THE COMPARATIVE ANALYSIS OF DISTRIBUTED POWER CONTROL ALGORITHMS IN CDMA

R. Evdochimov, PhD
Beltsy State University „Alecu Russo”

INTRODUCTION

In this work are presented results of comparison of various distributed power control (DPC) algorithms. The control of transmit power has been recognized as an essential requirement in the design of cellular code-division multiple-access (CDMA) systems. Indeed, power control allows for mobile users to share radio resources equitably and efficiently in a multicell environment. For this purpose they were modelled in the simulation environment MATLAB, basing on the CIR (Carrier to Interference Ratio) by the following two criteria: speed of convergence and system’s outage performances. For modeling a cellular system model of 19 co-channel cells, which are spaced with a reuse distance, has been considered on the assumption that each cell is a hexagon.

1. DPC ALGORITHMS

Unlike Centralized Power Control (CPC) algorithm which uses the global information to update the powers and balancing the CIRs Distributed Power Control (DPC) algorithms use the local information for the power updating and CIR balancing. There are different types of DPC algorithms suited for fulfilling different QoS requirements.

These algorithms are iterative and generally each algorithm converges to the desired value after certain number of iterations. The iterations taken to converge to the desired value depends on the responsiveness of the algorithm.

Some of the DPC algorithms considered are given below.

1. Distributed Power Control (DPC);
2. Fully Distributed Power Control (FDPC);
3. Improved Fully Distributed Power Control (Improved FDPC);
4. Balanced Distributed Power Control (BDPC);
5. Fixed Step Distributed Power Control (FSDPC);
6. Augmented Constant Improvement Power Control (ACIPC).

2. SPEED OF CONVERGENCE

As the radio channel is highly stochastic, the channel characteristics vary very quickly. So, the power update by any power control algorithm should be fast enough to converge and stabilize the system quickly. So, the speed of convergence is an important performance comparison parameter that gives the responsiveness of the power control algorithm.

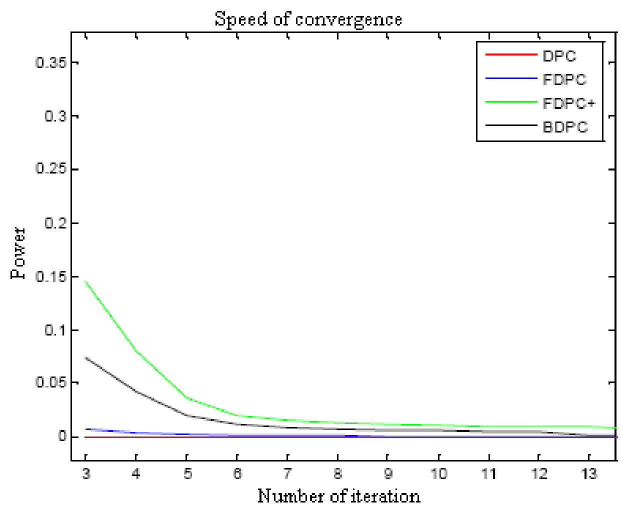

Figure 1. Comparison of speed of convergence of various power control algorithms:
DPC – Distributed Power Control algorithm
FDPC – Fully Distributed Power Control algorithm
FDPC+ – Improved Fully Distributed Power Control algorithm
BDPC – Balanced Distributed Power Control algorithm.

The figure 1 represents a dispersion of power levels in all consecutive iterations for the four algorithms. From the diagram it is clear that DPC algorithm converges faster than FDPC algorithm, BDPC algorithm and Improved FDPC+ algorithm. DPC algorithm almost converges instantly, but the deficiency of fully distributed quality makes it impractical for implementation.

Though the convergence of FDPC algorithm is more slowly than the DPC algorithm, its property of the full distribution makes it more effective than DPC algorithm. BDPC algorithm converges slowly, but it has good power balancing property. The powers are balanced unlike FDPC algorithm and Improved FDPC algorithm which makes it more effective for practical implementation. Improved FDPC algorithm has the worst parameters, both in convergence, and in balancing of power that makes it improper for practical implementation.

3. ALGORITHM'S OUTAGE

Viability of system also is important parameter of work which shows system effectiveness. DFSPC – Distributed Fixed Step Power Control algorithm and ACIPC – Augmented Constant Improvement Power Control algorithm are compared on their outage performance since they can be implemented for satisfying different QoS (Quality of Service) requirements.

Fixed Step algorithm supports a communication quality depending on target CIR (Carrier to Interference Ratio), and ACIPC algorithm involves in cell removal if target CIR is not attained. Outage performance for these two algorithms in every iteration is shown on fig. 2.

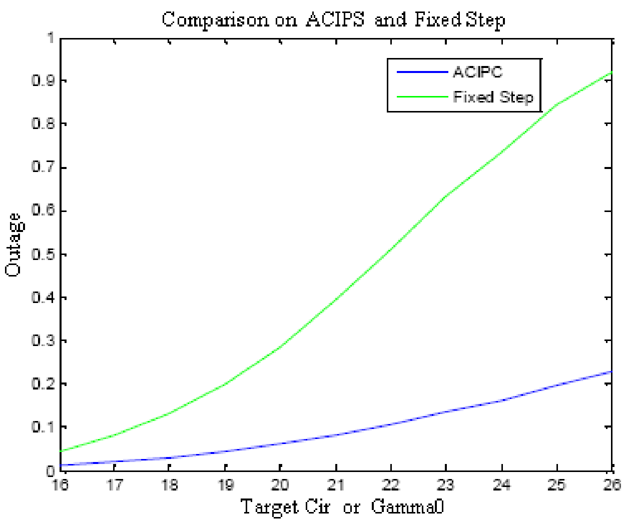

Figure 2. Comparing on outage performance of ACIPC algorithm and DFSPC algorithm.

From figure 2, it is clearly that Fixed Step algorithm has got worse outage performance in comparison with ACIPC algorithm. Fixed Step algorithm's protection property of a communication quality makes it more attractive to practical implementation and for satisfaction of QoS requirements that raises system capacity. ACIPC algorithm has very good outage performance in comparison with Fixed Step algorithm. Its disadvantage consists in that it launches procedure of removal of cell. So, ACIPC algorithm can be the considerable option for achievement of the best QoS requirements and enhanced features of system.

CONCLUSIONS

The presented results of modeling show that each algorithm possesses different speeds of convergence and outage performance. From these results it is possible to conclude that speed of convergence only partially sizes up efficiency of algorithm. Other factors like tremendous increase or decrease in the transmitting powers, call dropping probability and maintaining required QoS all the time, also need to be considered here.

Thus, it is possible to conclude that each of the observed algorithms is good or bad depending on certain conditions. In convergence DPC algorithm has the best parameters among the remaining studied algorithms. BDPC algorithm is the best in power equalization whereas ACIPC algorithm exceeds other algorithms under QoS requirements. Thus, each algorithm has own advantages and lacks.

Bibliography

1. *C.W.Sung, W.S Wong.* *A distributed fixed step power control algorithm with quantization and active link quality protection., IEEE Trans. on Veh. Technology, vol. 48, pp.553-562, March 1999.*

2. *D.Kim, K.N.Chang, S.Kim.* *Efficient distributed power control for cellular mobile systems., IEEE Trans. on Veh. Technology, vol.46, pp.313-319, May 1997.*

3. *B.Dillon, S.Koskie*. *Comparison in simulation of power control algorithms for wireless systems., Princeton University and WINLAB Rutgers University, Piscataway, NJ 00854, USA.*

Recommended for publication: 25.05.2011