MODELING AND ANALYSIS OF ENERGY EFFICIENT NETWORK IN 5G TCHNOLOGY

Manvi Chib[1] Tamanna Pathania[2]

M.Tech Scholar, Department of Electrical & Electronics Engineering[1]

Arni University, H.P

Assistant Professor, Department of Electronics & Communication Engineering[2]

Arni University, H.P

Abstract

Energy consumption has become a primary concern in style and operation of wireless communication networks thanks to two main reasons- Environmental issues and value. the subsequent generation network systems can must think about energy economical styles in any facet. The 5G network that is most expected nowadays although proposes higher knowledge rates however additionally speaks regarding energy potency in its agenda.

Keywords- 5G, beamforming, MIMO.

Introduction

5G networks is that the most anticipated mobile technology development within the next five years. lots of talks, proposals and ideas are suggests in several conferences, congresses and events across the world concerning the necessities and preparation of this technology. Next-generation cellular communication systems, or 5G, are aided by technologies that manufacture vital enhancements in cell outturn. In recent years, varied studies have targeted on large multiple input multiple output (MIMO) systems, that are thought-about to play a major role in coming back 5G technology. The technology until date has primarily focused on the info rates. But energy conjointly changing into a vital parameter for the human survival thence plays a vital role within the improvement of technology. Realizing this, industries are functioning on moving to renewable energy sources like star or wind for powering the bottom stations. The results are promising and appear to cut back the strain on non-renewable resources. large MIMO is another space wherever lots of analysis is being focused on, whereby the quantity of antennas is extremely massive in comparison to the number of users that the bottom station is serving. because the antennas increase, the quantity of power consumed can greatly cut back. it's undoubtedly true that the initial price of installation of large MIMO are very big-ticket because the hardware demand is extremely high in comparison to this variety of antennas that the telecommunication trade is exploitation. However, the energy savings by exploitation large MIMO yield nice leads to the long term. A broad study of various techniques for energy potency reveals that beamforming conjointly plays an awfully crucial role. Beamforming even if has been into existence for over a decade, continuous enhancements within the methodology keeps it earlier than several different technologies used for the common goal.

Problem Definition

Currently in operation wireless networks are principally designed and deployed to maximize user's performance and specialize in turnout, information rates and responsibleness, whereas sometimes paying less attention to energy efficiency. The long run styles of wireless networks must think about energy efficiency, since it's currently a priority of the ICT business to realize energy potency gains. Seeing this, a replacement analysis discipline known as inexperienced cellular networks, concentrating on environmental influences of cellular networks, has been shaped and attracted several researchers. The term inexperienced is originally a nickname for the dedicated efforts to cut back unneeded greenhouse gases like (CO2) emissions from industries. As for analysis the architecture of 4G LTE Network is not based on energy efficient concept even if there was no traffic load the network still consumes energy and to minimize the cost energy consumption there is a need of perfect energy efficient network. Environmental considerations are prime concern and to make green environment we need energy efficient networks.

Methodology

This work can adopt a research methodology that mixes the idea model with empirical analysis and refinement of the planned theme on MATLAB simulation tool. MATLAB could be helpful high-level development surroundings for systems that need mathematical modeling, numerical computations, information analysis, and improvement ways. Cellular network takes Energy consumption (in watt or joule/s) (Cost) as input and gives us data throughput (in bit/s) (Benefit) as output. In order to measure how cost and benefit are balancing each other, we define benefit cost ratio:

$$\text{Energy efficiency [bit/joule]} = \frac{\text{Data throughput [bit/s/km2]}}{\text{Energy consumption } [\frac{\text{joule}}{\text{s}}/\text{km2}]}$$

For, Energy efficiency to be high, Energy consumption should be low. Also, due to environmental conditions and energy being non-renewable, energy consumption should be low. Also, energy costs money. In 4G network, as traffic load increases, we go from a rather high initial Energy consumption to slightly higher one, and Energy efficiency for that reason has grown gradually as the traffic load increases. The reason for initial cost when we don't have any traffic is because of the Architecture of 4G. We have designed 4G network in the way that when no traffic is there, still energy is consumed by the network.We want energy consumption to be linear with traffic load and Energy efficiency be roughly high all the time. Now to find Energy Efficient Network Design, we have used Energy Efficiency Optimization method. The optimization methods are described below:

1. Select network design variables; M, K, ρ, λ, τ
2. Model throughput and energy consumption as functions of these variables.
3. Solve :

$$\text{Maximize } (M, K, \rho, \lambda, \tau) \quad \frac{\text{Data throughput } (M,K,\rho,\lambda,\tau)}{\text{Energy consumption}(M,K,\rho,\lambda,\tau)}$$

Optimization Variables:

M = Number of Antennas, *K* = Number of Active Users, P = Transmitted power, λ = Base station density, τ = Pilot re-use factor (Frame: U channel users)

Simulation Parameters

PARAMETER	SYMBOL	VALUE
Frame Length	U	400
Bandwidth	B	20 MHz
Pathloss exponent	A	3.76
Noise over pathloss at 1 km	$(B N_o)/\omega$	33 dBm
Amplifier efficiency	H	0.39
Static power	$C_{0\,0}$	10W
Circuit power per active user	$C_{1\,0}$	0.1W
Circuit power per BS antenna	$C_{0\,1}$	0.2W
Signal processing coefficient	$C_{1\,1}$	3.12 mW
Coding/decoding/backhaul	A	$1.5*10^{-9}$ J/bit

MODELING DATA THROUGHPUT

Data throughput = $K.(1 - \frac{\tau K}{U})\ Blog_2(1 + SINR)$

K= Multiplexed users

$(1 - \frac{\tau K}{U})$ = Data fraction per frame

$Blog_2(1 + SINR)$ = Data rate per user

SINR =

$$\left(K+\frac{BN_0}{\rho}\right)\left(1+\frac{2}{\tau(\alpha-2)}+\frac{BN_0}{\rho}\right)+\frac{2K}{\alpha-2}\left(1+\frac{BN_0}{\rho}\right)+\frac{K}{\tau}\left(\frac{4}{(\alpha-2)^2}+\frac{1}{\alpha-1}\right)+\frac{M}{\tau(\alpha-1)}$$

Pathloss exponent: α

MODELING ENERGY CONSUMPTION

It depends strongly on hardware.

Characterized by parameters: μ, $C_{0,0}$, $C_{0,1}$, $C_{1,0}$, $C_{1,1}$, A

Energy consumption =

Fixed circuit power

Signal processing

$$K\frac{\rho\omega}{\mu}\frac{\Gamma\left(\frac{\alpha}{2}-1\right)}{\pi\lambda^{\frac{\alpha}{2}}}\left(1-\frac{\tau K-1}{U}\right)+C_{0,0}+C_{0,1}M+C_{1,0}K+C_{1,1}MK+A.\ \text{Data throughput}$$

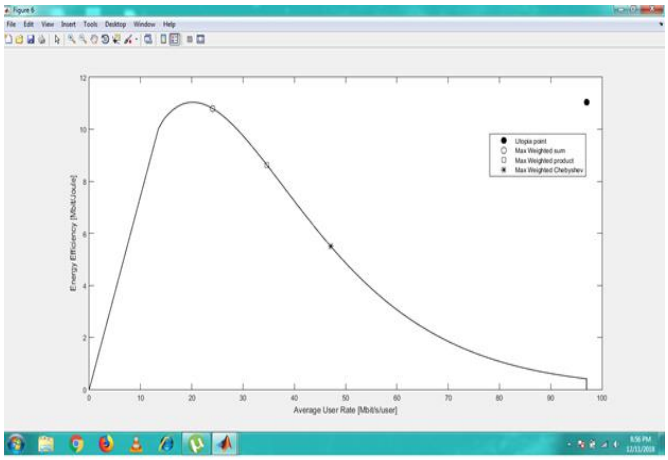
Transmit power with amplifier inefficiency

Power per Transceiver chain

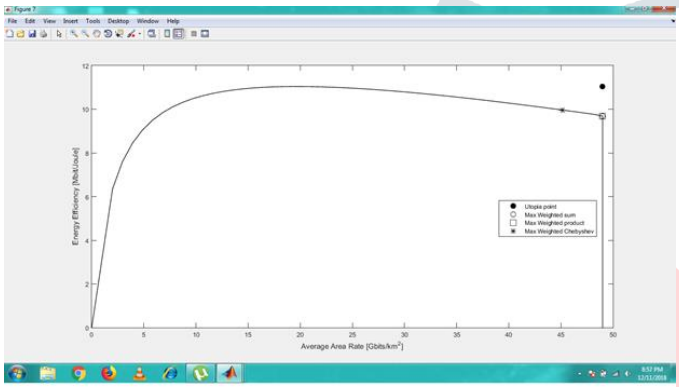
Coding/decoding/backhaul

Results

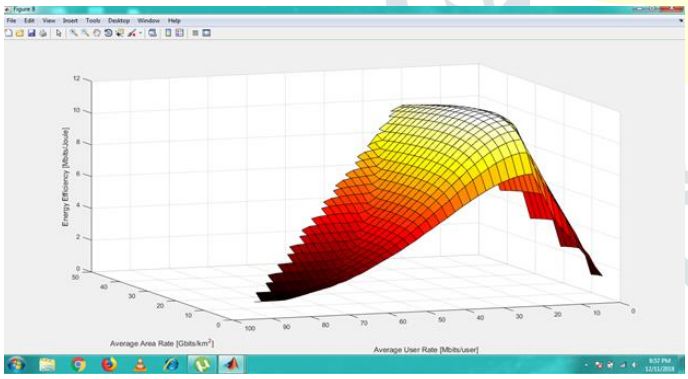
The results are very important for research and development work to prove the problem definition practically. In my research I am using MATLAB tool to simulate the results.



Average user rate and energy efficiency



Average area rate and energy efficiency



Average user rate, average area rate and energy efficiency

Conclusion

The aim of this paper is to gift a number of the foremost promising or potential trendy wireless technologies capable in achieving positive energy savings over the present ways, and to know their potential and relations in energy savings. The work is an initial analysis towards achieving energy efficiency in 5G networks and depth initial study was done on the potential places wherever there's most power consumption in whole mobile network.

References:

1. A. S. Andrae and T. Edler, "On global electricity usage of communicationtechnology: trends to 2030," Challenges, vol. 6, no. 1, pp. 117–157, 2015.

2. MobiThinking, "Global mobile statistics." [Online]. Available: http://mobithinking.com/mobile-marketing-tools/latest-mobile-stats

3. S. Vandris and K.-U. Killiches, "Power optimization in wireless heterogeneousnetworks," LSI White paper.

4. G. Auer, V. Giannini, C. Desset, I. Godor, P. Skillermark, M. Olsson, M. A.Imran, D. Sabella, M. J. Gonzalez, O. Blume et al., "How much energy isneeded to run a wireless network?" IEEE Wireless Communications, vol. 18,no. 5, 2011

5. O. Jumira and S. Zeadally, "Energy efficiency in cellular networks," EnergyEfficiency in Wireless Networks, pp. 1–16.

6. J. M. Elmirghani, T. Klein, K. Hinton, T. El-Gorashi, A. Q. Lawey, andX. Dong, "Greentouchgreenmeter core network power consumption modelsand results," in Green Communications (OnlineGreencomm), 2014 IEEE On-line Conference on. IEEE, 2014, pp. 1–8.

7. O. Arnold, F. Richter, G. Fettweis, and O. Blume, "Power consumption modeling of different base station types in heterogeneous cellular networks," in FutureNetwork and Mobile Summit, 2010. IEEE, 2010, pp. 1–8.

8. S. Cui, A. J. Goldsmith, and A. Bahai, "Energy-constrained modulation optimization," IEEE transactions on wireless communications, vol. 4, no. 5, pp.2349–2360, 2005.

9. H. Holtkamp, G. Auer, S. Bazzi, and H. Haas, "Minimizing base station powerconsumption," IEEE Journal on Selected Areas in Communications, vol. 32, no. 2, pp. 297–306, 2014.

10. R. Combes, S. E. Elayoubi, A. Ali, L. Saker, and T. Chahed, "Optimal onlinecontrol for sleep mode in green base stations," Computer Networks, vol. 78, pp.140–151, 2015.

11. Z. Hasan, H. Boostanimehr, and V. K. Bhargava, "Green cellular networks: Asurvey, some research issues and challenges," IEEE Communications surveys &tutorials, vol. 13, no. 4, pp. 524–540, 2011.

12. T. Chen, H. Kim, and Y. Yang, "Energy efficiency metrics for green wirelesscommunications," in Wireless Communications and Signal Processing (WCSP),2010 International Conference on. IEEE, 2010, pp. 1–6.

13. M. De Sanctis, E. Cianca, and V. Joshi, "Energy efficient wireless networkstowards green communications," Wireless Personal Communications, vol. 59, no. 3, pp. 537–552, 2011.

14. H. Yang and T. L. Marzetta, "Total energy efficiency of cellular large-scale antenna system multiple access mobile networks," in Online Conference onGreen Communications (GreenCom), 2013 IEEE. IEEE, 2013, pp. 27–32.

15. D. Feng, C. Jiang, G. Lim, L. J. Cimini, G. Feng, and G. Y. Li, "A survey ofenergy-efficient wireless communications," IEEE Communications Surveys &Tutorials, vol. 15, no. 1, pp. 167–178, 2013.

16. R. Fedrizzi, K. Gomez, S. Kandeepan, T. Rasheed, and C. V. Saradhi, "Energyaware routing in heterogeneous multi-hop public safety wireless networks," inCommunications Workshops (ICC), 2014 IEEE International Conference on.IEEE, 2014, pp. 218–224.

17. S. Verdu´, "Spectral efficiency in the wideband regime," IEEE Transactions onInformation Theory, vol. 48, no. 6, pp. 1319–1343, 2002.

18. A. El Gamal, C. Nair, B. Prabhakar, E. Uysal-Biyikoglu, and S. Zahedi,"Energy-efficient scheduling of packet transmissions over wireless networks", in INFOCOM 2002. Twenty-First Annual Joint Conference of the IEEE Computer and Communications Societies. Proceedings. IEEE, vol. 3. IEEE, 2002, pp. 1773–1782.\

19. C.-Y. Li, C. Peng, S. Lu, and X. Wang, "Energy-based rate adaptation for802.11 n," in Proceedings of the 18th annual international conference on Mobilecomputing and networking. ACM, 2012, pp. 341–352.

20. S. Nedevschi, L. Popa, G. Iannaccone, S. Ratnasamy, and D. Wetherall, "Reducing network energy consumption via sleeping and rate-adaptation." in NsDI,vol. 8, 2008, pp. 323–336.

21. D. Xenakis, N. Passas, and C. Verikoukis, "A novel handover decision policy forreducing power transmissions in the two-tier lte network," in Communications(ICC), 2012 IEEE International Conference on. IEEE, 2012, pp. 1352–1356.

22. Zheng Chang, Zhenyu Zhou, Sheng Zhou, Tao Chen, TapaniRistaniem "Towards Service-Oriented 5G: Virtualizing the Networks for Everything-as-a-Service" 2017, IEEE Access.

23. Ali Sahlli, Nordin, Mahamod Ismail, FadzilahAbdulah "Beamforming techniques for massive MIMO systems in 5G: overview, classification and trends for future research" 2017, Frontiers of Information Technology and Electronic Engineering, DOI: 10.1631/FITEE.1601817.

24. G. Charis. N. Showme "Beamforming in Wireless Communication Standards: A Survey" 2017, Indian Journal of Science and Technology, Vol 10(5), DOI: 10.17485/ijst/2017/v10i5/99018

25. Shoriful Islam, KartickMondal, TazkiaJessy "Suitable Beamforming Technique for 5G Wireless Communications" 2016, ResearchGate.