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Coverage Optimization in Heterogeneous Networks Using UER

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ABSTRACT:- The main motto of this paper is to explore user equipment deployed as relays node in heterogeneous networks and analyses the energy efficiency aspect of such communication and show that using user equipment's as relay helps improving energy efficiency too and to use mobile device as relay is to extend cellular coverage whilst saving capital expenditure of base station deployment. Analyses the possibility of using user equipment as relay to improve Performance of cell edge users and suggest a time based resource partitioning method for relay user equipment to handle Cross-tier interference. Simulate the SINR and bit rate received at UEs. To compare performance, two scenario viz. macro only and macro plus Pico deployment is considered as baseline.

KEYWORDS:- Heterogeneous Network, Coverage Optimization, UER

INTRODUCTION

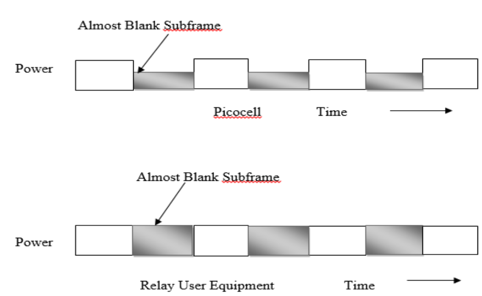
Wireless communication networks are broadly deployed to provide different communication services such as voice, video, packet data, messaging, broadcast, etc. These wireless networks may be multiple-access networks capable of supporting multiple users by sharing the available network resources e.g., bandwidth and transmit power. Examples of such multiple-access networks include Code Division Multiple Access networks, Time Division Multiple Access works, Frequency Division Multiple Access networks, Orthogonal FDMA networks, Single-Carrier FDMA networks, Third Generation Partnership Project Long Term Evolution networks, and Long Term Evolution Advanced networks.

A wireless communication network may include a number of base stations that can support communication with a number of user equipment devices. A UE may communicate with a base station via the downlink and uplink. The downlink or forward link refers to the communication link from the base station to the UE, and the uplink or reverse link refers to the communication link from the UE to the base station. A base station may transmit data and control information on the downlink to a UE and or may receive data and control information on the uplink from the UE.

This communication link may be established via a single-input single-output, multiple-input single-output or a multiple-input multiple-output system. Wireless communication systems may comprise a donor base station that communicates with wireless terminals via a relay node, such as a relay base station. The relay node may communicate with the donor base station via a backhaul link and with the terminals via an access link. In other words, the relay node may receive downlink messages from the donor base station over the backhaul link and relay these messages to the terminals over the access link. Similarly, the relay node may receive uplink messages from the terminals over the access link and relay these messages to the donor base station over the backhaul link. The relay node may, thus, be used to supplement a coverage area and help fill coverage holes.

PROPOSED TECHNIQUE

In this section, propose a time based resource partitioning method wherein one set of devices are allowed to transmit in certain sub frames and the rest in the remaining sub frames so that there transmission never overlap. Thus, able to mitigate interference by achieving time domain orthogonality in spectrum access. This technique is also referred as Inter Cell Interference Coordination using Almost Blank Sub frames.



PROPOSED FORMULA TO CALCULATE THE MAXIMISE THROUGHPUT OF RELAY DEPLOYMENT

In this technique, divide the available wireless resources into two partitions. First partition of FABS = αF subframes are reserved exclusively for REUEs' transmission as to protect their signal quality. While the remaining F_{nABS}= F $-F_{ABS}$subframes are reused by MBS, PBSs and RUEs to serve their UEs. To protect the signal quality of macro and pico UEs, perform subchannel power control over F_{nABS} subframes for REUEThe aim is to maximise throughput of relay deployment by solving the following optimization problem,

Maximize

$$\Gamma_j^k \quad \sum_{K=1}^{N_R} \sum_{J=1}^{N_U^k} \frac{F_{nABS}}{N_U^k} \log_2\left(1 + \Gamma_j^k P_{tx}^k H_j^k\right)$$

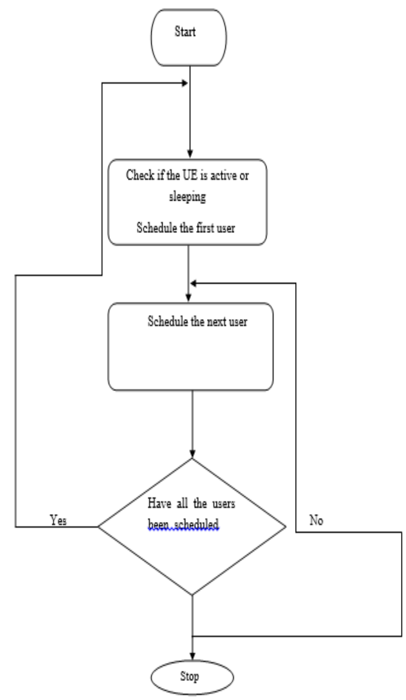
Subject to, $\sum_{k=1}^{N_R} \Gamma_j^k P_{tx}^k H_j^k \le I_{max} \qquad \forall_j$

$$\Gamma_j^k \ge 0 \qquad \forall_{j,k}$$

Where N_R and N_U^krepresent to total number of RUEs and number of REUEs in k^{th} RUE, respectively.H_j^krepresent to path loss.$\Gamma_j^k$is the non negative power factor that is applied to each UE of RUEs to perform power control over F_{nABS} subframes. To solve this problem, here is convert it into Lagrange's dual problem and find out the power factor values for each REUE.

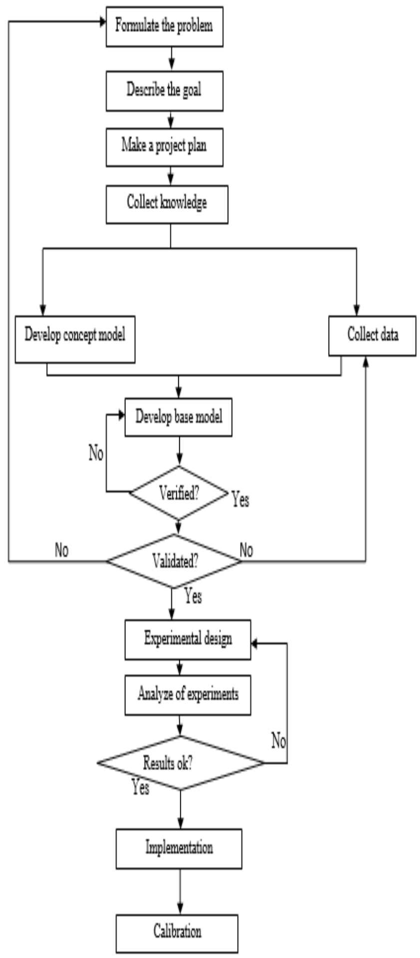
In the following example a round robin scheduler is considered where Macro-eNB users and center picoeNB users are only allowed to be scheduled in the non-ABS while the range extension Pico-eNB users are only allowed to be scheduled in the ABS. The constraint on the center Pico-eNB users is introduced for simplicity and to allow the range extension users some fairness in using the ABS because in reality ABS are shared between center and range extension Pico-eNB users and it becomes harder to determine which users are scheduled in the ABS. And an introduction about round robin scheduler.

Round robin is a simple scheduling method that is based on assigning the resources to the terminals in turn, one after another, which means that all the users have equal chances to be scheduled without considering their channel quality indicator which is explained in the flow chart.



FLOW DIAGRAM OF THE PROPOSED MODEL

I. Formulate the problem is detected by using a formula.
II. Describe the energy efficiency and throughput is the key goal in this phase.
III. Make a project plan the events of the simulation to achieve the goal.
IV. Collect Knowledge collect knowledge from survey papers.
V. Develop concept model Using ABS Technique the concept model is developed in heterogeneous networks.
VI. Collect data for the SINR and Throughput are collected.
VII. Develop bas model the base model is developed depending on proposed technique.
VIII. Experimental design simulates the developed scenario depending on various scenarios and users.
IX. The experiment design is analysed.
X. Implementation and calibration the developed model is implement and standardised according to the need.



CHANNEL AND INTERFERENCE MODEL

Considering OFDMA and Rayleigh flat fading sub channels, inter-channel interference is assumed to be negligible. In Reuse 1 case, the downlink Signal to Interference plus Noise ratio, SINR$Y_{m,j(d)}$, of UE j when connected to BS m over a distance d is given by,

$$\Upsilon_{m,j(d)} = \frac{P_{tx,m} S_j^m}{\sum_{l=1,l\neq m}^{N_{MBS}} P_{tx,l} I_j^l + \sum_{t=1,t\neq m}^{N_{PBS}} P_{tx,t} I_j^t + N_0}$$

Where S_j^m is the signal gain between UE_j and base stationm. Similarly I_j^l is the effective interference loss at UE_j frombase station l. N_0 represents the adaptive white Gaussian noisewith zero mean.

Based on the received SINR at user, an instantaneous bit rate is assigned using the following formula

Bit rate = N *W *$\log_2$(l +$\Upsilon_{m,j(d)}$)

Where N is the number of sub channels assigned to UE_j and W is the bandwidth of each sub channel.

ENERGY CONSUMPITION

In this section, the total energy consumption of the system has been evaluated. This model consists of two different types of base stations viz. MBS/PBS and RUE. MBS and PBS serve quite large number of users over much higher distance. Energy consumption of MBS/PBS is considered to be load dependent with some fixed "zero-load" power loss. While, RUE is assumed to serve only a small number of UEs over much smaller distance 10-15 Meters. Due to this, their energy consumption is assumed to linear with offered load. Energy consumption of MBS/PBS can be calculated using the following equation,

$$E_{MBS} = E_{zero} + \left(\frac{Tm}{\varsigma PA} + P_{SP}\right)$$

Where E_{zero} is fixed "Zero Load" energy consumption andςPA, P_{SP} represent power amplifier efficiency and signal processing loss, respectively. Here Tm is the total power at which base station transmission is done. In order to analyze energy efficiency of the system, Energy Consumption Rating has been used as energy efficiency metric. This metric gives the energy consumption normalized to capacity (Watts/Mbps) [40].

ECR = System Capacity/Energy Consumption

ALLOCATION CHALLENGE

As seen earlier, a relay BS can either work in in-band mode or in out-of-band mode. Since UEs are generic equipments, the support required in them to handle multiple bands poses a challenge. Hence, it is a natural choice to reuse the spectrum that is used between the RUE and the donor base station. UEs, being power restricted, are designed to use lower frequency bands for uplink transmission to the base station while higher frequency bands are reserved for its downlink transmission.

When a UE decides to be an RUE, it can adopt one of the following options

1. High Frequency Transmission
2. Low Frequency Transmission

RESULTS AND DISSCUSSION

Simulation Parameters:

Parameter	Value	
Bandwidth	10 MHz	
No. of Sub channels	256	
MBS Transmit Power	46dBm	
UE Transmit Power	23dBm	
Wall Loss	10 dB	
Gaussian Noise Figure	-174dBm/Hz	
UE Power Consumption	1Watt	
Zero-Load MBS Power Consumption	500 Watt	
Zero-Load PBS Power Consumption	150 Watt	
Path Loss Coefficient	Macro cell Pico cell Relay UE	2 2.5 2.5
Antenna Gain	Macro cell Pico cell User Equipment	14 dB 7 dB 0 dB

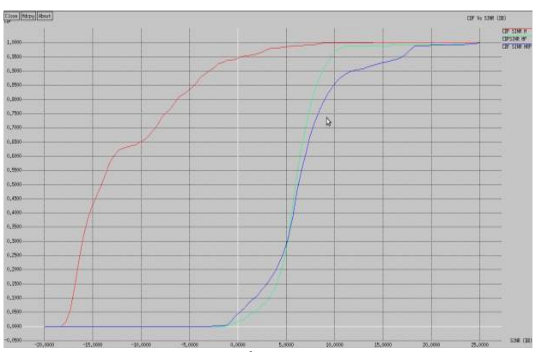


Fig. CDF of UE SINR

To analyze the performance of the technique, here is compare the SINR and bit rate received at UEs. To compare performance, two scenario viz. macro only or M and macro plus Pico or MP deployment are considered as baseline. In these figures depicts the CDF of SINR and CDF of received bit rate at UEs, respectively. As can be seen, the CDF of UEs for proposed allocation technique outperforms the macro only and macro/pico deployment scenario. In figure is show that UE SINR of MPR or Proposed technique is better as compare to MP and M.

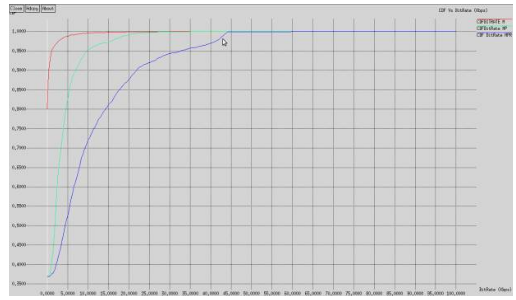


Fig. CDF of UE Bitrate

In figure is show that UE bit rate of MPR is better as compare to MP and M.

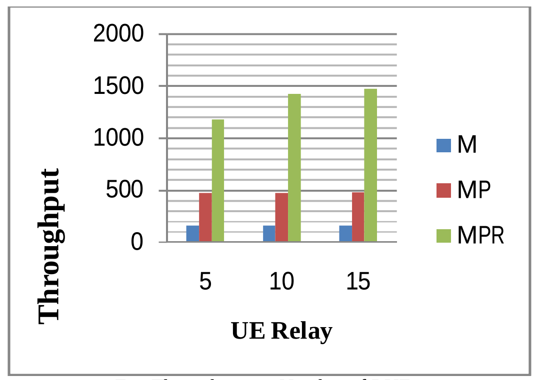


Fig. Throughput vs. Number of RUEs

RUE deployment, more and more users now able to communicate whilst is improving overall network utilization. With slight loss in RUE throughput, not only able to support more users but also reduce per user energy expenditure. Consequently, this improvement in throughput is clearly visible in figure, where can see huge gain in system capacity is observed for suggested technique. Additionally, now more UEs are served using RUE, no additional power.

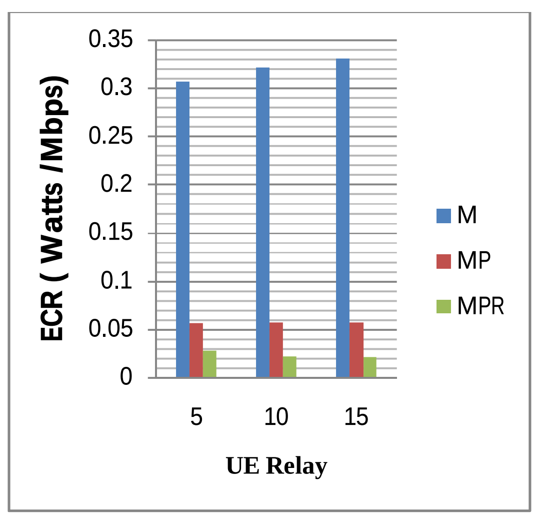


Fig. Energy Consumption Rating vs. Number of RUEs

In this figure Consumption is involved at BS, thereby improving energy efficiency of the system. Here is also analyse the lifetime of RUEs and found that average life time of RUEs reduced by just 10% and also analyse the blocking probability of the system. As RUE able to support additional UEs in extended region, the overall blocking probability of the system also greatly improved. For deployment scenario, initial blocking probability of 5.6% drop down to as low as 0.23 percentages.

CONCLUSION

Deployment of Relay User Equipments in a heterogeneous network not only shows improvement in coverage and capacity of the network, but also helps in decreasing networks' energy consumption. While the current simulation is done with fixed almost blank frame density, the same can be made dynamic based on system load and relay node availability. Combined with the efficient discovery algorithms, let's see relay user equipment as a natural extension for heterogeneous cellular networks to improve capacity and coverage.

REFERENCES

[1]. 3GPP TR 36.913,"Requirements for further advancements for Evolved UTRA or EUTRA Release 10", version 10.0.0., March 2011. Available: www.3gpp.org.

[2]. A. Bou Saleh, O¨ . Bulakci, S. Redana, B. Raaf, J. Ha¨ma¨la¨inen.: "Enhancing LTE advanced relay deployments via biasing in cell selection and handover decision", IEEE 21st International Symposium on Personal Indoor and Mobile Radio Communications , September 2010.

[3]. T. Beniero,S. Redana, B. Raaf, J. H¨am¨al¨ainen.: "Effect of relaying on coverage in 3GPP LTE-advanced", IEEE 69th Vehicular Technology Conference Spring 2009, April 2009.

[4]. A. Bou Saleh, S. Redana, B. Raaf, J. H¨am¨al¨ainen.: "On the coverage extension and capacity enhancement of inband relay deployments in LTE-advanced networks", Journal of Electrical and Computer Engineering - Special issue on LTE/LTE advanced cellular communication networks archive Volume 2010, Article No. 4,January 2010.

[5]. E. Lang,S. Redana, B. Raaf.: "Business impact of relay deployment for coverage extension in 3GPP LTE-advanced", IEEE International Conference on Communications Workshops, 2009. ICC Workshops2009, June 2009.

[6]. Bulakci, S. Redana, B. Raaf, J. H¨am¨al¨ainen. Performance enhancement in LTE advanced. relay networks via relay site planning", IEEE 71st Vehicular Technology Conference , May 2010.

[7]. Bou Saleh, S. Redana, B. Raaf, J. H¨am¨al¨ainen. "On the coverage extension and capacity enhancement of inband relay deployments in LTE-advanced networks", Journal of Electrical and Computer Engineering - Special issue on LTE/LTEadvanced cellular communication networks archive Volume 2010, Article No. 4, January 2010.

[8]. A. Bou Saleh, .Bulakci, S. Redana, B. Raaf, J. Ha¨ma¨la¨inen. "Enhancing LTE advanced relay deployments via biasing in cell selection and handover decision", IEEE 21st International Symposium on Personal Indoor and Mobile Radio Communications , September 2010.

[9]. S.pingYeh, S. Talwar, G. Wu, N. Himayat, and K. Johnsson, "Capacity and coverage enhancement in heterogeneous networks," Wireless Communications, IEEE, vol. 18, no. 3, 2011.

[10]. C.E. Shannon, "A mathematical theory of communication", Bell system Tech. J. 27 July and October 1948.

[11]. A. Damnjanovic, J. Montojo, Y. Wei, T. Ji, T. Luo, M. Vajapeyam, T. Yoo, O. Song, and D. Malladi, "A survey on 3gpp heterogeneous networks," Wireless Communications, IEEE.

[12]. A survery on 3GPP Heterogeneous networks" Aleksandar damnjanovic, juanmontojo Yongbinwel, tingfangji, taoluo, madhavan vajapeyan, taesangyoo, osoksong, durgamalladi, qualcomminc.

[13]. J. Andrews, H. Claussen, M. Dohler, S. Rangan, and M. Reed, "Femtocells: Past, Present, and Future," IEEE Journal on Selected Areas inCommunications,, vol. 3,April 2012.

[14]. J. Kim, J. R. Yang, and D. I. Kim, “Optimal relaying strategy for ue relays,” in Communications , 2011 17th Asia-Pacific Conferenceon, 2011.

[15]. K. Vanganuru, S. Ferrante, and G. Sternberg, “System capacity and coverage of a cellular network with d2d mobile relays,” in MILITARY COMMUNICATIONS CONFERENCE, 2012.

[16]. Z. Shi, M. Zhao, H. Wang, and M. Reed, “On the uplink capacity and coverage of relay-assisted umts cellular network with multiuser detection in Wireles Communication and Networking Conference (WCNC), 2012 IEEE, 2012.

[17]. I. Katzela and M. Naghshineh, “Channel assignment schemes for cellular mobile telecommunication systems: A comprehensive survey,” IEEE Communications Surveys Tutorials, vol. 3, no. 2, June 2000.

[18]. S. Tombaz, M. Usman, J. Zander, “Energy Efficiency Improvements Through Heterogeneous Networks in Diverse Traffic Distribution Scenarios,” CHINACOM’11, Aug., 2011.

[19]. Qualcomm, “LTE Advanced: Heterogeneous networks,” Qualcomm HP, January 2011.

[20]. K. Kikuchi and H. Otsuka, “Proposal of adaptive control CRE in heterogeneous networks,” in Proc. PIMRC 2012, NET7, Sept. 2012.

[21]. 4G Americas; “4G mobile broadband evolution: 3GPP release 10 and beyond,” 4G Americas HP, Feb. 2011.

[22]. 3GPP, TR36.806 (V9.0.0), “Relay architectures for E-UTRA (LTE Advanced),” Mar. 2010.

[23]. H. Otsuka, H. Masuda, and A. Nakajima, “Design and performance of fiber-optic relay node for mobile communication systems,” in Proc. Eu MW 2012, Oct. 2012.Yuki NAKANISHI, Ryohta YANAGUCHI “A New Collision Judgment Algorithm for Pedestrain – Vehicular Collision Avoidance Support System in Advanced ITS” *Information Network laboratory*, 2010.

[24]. P. Tian, H. Tian, J. Zhu, L. Chen, and X. She, “An adaptive bias onfiguration strategy for Range Extension in LTE-Advanced Heterogeneous Networks,” in Proceedings of the IET International Conferenceon Communication Technology and Application, October 2011.

[25]. S. Strzyz, K. Pedersen, J. Lachowski, and F. Frederiksen, “Performance optimization of pico node deployment in LTE macro cells,” in Proceedings of the Future Network and Mobile Summit, June 2011.

[26]. A. Bou Saleh, O. Bulakci, S. Redana, B. Raaf, and J. Hamalainen, “Enhancing LTE-Advanced relay deployments via Biasing in cell selection and handover decision,” in Proceedings of the IEEE International Symposium on Personal Indoor and Mobile Radio Communications, September 2010.

[27]. Cell Selection Techniques in Heterogeneous LTE-Advanced System” Dhaval M. Tandel, Tanvi Shah, Department of the Electronics and communication, Parul Institute of the Engineering, Limda, Vadodara. International Journal on Recent and Innovation Trends in Computing and Communication.

[28]. “Enhancing LTE-Advanced Relay Deployments via Biasing in Cell Selection and Handover Decision” Abdallah Bou Saleh, Omer Bulakci, Simone Redana, Bernhard Raaf Nokia Siemens Networks St.-Martin-Strasse 76, 81541, Munich, Germany.

[29]. R. Shah, S. Roy, S. Jain, and W. Brunette, “Data mules: Modeling a three-tier architecture for sparse sensor networks,” in Proc. IEEESNPA, May 2003.

[30]. R. Thakur, A. Sengupta, and C. Siva Ram Murthy, “Improving capacity and energy efficiency of femtocell based cellular network through cell biasing,” in Proceedings of the 11th International Symposium onModeling Optimization in Mobile, Ad Hoc Wireless Networks, 2013.

[31]. 3GPP, 3rd generation partnership project; Technical specification group radio access network; ‘‘Way forward on time-domain

extension of Rel 8/9 backhaul-based ICIC'',R1-105779, October 2010.

[32]. E. Dahlman, S. Parkvall, J. Sk¨old,"4G LTE/LTE-advanced for mobile broadband" Elsevier Ltd, 1st Ed. 2011.

[33]. H. Holma, A. Toskala,:"LTE for UMTS evolution to LTE-Advanced", John Wileyand Sons Ltd, 2nd Ed. 2011.

[34]. A. Bou Saleh, S. Redana, B. Raaf, Taneli Riihonen, RistoWichman, J. H¨am¨al¨ainen "Performance of amplify-and-forward and decode-and-forward relays in LTE advanced", IEEE 70th Vehicular Technology Conference (VTC 2009-Fall), September 2009.

[35]. Jsydir Harmonized contribution on 802.16j (Mobile Multihop Relay) usage models," IEEE 802.16 Broadband Wireless Access Working Group, September, 2006.

[36]. Nagata, S.; Yan, Y.; Gao, X.; Li, A.; Kayama, H.; Abe, T.; Nakamura, T. "Investigation on system performance of L1/L3 relays in LTE-advanced downlink", IEEE 73rd Vehicular Technology Conference (VTC Spring), May 2011.

[37]. G. Shen, K. Zhang, D. Wang, J. Liu, X. Leng, W. Wang, S. Jin."Multi-hop relay operation modes", Alcatel Shanghai Bell, IEEE 802.16 Broadband Wireless Access Working Group, October 2008.

[38]. 3GPP TR 36.814, "Requirements for further advancements for Evolved UTRA Release 9," physical layer aspects version 9.0.0., March 2010. Available: www.3gpp.org.

[39]. Z. Ma, Y. Zhang, Kan Zheng, W. Wang, M. Wu.: "Performance of 3GPP LTE advanced networks with type I relay nodes", 5th International ICST Conference on Communication and Networking in China (CHINACOM), August 2010.

[40]. X. Wang, A. V. Vasilakos, M. Chen, Y. Liu, and T. T. Kwon, "A Survey of Green Mobile Networks: Opportunities and Challenges," ACM Mobile Networks and Applications, vol. 17,February 2012.

[41]. Book Simulation: The Practice of Model Development and Use by Stewart Robinson (Feb 13, 2004).