ISSN (Print) : 2320 – 3765
ISSN (Online): 2278 – 8875

International Journal of Advanced Research in Electrical, Electronics and Instrumentation Engineering

(An UGC Approved Journal)

Website: www.ijareeie.com

Vol. 6, Issue 9, September 2017

A Distributed Power Control Algorithm to Improve Energy Efficiency in Wireless Technologies

B.Kaveri[1], A.M.Prasad[2]

PG Student [C&C], Dept. of ECE, UCEK, JNTUK, Kakinada, Andhra Pradesh, India[1]

Professor, Dept. of ECE, UCEK, JNTUK, Kakinada, Andhra Pradesh, India[2]

ABSTRACT: The power control algorithms are developed for Energy efficiency (EE) maximization can be measured in bit/joule in wireless networks. The minimum rate constraints and signal-to-interference plus noise ratio are the mainly used expressions. This paper proposes the distributed power control algorithms for the energy-efficiency measurements in both centralized and de-centralized models. The minimum energy efficiency (EE) and Global energy efficiency (GEE) can be measured in centralized model. The equilibrium of the network is measured in de-centralized model. Unlike previous contributions, we develop centralized algorithms that are guaranteed to converge, with affordable computational complexity, to a Karush-Kuhn-Tucker point of the considered non-convex optimization problems**.** An optimization framework is required to effectively determine the global solution of Energy-efficient optimization problems in interference-limited networks, which has reflected in the results of energy efficiency (EE) as constant value irrespective of increase of power. So by using the dynamic power control method based on rate constraint per user can improve the efficiency.

KEYWORDS: Power control, Energy efficiency (EE), User rate constraint, Dynamic power, Equilibrium.

I.INTRODUCTION

The main objective of developing the power control algorithms is to minimize the power consumption of wireless networks, why because the evolution of wireless technologies increases in terms of data rate, mobility, coverage and spectral efficiency. If the evolution of wireless technologies increases the data rate, mobility, coverage and spectral efficiency becomes increases. This will cause unmanageable energy demand from the users. As the wireless generations increases, the number of users will also growing day by day. So the higher data rates must be needed for connecting all the users. But it is impossible to reach such high data rates by scaling the transmitting powers.

With network infrastructure accounting for a considerable share of the electricity consumed by current data centres, reducing the energy consumption of wired networks has become a key concern for equipment manufacturers and providers. While designing the networks energy efficiency is considered alongside important goals such as scalability, reliability, response-time, low overhead, interoperability and ease of use. Moreover the design of policies for reducing power consumption should be adapted to the network characteristics, including its topology, traffic and usage scenario (e.g. peer-peer, web servers, VoIP). This work focuses on improving the energy efficiency of dedicated networks, such as those deployed in data centres, enterprises, across banks and research networks (e.g. Ultra Science Net1). Unlike the Internet, these networks present more controlled traffic conditions and less intricate topologies. In such networks, most traffic is concentrated on a few links and it consists of relatively large data transfers such as bulk transfers, backup operations and file transfers. By using a reservation system, we can plan and schedule these data transfers in more energy-efficient ways. However, the manner bandwidth reservations are managed can influence the amount of energy consumed by the network infrastructure. Hereafter, we term as management system the system responsible for managing bandwidth reservations in wired networks. Different architectural approaches can be applied to building management systems, including centralized, decentralized and clustered (where cluster heads are responsible for the resources of clusters). In mathematical optimization, the Karush-Kuhn-Tucker (KKT) conditions, also known as the

ISSN (Print) : 2320 – 3765
ISSN (Online): 2278 – 8875

International Journal of Advanced Research in Electrical, Electronics and Instrumentation Engineering

(An UGC Approved Journal)

Website: www.ijareeie.com

Vol. 6, Issue 9, September 2017

Kuhn–Tucker conditions, are first-order necessary conditions for a solution in nonlinear programming to be optimal, provided that some regularity conditions are satisfied. By allowing inequality constraints, the KKT approach to nonlinear programming generalizes the method of Lagrange multipliers, which allows only equality constraints. The system of equations and inequalities corresponding to the KKT conditions is usually not solved directly, except in the few special cases where a closed-form solution can be derived analytically. In general, many optimization algorithms can be interpreted as methods for numerically solving the KKT system of equations and inequalities.

II.CENTRALIZED POWER CONTROL METHOD

The energy efficient power control can be achieved by measuring the global energy efficiency and minimum energy efficiency in the centralized model. The measurement which includes minimum user rate constraints and signal-to-interference plus noise ratio (SINR). The SINR which measures the amount of useful received signal power to the undesirable power collected at the receiver side and can be expressed as

$$\gamma_{k,n} = \frac{\alpha_{k,n} p_{k,n}}{\sigma_{k,n}^2 + \phi_{k,n} p_{k,n} + \sum_{j\neq k} w_{kj}, np_{j,n}} \qquad (1)$$

Where $p_{k,n}$ is transmitting power of user *k* over resource block *n* and $\alpha_{k,n}$, $\phi_{k,n}$, $w_{kj,n}$ are positive quantities. The energy efficiency can be defined as the ratio of achieved rate of *N* resource blocks to the total power consumed and can be expressed as

$$\eta_k \triangleq \frac{\sum_{n=1}^{N} B\log_2(1+\gamma_{k,n})}{p_{c,k} + 1^T P_k} \qquad (2)$$

Where *N* is total number of resources and *B* is the bandwidth and P_k is user *k* power allocation vector over *N* resources. Global energy efficiency can be defined as the ratio of sum achievable rate of users to total amount of consumed power and can be expressed

$$\psi = \frac{\sum_{k=1}^{K} \sum_{n=1}^{N} B\log_2(1+\gamma_{k,n})}{p_c + \sum_{k=1}^{K} 1^T P_k} \qquad (3)$$

Where *K* refers number of users and *N* refers number of resources and p_c is the dissipated power of system.

In centralized method by using the energy efficiency and global energy efficiency creating a communication channel and give frequency of channel and based on that frequency the channels will be created. The power consumption will be depends on the value of frequency. If the frequency is high the power consumption will be more and if the frequency is less the number of channels will be less, so the power consumption will also reduced. The GEE maximization is can be accomplished by leveraging the following lower-bound of the logarithmic function is

$$\log_2(1+\gamma) \geq a\log_2\gamma + b \qquad (4)$$

With

$$a = \frac{\tilde{\gamma}}{1+\tilde{\gamma}} \qquad b = \log_2(1+\tilde{\gamma}) - \frac{\tilde{\gamma}}{1+\tilde{\gamma}}\log_2\tilde{\gamma} \qquad (5)$$

Algorithm1: Centralized EE maximization for single resource block

```
1: Test feasibility
2: if Feasible then
3: Set $i = 0$ and choose any $p^{(0)} \in P$ ;
4: Set $\tilde{\gamma}^{(0)} = \gamma_k^{(0)} (p^{(0)})$ and compute $a_k^{(0)}, b_k^{(0)}$ ;
5: repeat;
```

```
$i = i + 1$;
if GEE then
    Solve parameters $a_k^{(i-1)}$ and $b_k^{(i-1)}$ and
        set $\left\{q_k^{(i)}\right\}k = \arg\max\ \tilde{\psi}_i$ , $p_k^{(i)} = 2^{q_k^{(i)}}$;
end if
if Minimum EE then
    Solve parameters $a_k^{(i)}$ and $b_k^{(i)}$ and
        set $\left\{q_k^{(i)}\right\}k = \arg\max\ \tilde{\eta}_i$ , $p_k^{(i)} = 2^{q_k^{(i)}}$;
end if
Set $\tilde{\gamma}_k^{(i)} = \gamma_k^{(i)}(p^{(i)})$ and compute $a_k^{(i)}$ and $b_k^{(i)}$;
until convergence
end if
```

III.DYNAMIC POWER CONTROL METHOD

The dynamic power control method can be used to improve the energy efficient power control of the system. Unlike centralized method here it will consider the carrier frequency, data length, number samples and number transmitters dynamically. In centralized method the number of transmitters, carrier frequency, and data length are fixed, so the power wastage will occurs. So by considering the channel state information (CSI) with respect to SNR gain and receiving antennas with equal gain combining will make it possible to achieve reliable communication with high data rates in multi-antenna systems. In wireless communications, channel state information (CSI) refers to known channel properties of a communication link. The channel state information describes how a signal propagates from the transmitter to the receiver and represents the combined effect of fading, and power decay with distance. CSI needs to be estimated at the receiver and usually quantized and fed back to the transmitter.

The channel state can be estimated using training signals, then the relative estimation error (normalized mean-squared error) becomes smaller and the SNR will be larger. So it is easy to estimate the channel with high SNR value. Noise is one aspect, and fading is another, which means that the SNR at the receiver will definitely be affected by channel state information. SNR value varies based on the channel state information.

Perfect CSI: The transmitter has full knowledge of the instantaneous channel realization and, possibly, of the interferences statistics at the receiver. In this case, since full information is available, there are many possible strategies and optimization criteria to carry out the design depending on the detection method at the receiver or on the performance metric.

Bayesian estimator: Location information has become an important feature in many wireless networks, and enabled a variety of applications, including navigation, tracking, monitoring, and emergency services. Bayesian estimators are utilized to locate the users, which treat the nodes positions as random variables.

Gaussian Message Passing (GMP): The Gaussian message passing is the process for reducing the communication overhead. As the more number of users are in communication at a time the white Gaussian noise is added to the channel. So Gaussian message passing is used for reducing noise for getting efficient results.

V. RESULT AND DISCUSSION

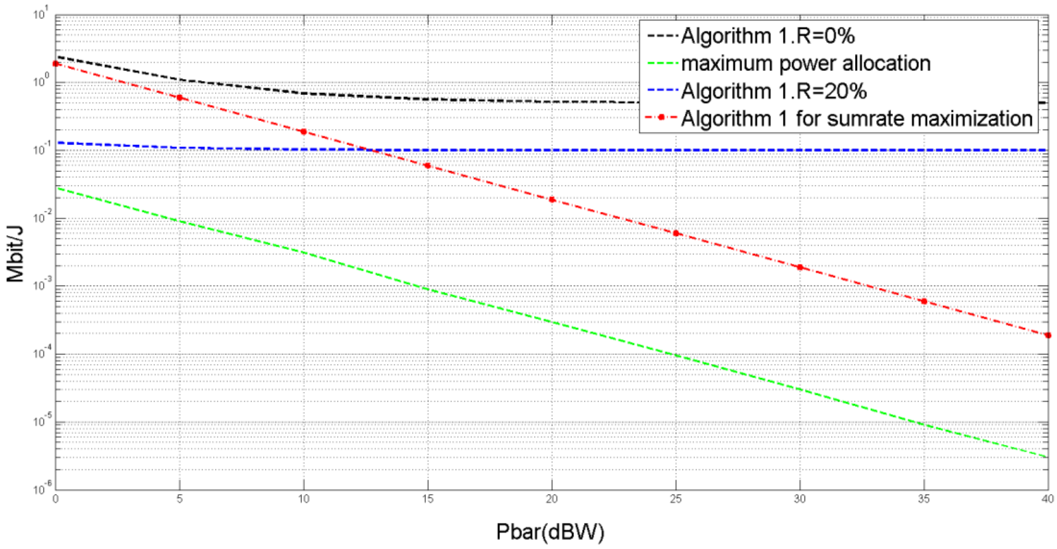

Figure 1: Average achieved GEE Vs Power

In the figure 1, it shows the graph of Average achieved GEE Vs power of user resource allocation policy. For R=0% and R=20% the algorithm performs similarly for low values of Power and it will remains constant for irrespective of power increases. At the same time R=0% and sum rate maximization also perform similarly for low values of power and the GEE will decreases as power increases. So the reduction of GEE will cause higher minimum rate is the remark for using high transmit powers.

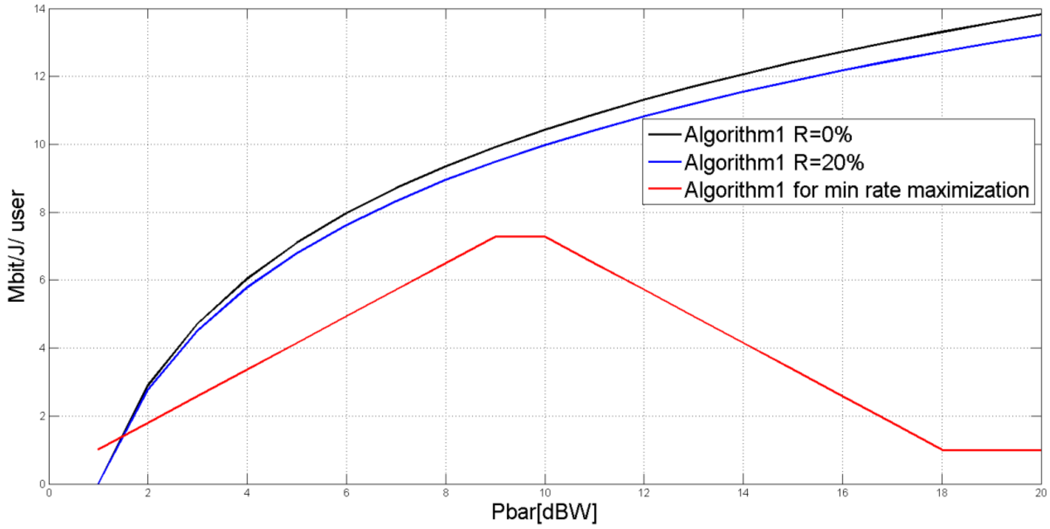

Figure 2: Minimum EE Vs Power

In the figure 2, it shows the graph of averaged achieved minimum user energy efficiency to power. This is used mainly for maximizing the user minimum energy efficiency. Here the rate maximization will decreases as the transmitting powers increases gradually.

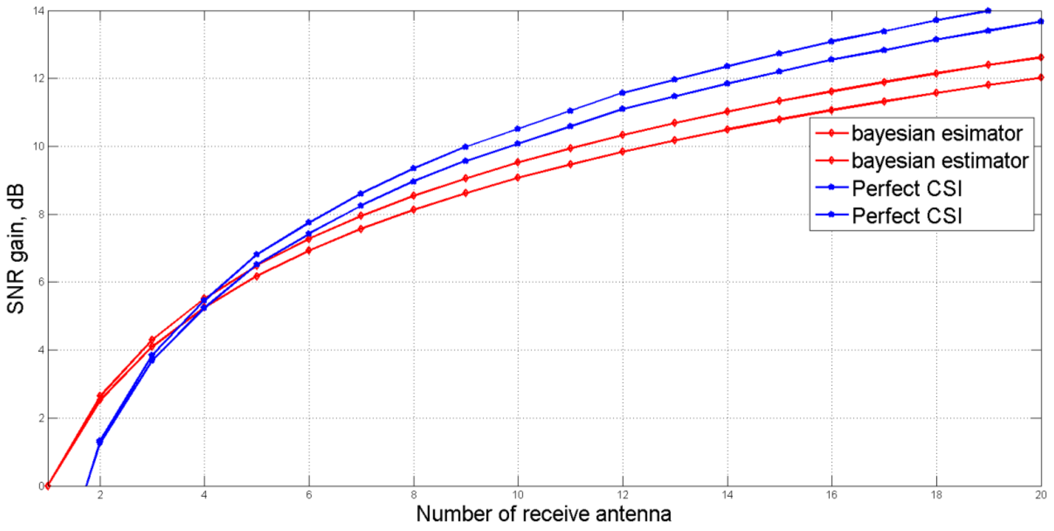

Figure 3: SNR Improvement with equal gain combining

In Figure 3, it shows the graph of SNR Improvement to the receiver antenna with equal gain combining for improving the energy efficiency. The CSI makes it possible to achieve reliable communication with high data rates in multi antenna systems. CSI needs to be estimated at the receiver and usually quantized and fed back to the transmitter.

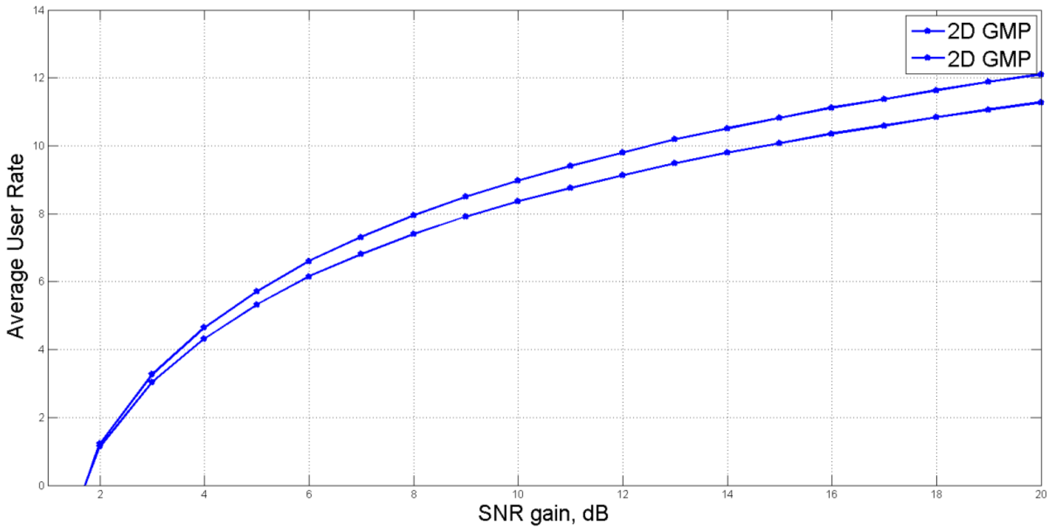

Figure 4: SNR improvement with equal gain combining

In figure 4, it shows the graph of average user rate to SNR gain with equal gain combining by considering the Gaussian message passing for noise efficient communication.

VI.CONCLUSION

The proposed method is to develop centralized and decentralized power control algorithms for EE optimization in wireless networks. Here the user rate constraints considered and a more general SINR expression so as to encompass emerging 5G technologies. The centralized algorithms perform better than their distributed counterparts, both with and without rate constraints, at the expense of a higher computational complexity and feedback requirements. An optimization framework is required to effectively determine the global solution of Energy-efficient optimization problems in interference-limited networks, which has reflected in the results of energy efficiency (EE) as constant value irrespective of increase of power. By using the Dynamic power control based on rate constraint per user can improve the efficiency.

REFERENCES

[1] G. Miao, N. Himayat, Y. Li, and A. Swami, “Cross-Layer optimization for energy-efficient wireless communications: A survey”, Wireless Comm. and Mobile Computing, vol. 9, no. 4, pp. 529–542, Apr. 2009.
[2] H. Kremling, “Making mobile broadband networks a success - Operator requirements”, Next Generation Mobile Networks Conference at CBIT, Frankfurt/Hannover, Germany, Mar. 2008.
[3] E. Telatar, “Capacity of multi-antenna Gaussian channels”, AT&T Bell Labs, Technical Report, 1995.
[4] G. J. Foschini, and M. J. Gans, “On limits of wireless communications in a fading environment when using multiple antennas”, Wireless Personal Comm., vol. 6, no. 3, pp. 311-335, Jan. 1998.
[5] E. Telatar, “Capacity of multi-antenna Gaussian channels”, European Trans. on Telecomm., vol. 10, no. 6, pp. 585–596, 1999.
[6] V. Rodriguez, “An Analytical Foundation for Resource Management in Wireless Communication”, IEEE Proc. of Globecom, pp. 898–902, San Francisco, CA, USA, Dec. 2003.
[7] V. Shah, N. B. Mandayam and D. J. Goodman, “Power control for wireless data based on utility and pricing”, IEEE Proc. of Personal, Indoor, Mobile Radio Comm., Boston, MA, Sep. 1998.
[8] D. J. Goodman and N. Mandayam, “Power Control for Wireless Data”, IEEE Personal Comm., Vol. 7, pp. 48–54, 2000.
[9] D. Fudenberg and J. Tirole, “Game Theory”, MIT Press, 1991.
[10] S. Lasaulce, M. Debbah, and E. Altman, “Methodologies for analyzing equilibria in wireless games”, IEEE Signal Processing Magazine, vol. 26, no. 5, pp. 41–52, Sep. 2009.
[11] C. U. Saraydar, N. B. Mandayam and D. J. Goodman, “Efficient power control via pricing in wireless data networks”, IEEE Trans. on Comm., vol. 50, no. 2, pp. 291–303, Feb. 2002.
[12] S. Lasaulce, Y. Hayel, R. El Azouzi, and M. Debbah, “Introducing hierarchy in energy games”, IEEE Trans. on Wireless Comm., vol. 8, no. 7, pp. 3833–3843, Jul. 2009.
[13] G. He, S. Lasaulce, Y. Hayel, and M. Debbah, “A multi-level hierachical game-theoretical approach for cognitive networks”, IEEE Intl. Conf. CROWNCOM, Cannes, France, Jun. 2010.
[14] M. LeTreust, S. and Lasaulce, “A repeated game formulation of energyefficient decentralized power control”, IEEE Trans. on Wireless Comm., to appear 2010.
[15] F. Meshkati, A. J. Goldsmith, H. V. Poor and S. C. Schwartz, “A gametheoretic approach to energy-efficient modulation in CDMA networks with delay QoS constraints”, IEEE J. on Sel. Areas in Comm., vol. 25, no. 6, Aug. 2007.