Tuning in Outage Probability Threshold of a GCCS Impact on Operator's Cost-efficient

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ABSTRACT

The OP (outage probability) performance of a specified GCCS (green communication cellular system) is evaluated in this article. In order to obtain the most efficiency without modifying the circuit allocation, the deployment of GCCS is assumed to search a best way for adjusting most efficient in application of communication energy. Generally, most important point in the way to earn the energy saving for a cellular radio system is by means of reducing the transmission power. Generally, it is known that there is about over 50% energy wasting in handling the power of circuit, air condition, and others for a cellular system. For discussion such issue, by adopting an effect algorithm to distribute different mobile users to distinct BS (base station) proposed in the report. Certainly, the QoS (quality of service) of the mobile network is needed to be guaranteed, which is maintained by presetting a data rate threshold for both downlink and uplink communications. Finally, there are many parameters are assigned to obtain the purpose of the proposed scheme for power saving, such as preset the threshold value of outage probability, the time of after dark. Furthermore, the results from the derived system performance are shown to express the fact which exists between the cost-efficient for the system operators and the system performance of the cellular radio communications.

Keywords: after dark; GCCS (green communication cellular system); OP (outage probability); QoS.

微調斷話率臨界值於綠色峰巢通訊中影響營運效能之研究

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摘　要

本文研究無線綠色蜂巢通訊系統(green communication cellular system, GCCS)網路之斷話率(outage probability)，假設保留原電路能達有效能源利用。蜂巢系統的節能重點在於降低基站(base station, BS)與手機的發射功率，工作中的基站，50%以上能量消耗在電路處理、空調與其他因素；而非尖峰時期與尖峰時期的耗能必須有差。所以將手機分配到不同的基站，藉由在非尖峰時間重新配置使用者，使基站不負擔任何使用者，進入休眠(after dark)狀態，達到節能功效，當然 GCCS 須有相同服務品質(QoS, quality of service)。由本文研究結果發現，GCCS 營運可經由研究所提之參數，包括設定斷話率臨界值(threshold)，或者臨界功率等，進行調整。

關鍵詞：休眠，綠色蜂巢通訊系統，斷話率，服務品質。

文稿收件日期 103.07.02;文稿修正後接受日期 104.04.26; *通訊作者
Manuscript received July 02, 2014; revised April 26, 2015; * Corresponding author

Ⅰ. INTRODUCTION

Following up the footprint of the 4G (4th generation) wireless communications with LTE (long term evaluation) techniques is approaching the market. It is known that 4G radio system applies techniques of single or multiple carrier modulation that is seized by most persons all over the world. Partly, since all the system operators are trying to reduce the cost utility, thereafter, such interesting issue about GCCS (green communication cellular system) is addressed by a lot of researches who major in such research field [1]. There are a huge amount of issues for discussing the communication standard protocols of 3GPP (third generation partnership project) and 4G LTE are addressing deeply [2-4]. In real application of wireless communications, the exploration of power saving has become much more while cellular networks and new technologies are growing gradually. On the other hand, the issue of power saving in a GCCS turns out very important. Reviewing all the relevant works, in [5] a great power saving method is proposed in both environmental and cost point of view by improving the energy efficiency of BS (base stations) in cellular networks, and which is dealing with the improvement transmitter efficiency, system features, fresh air cooling, alternative energy sources, and energy saving during low traffic are given. The article in [6] elaborates on all levels of the communication system, covering network level aspects, including deployment, architecture and network management; link level perspective; and the component level, including hardware implementation targeted for improving energy efficiency in radio access network operation. Besides, to discuss the indoor coverage seriously affected by a macro BS shutdown is shown in [7]. Afterwards, it investigates the option of a small cell overlay to sustain network coverage in case of macro BS shutdowns and derives a strategy to operate a heterogeneous UMTS RAN (consisting of small and macro cells) in an energy efficient way. Finally, the authors give an example scenario in which the dynamic control of a heterogeneous UMTS RAN leads to energy saving up to 7.5% compared to a static macro cell operation. The study in [8] is with simple analytical to model the energy-aware management of cellular access networks, trying to characterize the amount of energy that can be saved by reducing the number of active cells during the period when the traffic is low. When some of cells are switched off, radio coverage and service provision is taken care of by the cells that remain active, so as to guarantee that the service is still available over the whole area. It also shows how to optimize the energy saving, first assuming that any fraction of cells can be turned off, and then accounting for the constraints resulting from the cell layout. On the basis of instantaneous traffic intensity, reduces the number of active access devices when they are underutilized (typically at night), the investigation in [9] propose a novel approach for the energy-aware management of UMTS access networks consisting in a dynamic network planning. The paper in [10] explores the green or energy efficient operation of cellular access networks through dynamic spectrum and traffic load management techniques. It discussed different energy saving techniques along with applications in realistic multi-cellular scenarios and by means of BS cooperation. The outage probability analysis is also discussed with different energy saving techniques in order to satisfy a particular QoS (Quality-of-Service) threshold for different services. The analysis is supported by different BS power consumption models, traffic models, and realistic statistics of different BSs in London, UK. Results show a considerable power saving potential of up to 65% or more in BS power. Consider energy efficiency in cellular network planning, a new parameter for traffic estimation is introduced in [11] which is low traffic time ratio. In order to switch off more cells for insufficient cell zooming, two solutions are feasible, that is, to deploy smaller but more cells or to implement coverage extension technologies. For reducing Carbon emissions in general in ICT from the present 3 percent and in particular in Mobile communications has been of a serious concern. In the next generation cellular technologies like LTE, BSs are very energy hungry, as they need to provide high spectral efficiency and wide coverage. Hence, the report in [12] discusses with the various possibilities and makes a practical assessment of a possible green form of LTE. In addition, the article [13] provides an overview of network energy saving studies currently conducted in the 3GPP LTE standard body. The aim of [13] is to gain a better understanding of energy consumption and identify key EE (electrical electronic) research problems in wireless access networks. It also to classify network energy saving technologies into the time, frequency, and spatial domains, the main solutions in each domain are described briefly. As presently the attention is mainly focused on solution involving a single radio BS, the authors involving multiple networks/systems will be the most promising technologies toward green wireless access networks. The introduction of the uplink technology, the current state of progress in 3GPP as well as expected schedule for actual specification availability and describes a couple of key features is presented in [14]. It also presented channel dependent frequency domain scheduling and Multi-User MIMO in more detail. Finally, the system performance results for channel dependent frequency domain scheduling are presented as well. The paper [15] examines SC-FDMA (single carrier frequency division multiple access) with frequency domain equalization for uplink data transmission, and it also investigates channel-dependent scheduling schemes to achieve multi-user diversity and frequency selective diversity. There are two subcarrier mapping schemes in SCFDMA: Localized FDMA (L-FDMA) and Interleaved FDMA (IFDMA). The results shown in [15] that rate-sum capacity can increase up to 130% for L-FDMA and 40% for I-FDMA relative to static round robin scheduling. On the other hand, the repot in [16] focuses on UMTS access networks, since access devices play a rule who is the main energy consumer in UMTS networks. The authors propose a novel approach for the energy-aware management of UMTS access networks consisting in a dynamic network planning, which bases on the instantaneous traffic intensity and reduces the number of active access devices when they are underutilized. With the rapid increase of modern communication networks, the environmental problem has emerged. To reduce the emission of CO2 has been considered as an important goal for the design of GCCS in future. There are many papers present the introduction to the opportunities and challenges in GCCS and discuss the key techniques in current research including cognitive networks, network coding and smart grid [17-20]. Since the energy consumption and efficiency of wireless networks have become a societal challenge propose, to combine CR (cognitive radio) and social network technologies in such a way that energy and spectrum information can be obtained through social network in order to reduce the sensing burden of CR devices. Furthermore, in paper [21] try to join the two aspects of CR adaptability and indirect cooperation typical of social networks together, thus, a much lighter and more flexible distributed infrastructure are developed. The functionalities of the network elements and their interfaces are detail described in it too. The authors in [22] note that the energy consumption in communication networks has attracted the increasing attentions. Hence, they proposed a user-motivated topology formation scheme for green communication networks, and they also model and analyze by using of a potential game. The equilibrium topology formation is proved to exist and the performance of their proposal in terms of price of stability is discussed in their works.

Authors try to propose a scheduling controller for handling the scheme between BS and the mobile unit in order to reduce the power consumption for a GCCS is one of the main contributions in this paper. After the completion of reviewing to those aforementioned works which are almost few articles to discuss with the issue addressing in the relationship between cost utility and outage performance. Consequently, the other one contribution of this article is to model a deployment for analyzing GCCS, and by means of tuning some important coefficients, for instance, cost utility, mobile user numbers, the distance between BS and mobile unit, and threshold value of outage probability, to obtain some optimization ways for power saving and to provide the information to the system operators. Moreover, the optimized time interval of after dark is adjusted with a best way for pursuing the balance of system performance and the performance of outage probability. In the real world according to the previously remained contributions which are going to provide with a lot of useful suggestions for wireless communication operators in making the strategies of power saving. The paper is organized as: after Section I the system model and system analysis are presented in Section II. In Section III the system performance is numerically discussed. There is a brief conclusion is drawn in Section IV.

Ⅱ. DEPLOYMENT AND EVALUATION OF A GCCS

Accordingly, a system model for system analysis is proposed and shown in Fig. 1 in which there are 3 mobile users deployed in 3 BSs (base stations), BS-A, BS-B, and BS-C, separately. The power control scheme is considered and all the users are assumed to be allocated uniformly within the BS. Besides, the data rate provided by the all 3 BSs is considered well suitable for these independent 3 mobile users On the other hand, for considering the reason of power saving two of the three BSs will be preset in "after dark" status, while there is just one of the mobile unit is active within the deployed environment. For clear explanation of the operation for power saving shown in Fig. 1, where the two BSs, BS-B and BS-C, are both going into "after dark" status. However, the BS-A is serving a mobile user under the assumption that all the BSs can provide equivalent QoS for all users. Moreover, under a much larger serving area of GCCS which operation can be known that there has a serving scheduling of the BS. Once a mobile unit is linking one of the BS, then there is a scheduling controller who is in charging of distributing the multiple BSs for the user's request. The scheduling controller has to repeat figure out some conditions, such as the numbers of BS which can serve to the mobile unit, the diversity channel gain, the data rate adopted for the up and down link services, the fixed number of BS which can provide with enough power for the mobile unit, and the most important one is to calculate a well appropriate BS for the linking user when some of the others are going into the state of "after dark". In words, for power saving within an environment of a GCCS, under the consideration of equivalent QoS the paper proposed an algorithm for scheduling the operation for serving the fair link operation between mobile and BS located in the deployment shown in Fig. 1. It is the significant contribution of the article which is to determine the threshold of outage probability of a GCCS, and tell what will the impact on operator's cost effect to the cellular system operators. In effect, there are many parameters also included in the evaluation of outage probability, for instance, the cost utility, user numbers which a BS can serve, the distance between the mobile user and BS, and the threshold value of outage probability, and so on.

By adopting the condition same as that considered in [1], assuming that one acceptable data rate is fixed and the QoS is kept in the assurance state. Then the scheduling controller is verified that it is able to handle well with all the communication links completely. Thus, in case the QoS condition is suitable for the referred mobile users and the overall cost utility can be expressed as

$$U_{tot} = \sum_{j=1}^{L} U_l \tag{1}$$

Where $j = 1,...,L$ define the BS number from 1 to *L*, the first and the *L-th* are considered as the two which has the worst and the best performance, respectively. Now, if all the conditions can match with these remained previously and consider that there is another BS can give the same service to all the active users, then it's cost utility denoted as U_{top}^{new}. As the variation of power is accepted and the comparison between the new one and the original one is same, the *j-th* BS will be closed and go into the "after dark" status, thus $U_{tot} = U_{tot}^{new}$. Assume that the original serving BS is still keeping on, while a new service is not applied by the new BS. Repeat the proposed scheduling algorithm until an appropriate BS is determined. It is known that the total power and the active user numbers will impact on the cost utility. Thereafter, following up the control scheduling, the total judgment cost utility, U_t, of a GCCS can be evaluated as [1]

$$U_t = N_{served,l} \times \exp(P_{out,th} - \frac{N_{out,l}}{N_{served,l} + N_{out,l}}) - C_l \tag{2}$$

Where $P_{out,th}$ denotes the tolerant threshold value of outage probability for a BS, $N_{served,l}$ is the total mobile users who are served with the qualified BS, $N_{out,l}$ indicates the number of the *l*-th BS user who are not getting from the service resources, and C_l, $j = 1,...,L$, express the original expense cost of a serving BS.

The initial cost is kept constant same as shown in [1], that is, the power is under stable state when the activity user number and the threshold value of outage probability for a BS are changeable. In fact, the formula of such cost utility evaluated in such situation is involving the conditions that an authorization of a GCCS is transferred from one communication's operator to the other one. The original cost is assumed expense in US dollar 35, however, it is considered that the cost should include many useful arguments, for example, the active mobile users, the threshold value of outage probability. Therefore, a new evaluation formula to close the fact of cost utility for a BS which is working in a GCCS is derived and expressed as in this report. The threshold of outage probability, $P_{out,th}$, is obtained in (2) already [1]. The $P_{out,th}$ definitely decided follow up several parameters or it may correlate with the limited preset values. A new evaluation way is defined in this paper after some inferring, first that a logarithm function is adopted for the relationship between the cost utility of a communication operator and the preset value of outage probability threshold, the power consumption is inverse to the cost utility, etc.. Furthermore, the distance between the mobile user and the working BS, and the operation income (cost) are also considered necessary. In summary, a theoretical formula to evaluate the cost utility can first determine the prime cost shown as

$$C_l = \frac{-\log(P_{out,th}) \times (N_{served,l} + N_{out,l})}{P} \qquad (3)$$

Where P is the power consumed between a BS and one of the mobile users. Finally, the cost utility is able to be determined by substituting (3) into (2), hence, an alternatively expression of the cost utility for a system operator can be written as

$$U_t = N_{served,l} \times \exp(P_{out,th} - \frac{N_{out,l}}{N_{served,l} + N_{out,l}}) - \frac{-\log(P_{out,th}) \times (N_{served,l} + N_{out,l})}{P} \qquad (4)$$

Where P is power dissipation of a BS within the scenario of the deployed GCCS, V denotes the transmission energy which adopts cost231 Walfish-Ikegami NLOS (non-line-of-sight) model [23], thus, the power dissipation of a BS can be obtained as

$$P = \frac{v^2}{R} = \frac{\left[\log_{10}(89.558 + 38 \times \log(d) + (24.5 + \frac{1.5 \times f}{925})\log(f))\right]^2}{R} \qquad (5)$$

Where, d is the distance between mobile user and the working BS, which will be assumed as 1*Km*, 2*Km*, 3*Km*, when the numerical evaluation is deploying, and the working frequency, f, is set as 750 *MHz*, and R is the input resistance which considers as *50* Ohm.

Ⅲ. NUMERICAL RESULTS AND DISCUSSION

In this section the results from numerical evaluation follow up the theoretical formulas aforementioned are illustrated. System parameter with $C_l = 35\ \text{cent} / \text{kHZ}$ is adopted the same one shown in [1]. By means different arguments which consider impact the cost utility of a GCCS. Normally, the threshold value of outage probability is specified in the interval of 0 to 0.1, and the total number of mobile users equal to $N_{servel,l} + N_{out,l}$ which is assumed as 1000 uniformly distributes within the GCCS. The channel model is given as Cost-231 Walfish-Ikegami NLOS [23], the working frequency is set as $750\,MHz$ with one roof in a house embedded in the LOS propagation channel, 50 Ohm is used for the input resistance, many different distances between mobile user and BS are considered as 1, 2, and 3 Km. Under the consideration of original cost C_l=35 $cent / kHZ$, in Fig. 2 which is clear to see that the C_l do not depend on the parameter of $P_{out,th}$. However, this phenomena will become variation when it comes out from the (4) derived in the remained previously. More preciously describe that the curves shown in Fig. 2 are among the relationship of 3 arguments, cost utility, mobile user numbers, and threshold outage probability. It is easy to know that the cost utility always reduces whatever the number of linking users and the threshold outage probability. On the other way, there is a 3-dimension graph illustrated in Fig. 2 which can also show off that the relationship between the number of linking users and the outage probability threshold is always going down, whenever both become lower gradually. The plots presented in Fig. 3 are compared the one comes out from the derivation in this article with the other one shown in [1] which is fixed with $C_l = 35\text{cent}/\text{kHZ}$. There are two respects can be applied to explain those curves shown in Fig. 3. It is reasonable to describe that the logarithm function more suitable for original cost and the outage probability threshold illustrated in Fig. 3. Besides, the issue addressing in the relationship between distance and the cost utility is interesting. Hence, the curves of cost utility versus distance between BS and mobile units are shown in Fig. 4 in which 0.05 is previously assigned as threshold value of outage probability. It is worthy to say that the larger number of mobile user, the more cost utility is.

Ⅳ. CONCLUSIONS

In this article several useful parameters which affect the OP performance of a specified GCCS are theoretically investigated. Generally, punish in cost utility will be accepted if the power saving can't be obtained completely. For discussion such issue, by adopting one well designed algorithm to distribute different mobile users uniformly to each BS (base station) proposed in the report. At last, there are many parameters are assigned to have appropriate the purpose of the proposed scheme for power saving, such as the threshold value of outage probability, the time of after dark. Furthermore, some of the results from the derived system performance are shown to express the fact which exits between the cost efficient of the system operators and the system performance of the cellular radio communications. In summary, model a deployment for analyzing GCCS by means of tuning some important coefficients, *e. g.* cost utility, mobile user numbers, distance between BS and mobile unit, obtain the optimization ways for power saving, and provide the information to the system operators are achieved in this paper. The optimize time interval of after dark is adjusted with a best way to pursue the balance of system performance and the performance of outage probability.

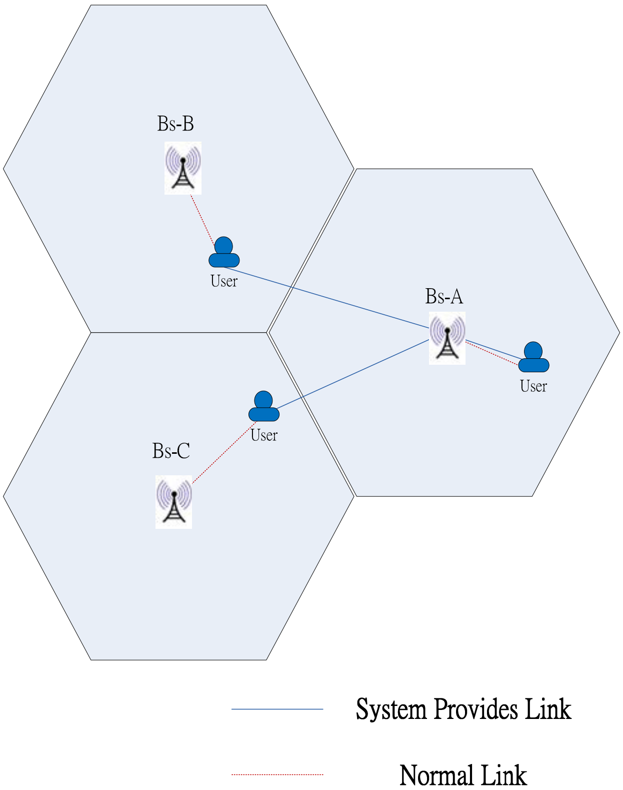

Fig. 1. System model of a GCCS.

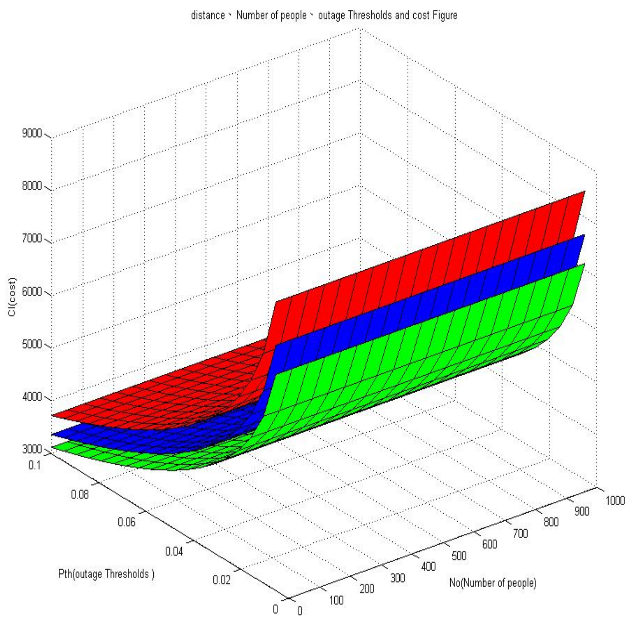

Fig. 2. The curves among cost utility, mobile user numbers, and threshold outage probability.

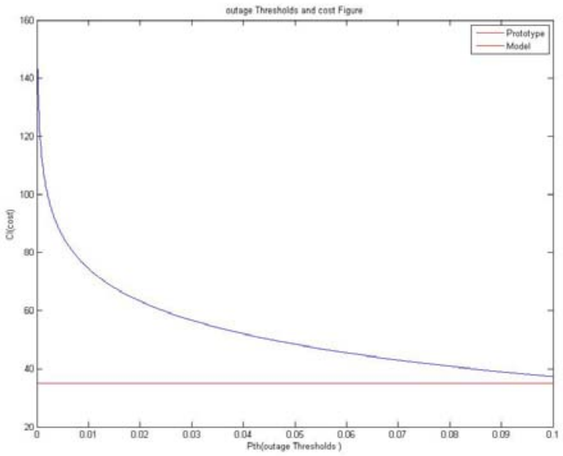

Fig. 3. The curves between cost utility, and threshold outage probability.

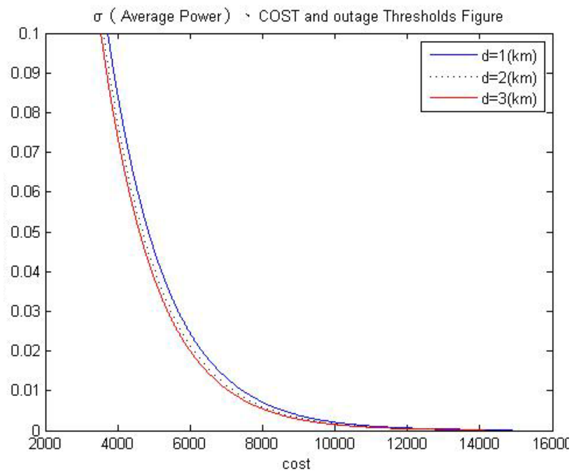

Fig. 4. The curves among cost utility, distance between BS and mobile units.

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