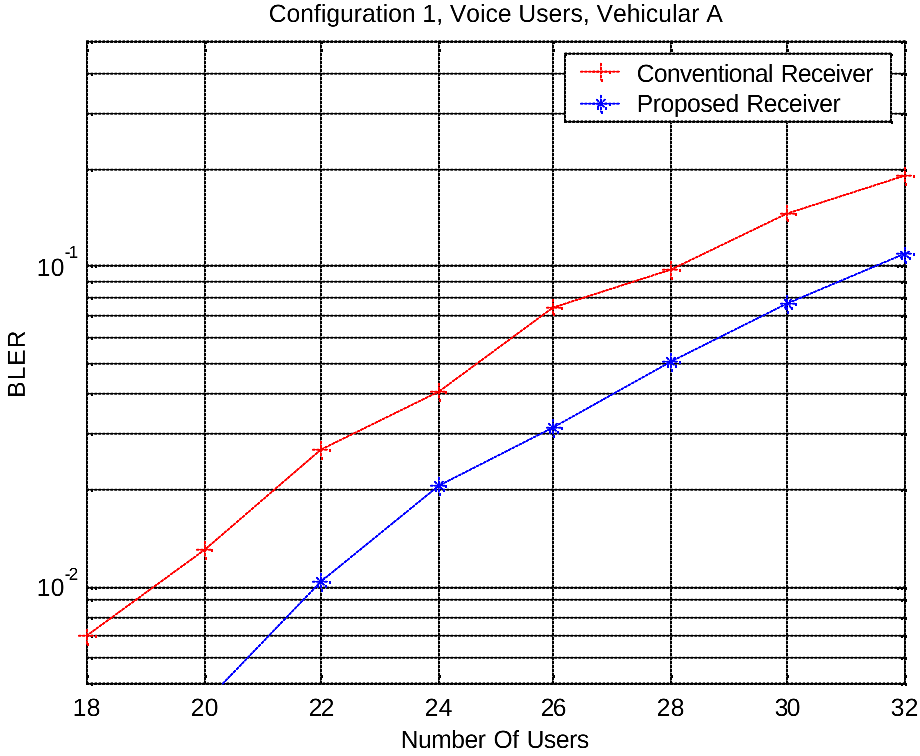

Figure 1: Performance with & without pilot MAI cancellation – Configuration 1 (Table 4), Voice Users, ITU Vehicular Channel A Model.

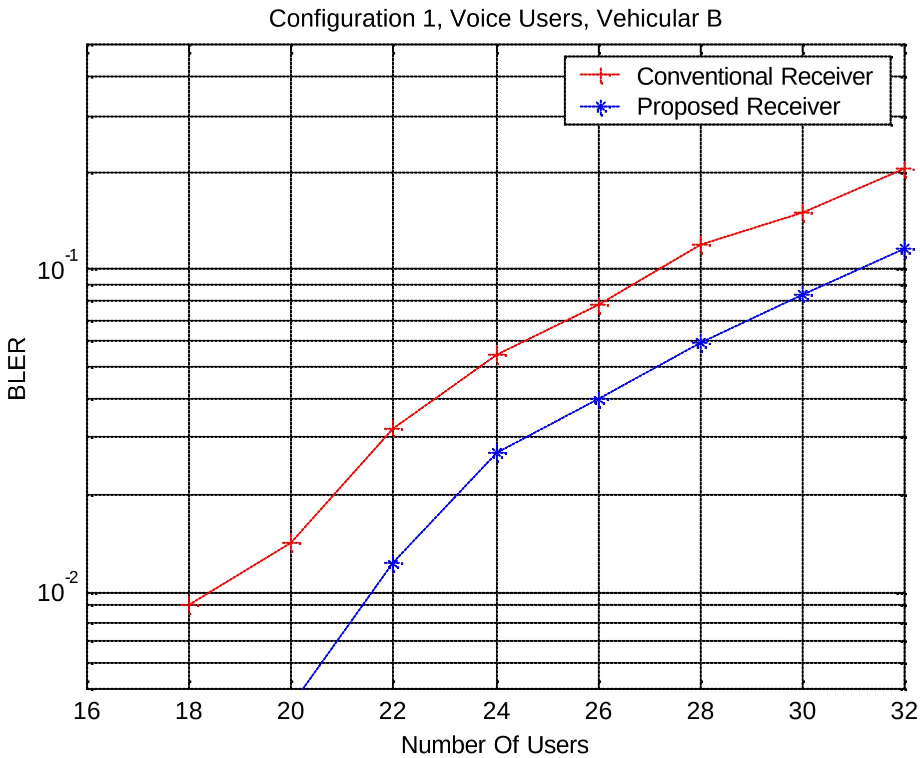

Figure 2: Performance with & without pilot MAI cancellation – Configuration 1 (Table 4), Voice Users, ITU Vehicular Channel B Model.

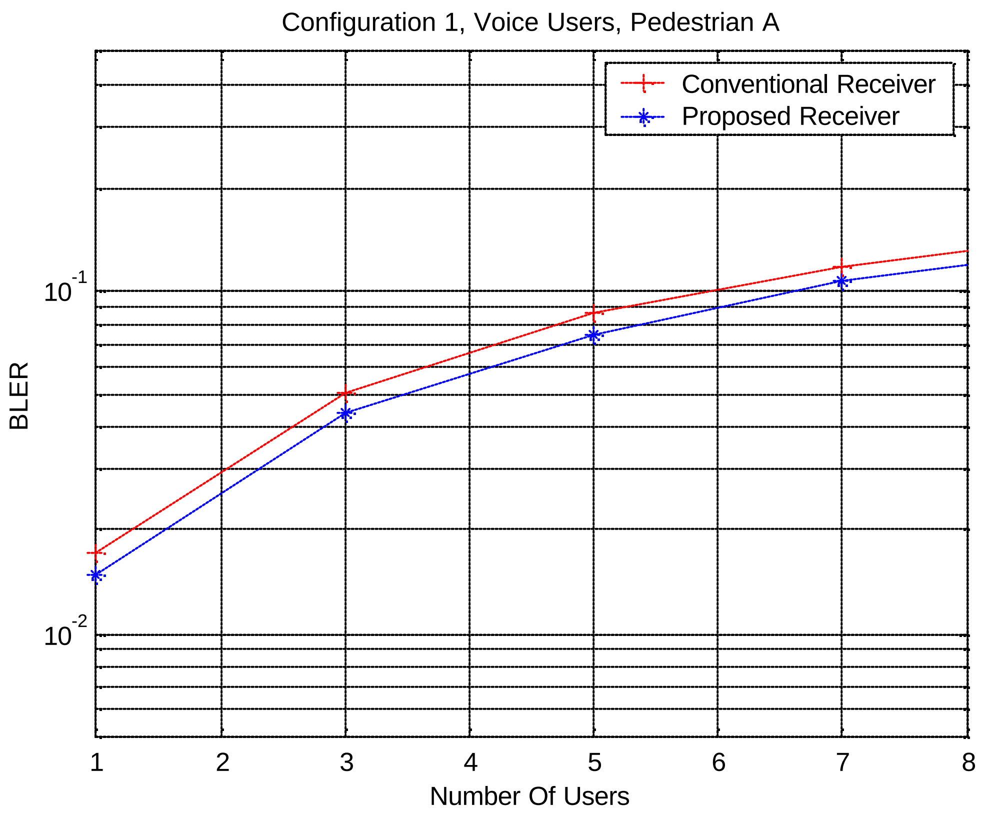

Figure 3: Performance with & without pilot MAI cancellation – Configuration 1 (Table 4), Voice Users, ITU Pedestrian Channel A Model.

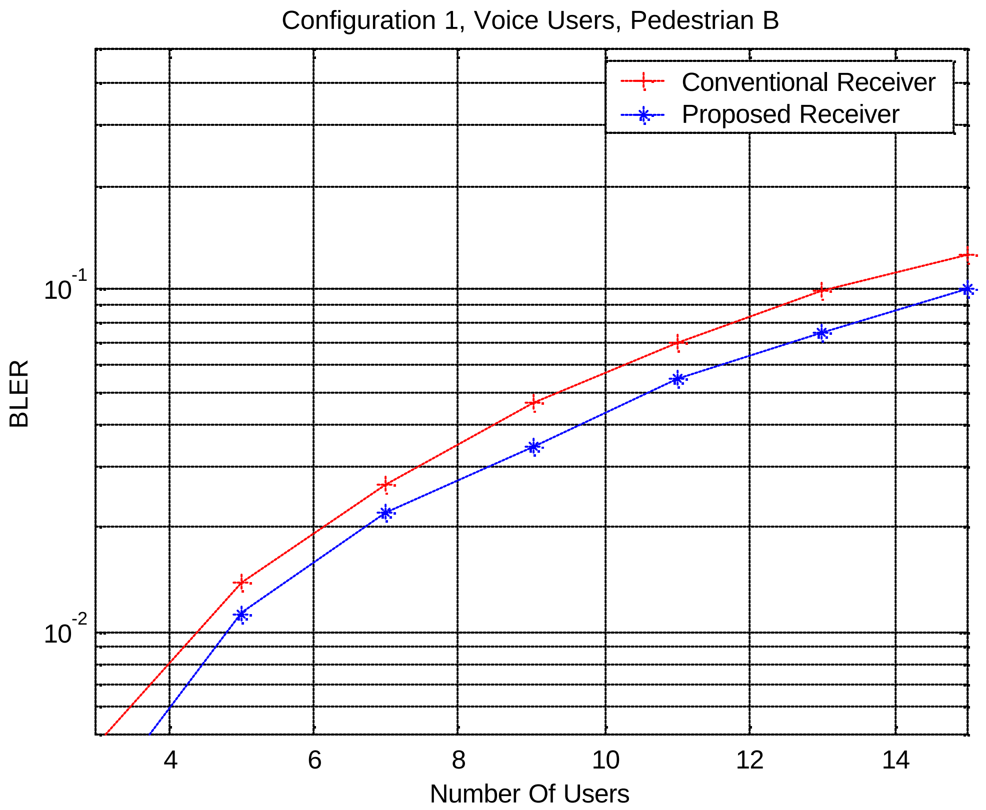

Figure 4: Performance with & without pilot MAI cancellation – Configuration 1 (Table 4), Voice Users, ITU Pedestrian Channel B Model.

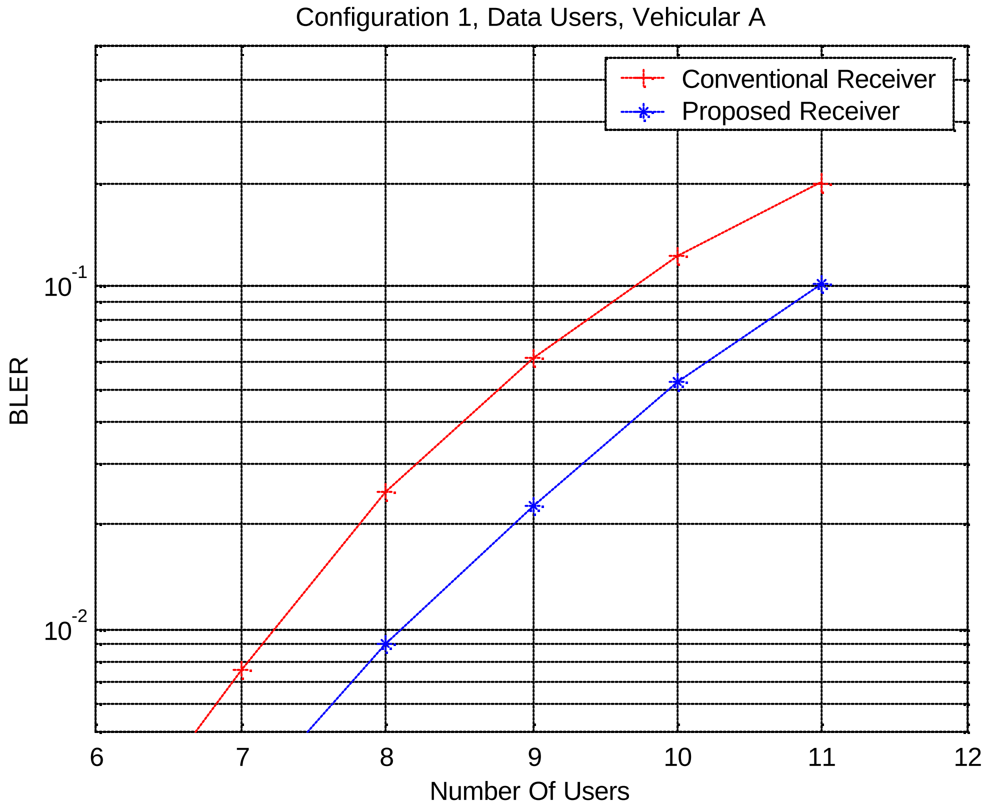

Figure 5: Performance with & without pilot MAI cancellation – Configuration 1 (Table 4), Data Users, ITU Vehicular Channel A Model.

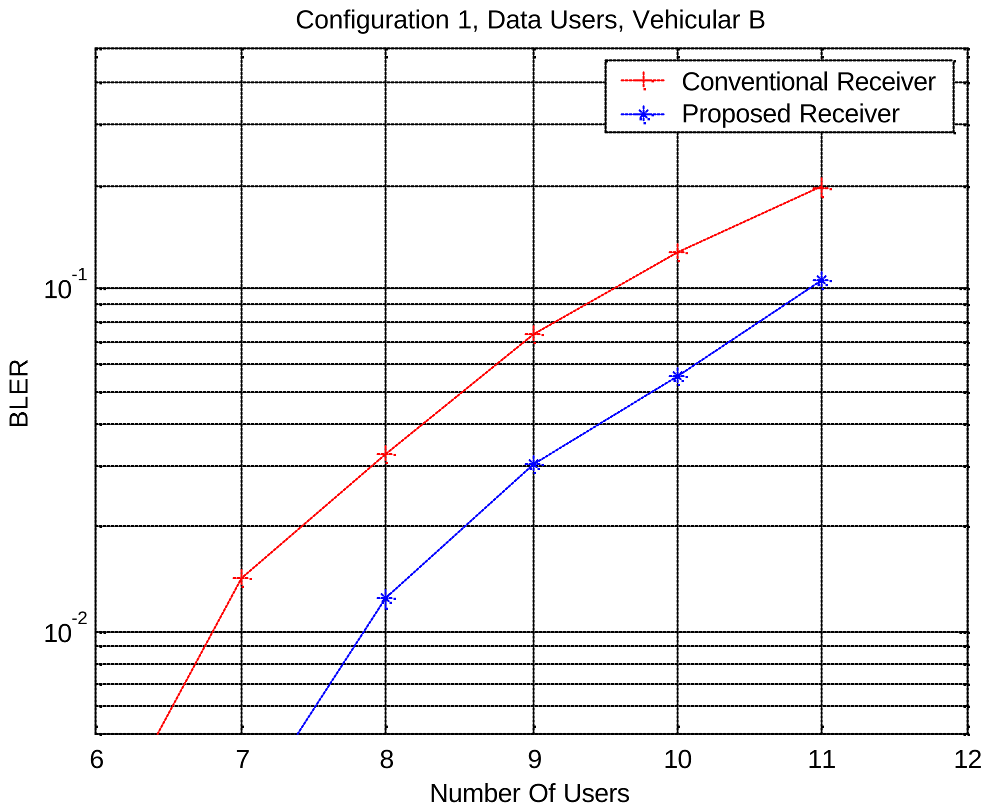

Figure 6: Performance with & without pilot MAI cancellation – Configuration 1 (Table 4), Data Users, ITU Vehicular Channel B Model.

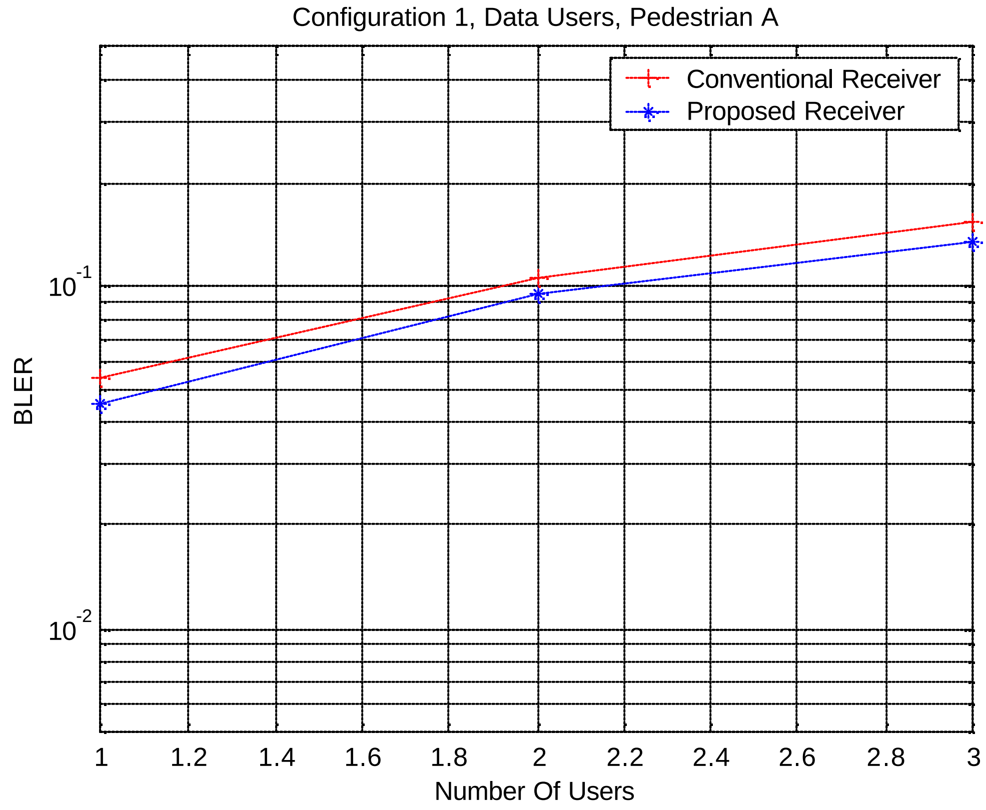

Figure 7: Performance with & without pilot MAI cancellation – Configuration 1 (Table 4), Data Users, ITU Pedestrian Channel A Model.

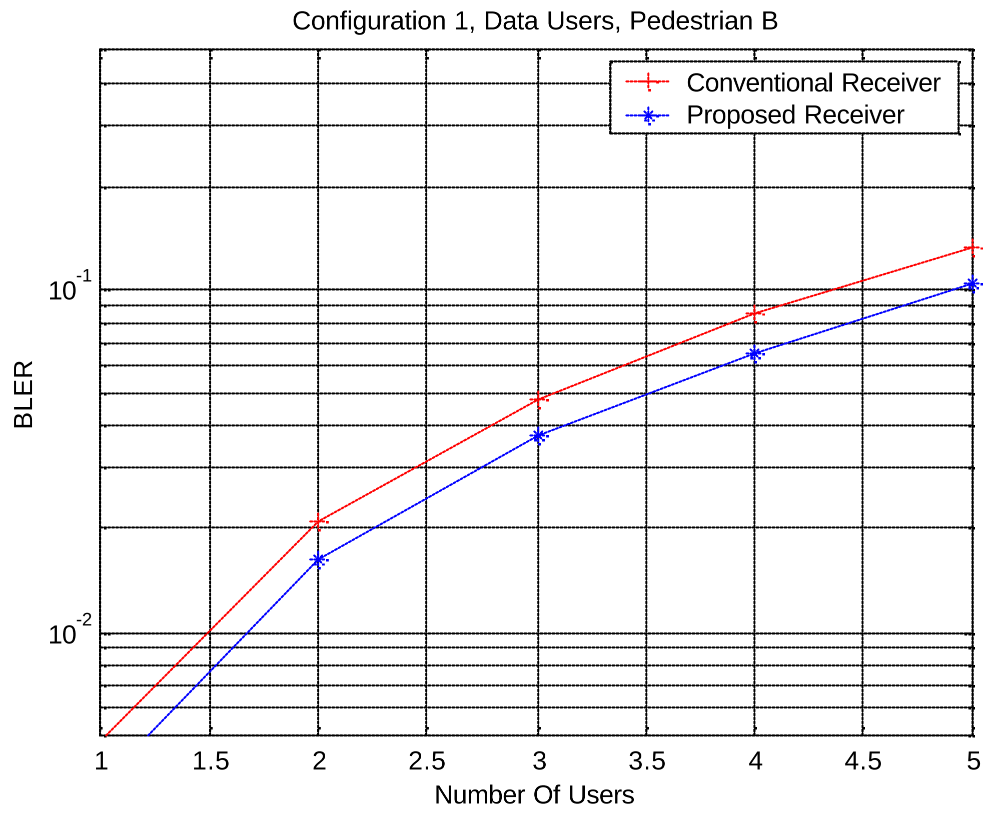

Figure 8: Performance with & without pilot MAI cancellation – Configuration 1 (Table 4), Data Users, ITU Pedestrian Channel B Model.

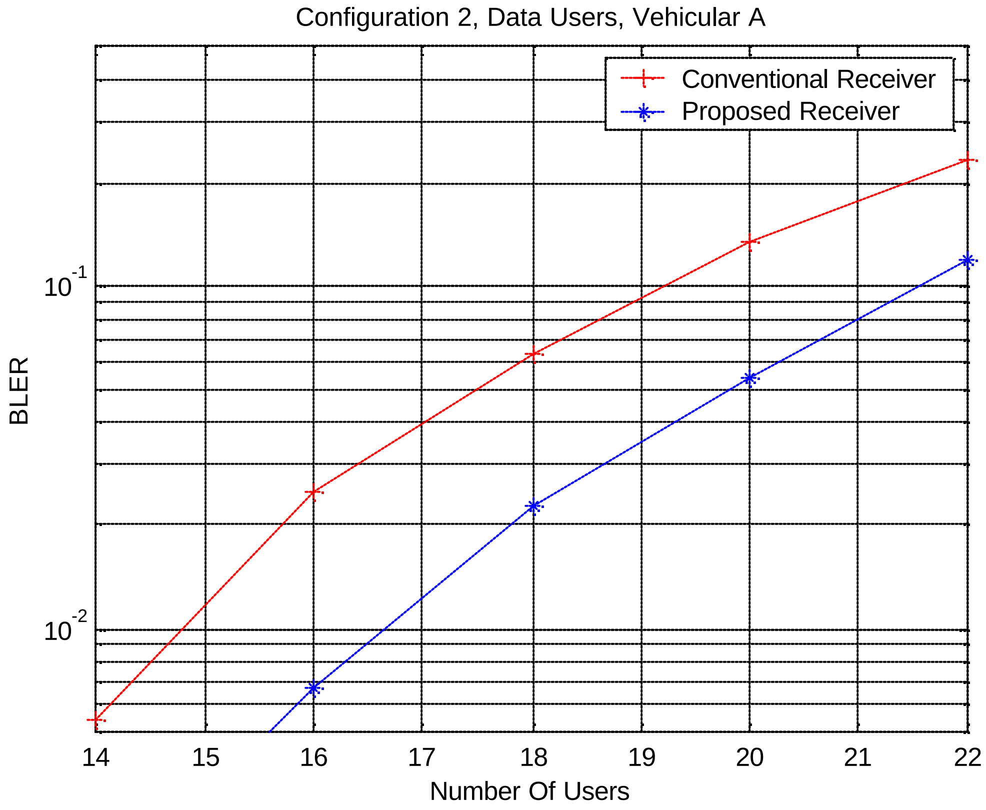

Figure 9: Performance with & without pilot MAI cancellation – Configuration 2 (Table 5), Data Users, ITU Vehicular Channel B Model.

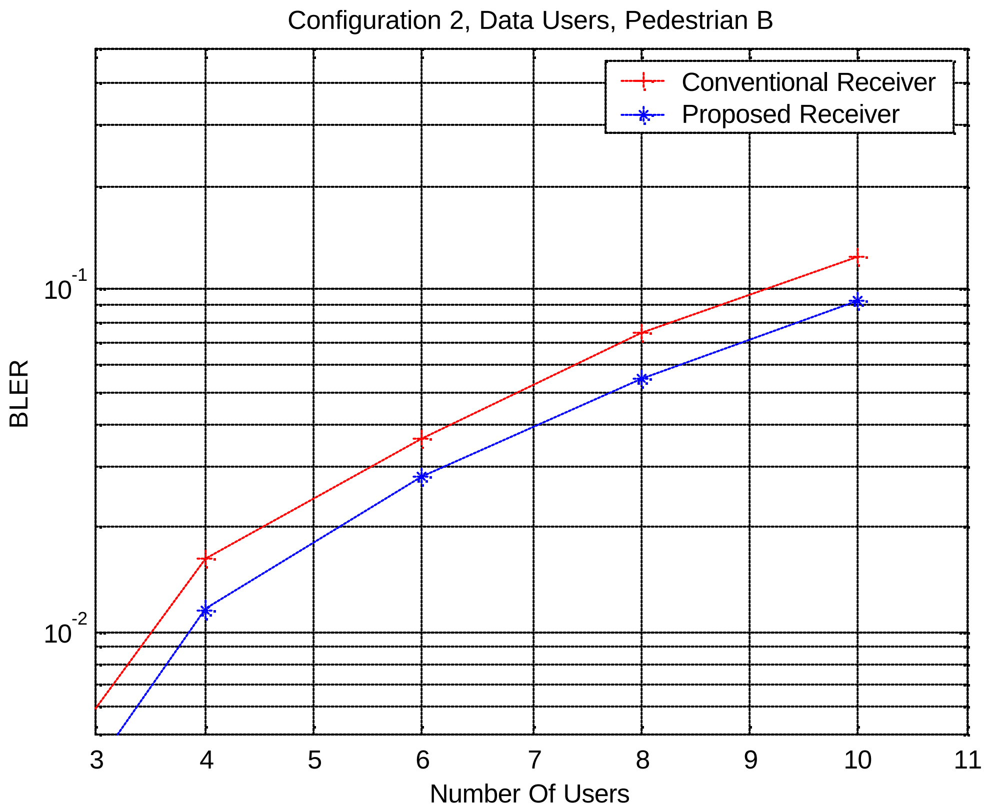

Figure 10: Performance with & without pilot MAI cancellation – Configuration 2 (Table 5), Data Users, ITU Pedestrian Channel A Model.

5. Summary and Conclusion

We have presented further simulation results on the pilot MAI cancellation receiver introduced in [1]. While [1] assumes the simplified Case 3 fast fading channel model found in [3] and a 2-base station configuration, the current contribution extends these results to ITU Vehicular and Pedestrian channel models [2], and 4-base station configurations.

The pilot MAI cancellation receiver is attractive since it provides several important advantages for relatively little added complexity. Its advantages include: **(1) Capacity Gain** – The receiver can achieve capacity gains of 10% or more. The lower bound of 10% results directly from the allocation percentage typically specified for the pilot, i.e., P-CPICH_Ec/Ior = -10 dB. If, however, all base stations being received are not transmitting at peak load (likely), then the pilot power allocation percentage will be higher, and thus, the potential capacity gains are larger. **(2) Secondary Pilots –** If a secondary pilot channel(s) (S-CPICH) is enabled, the total relative pilot power is increased, (e.g., to 20% as per [3, Annex 3, C.3.2]), enabling additional capacity gains from pilot MAI cancellation. **(3) Handover Improvement** – Since the pilot MAI cancellation receiver despreads additional pilots, a by-product of the receiver may be significantly improved soft-over performance. The additional despreaders and channel estimators can be used to more efficiently find strong pilots or multipath components, enabling the receiver to more quickly convert this energy from interference to useful signal. In addition, the load on the searcher will be reduced, enabling the searcher to more effectively look for neighboring base stations. **(4) Channel Estimation** – Performing channel estimation on the pilot signals after pilot MAI cancellation can provide better channel estimates.

Appendix: Simulation Assumptions

Table 1: ITU Vehicular Channel Models					
Tap	**Channel A**		**Channel B**		**Doppler Spectrum**
	Relative Delay (ns)	**Average Power (dB)**	**Relative Delay (ns)**	**Average Power (dB)**	
1	0	0	0	-2.5	Classical
2	310	-1.0	300	0	Classical
3	710	-9.0	8900	-12.8	Classical
4	1090	-10.0	12900	-10.0	Classical
5	1730	-15.0	17100	-25.2	Classical
6	2510	-20.0	20000	-16.0	Classical

Table 2: ITU Pedestrian Channel Models					
Tap	**Channel A**		**Channel B**		**Doppler Spectrum**
	Relative Delay (ns)	**Average Power (dB)**	**Relative Delay (ns)**	**Average Power (dB)**	
1	0	0	0	0	Classical
2	110	-9.7	200	-0.9	Classical
3	190	-19.2	800	-4.9	Classical
4	410	-22.8	1200	-8.0	Classical
5	-	-	2300	-7.8	Classical
6	-	-	3700	-23.9	Classical

Table 3: Number of Rake Fingers	
Channel	**Number of Fingers**
ITU Pedestrian A	2
ITU Pedestrian B	5
ITU Vehicular A	4
ITU Vehicular B	4

Table 4: Simulation Configuration #1					
Parameter	**Units**	**Base 0**	**Base 1**	**Base 2**	**Base 3**
Relative Power	dB	0.0	0.0	-3.0	-3.0
Ior	dBm/3.84 MHz	-83.0	-83.0	-86.0	-86.0
P-CPICH_Ec/Ior	dB	-10.0	-8.5	-8.5	-8.5
P-CCPCH_Ec/Ior	dB	-12.0	-12.0	-12.0	-12.0
SCH_Ec/Ior	dB	-12.0	-12.0	-12.0	-12.0
PICH_Ec/Ior	dB	-15.0	-15.0	-15.0	-15.0

Table 5: Simulation Configuration #2					
Parameter	**Units**	**Base 0**	**Base 1**	**Base 2**	**Base 3**
Relative Power	dB	0.0	-3.0	-6.0	-9.0
Ior	dBm/3.84 MHz	-83.0	-86.0	-89.0	-92.0
P-CPICH_Ec/Ior	dB	-10.0	-8.5	-8.5	-8.5
P-CCPCH_Ec/Ior	dB	-12.0	-12.0	-12.0	-12.0
SCH_Ec/Ior	dB	-12.0	-12.0	-12.0	-12.0
PICH_Ec/Ior	dB	-15.0	-15.0	-15.0	-15.0

References

[1] 3GPP TSGR1-00-1371, "CPICH interference cancellation as a means for increasing DL capacity," Intel Corporation, Nov. 2000.
[2] ITU ITU-R M.1225, "Guidelines for evaluations of radio transmission technologies for IMT-2000," 1997.
[3] 3GPP TS 25.101 v3.4.0 (2000-09), "UE radio transmission and reception (FDD)," Oct. 2000.