RNS Based PN Sequences of DS-CDMA

N.Chitra
CSJM University, Kanpur, Uttar Pradesh, India

Abstract
The success of mobile communication using CDMA technology will be gainful when there is encoding sequences with good correlation properties. Spreading codes with residual number system proposed earlier did not consider external interferences, multipath propagation, Doppler Effect etc. This paper discusses the use of residual number system in generation of the PN sequences which is used to spread the message signal for CDMA technology. This RNS based PN sequence has superior performance than most of the existing codes that are widely used in DS-CDMA applications.

Keywords
Direct-Sequence Code Division Multiple Access (DSCDMA), Multiple-Access Interference (MAI), PN Sequence, Residue Number System (RNS).

I. PN Sequence Generation Based on Residue Arithmetic

RNS based PN sequence generation for multi-user scenario consists of an off-line process for the generation of Initial Primal Vector and finally the generation of the required PN sequence which is done on-line. The off-line process is Summarized in Fig 1 .The external inputs to these blocks Include spread factor, _ and the cross-correlation threshold, T. Moduli set, P, for a given _ are selected either by consecutive method or exponential method Consecutive method of moduli selection is used here. For a given spread factor, the number of users that can be accommodated is huge in comparison to other spreading codes.

A primal, J1 is randomly selected from the range, R .The corresponding residue set, Rs(J1)

$$R = \prod_{i=1}^{n} pi$$

$$R_s(J_1) = (J_1|p1, J1|p2; .....|J1|p_m$$

is the output of Decimal to Residue Arithmetic Converter The generated residue numbers are concatenated and converted into 8 bit binary sequence of 1 and 0.
This sequence is passed through the NRZ encoder to get the sequence C1 corresponding to primal J1. This procedure is repeated for every primals in range, R..
Depending upon the application and number of users active in the system, the Primal Vector, J

J = [J1; J2; J3…..JU]T is selected from the Primal Pool with spread factor, _ along

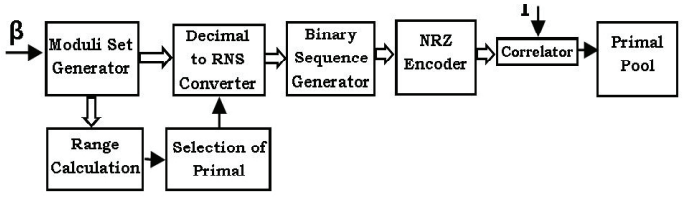

Fig. 1: Offline process for RNS Based PN Sequence Generation With number of active users, U as input.

The residue matrix R_s = lJlP is created in RNS converter block such that
Rs = [Rs(J_1);Rs(J_2);Rs(J_3); :::Rs(J_U)].
Finally the required RNS based PN code matrix, C = [C_1C_2:::C_U] of size U X β is formed after binary conversion and encoding.

This sequence is then used in DS-CDMA.

II. Results and Discussion

For the analysis of the cross-correlation properties of RNS Based PN sequence in comparison with other standard PN sequences, spreading codes have been generated with a spreading factor, β = 8, and moduli set P = [255]. The primal vector, J = [10 39 60 77 86 25 140], is generated by varying the threshold value from 0 to 0.25. The correlation matrix of RNS based PN sequence .In order to validate the improved performance with decrease in cross correlation factor, the generated sequence is used in DS-CDMA system..
Detailed study of the behavior of RNS based PN Sequence unscenarios by varying cross correlation factor is done for β =64 and β = 128; because a DS-CDMA system using a higherspreading factor is capable of supporting a higher number of active users than that using a lower spreading factor, while maintaining the target performance. Bit error rate (BER) was considered as the performance index throughout. Monte Carlosimulation were conducted to estimate the BER performance different channel environment and with different loading

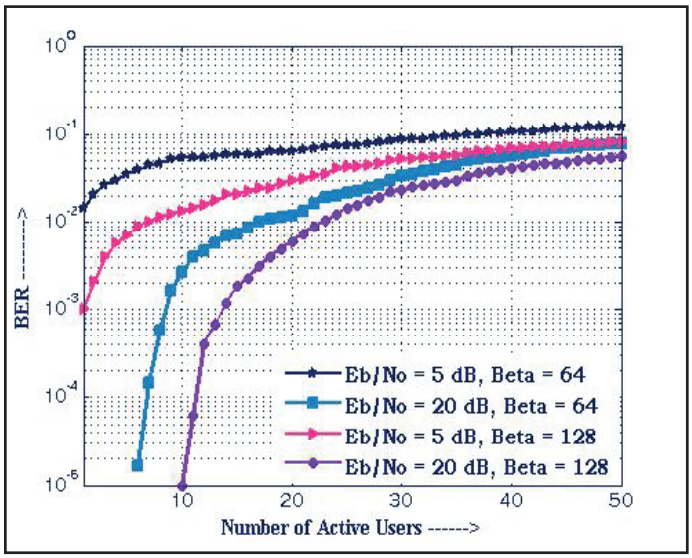

Fig. 2: BER Performance v ersus the number of active users for Eb/No of 5 dB and 20 dB with β = 64 and β = 128

III. Conclusion

The proposed sequence offers provision to vary correlation threshold based on the channel properties and error tolerance unlike any existing techniques. It also inherits high dynamic key range such that it yields a PN sequence which has pragmatically a nether correlation. DS-CDMA performance in all of MAI-AWGN, Rayleigh flat fading and different stationary multipath channels has been evaluated. It offers MAI resistant operation in both synchronous and asynchronous MAI-AWGN channels,

reducing co-channel interference and increasing capacity in a mobile cellular system. The joint effect of ideal auto-correlation function and good cross correlation function makes RNS based PN sequence superior to all other standard PN sequences like Gold codes, Kasami codes and Maximal Length sequence

References

[1] Juha Korhonen,"Introduction to 3G Mobile Communications", 2nd ed., Artech House Mobile Communications Series, 2003.

[2] Hsiao-Hwa Chen,"The Next Generation CDMA Technologies", 1st ed.,John Wiley and Sons, 2007.

[3] L. Yang, L. Hanzo,"Performance of residue number system based DS-CDMA over multipath fading channels using orthogonal sequences," European Transactions on Telecommunications, Vol. 9, No. 6, pp. 525-535, 1998.

[4] Lie-Liang Yang; Hanzo, L.,"Residue number system based multiple code DS-CDMA systems," Vehicular Technology Conference, 1999 IEEE 49th , Vol. 2, pp. 1450-1454, Jul 1999.