Energy Conservation by Traffic Switching Process in Cellular Radio Access Networks

Sugasini. S, I. Muthumani
Department of Electronics and Communication Engineering, ACCET, Karaikudi, Tamil Nadu, India

Article Info
Article history:
Received 3 February 2015
Received in revised form
20 February 2015
Accepted 28 February 2015
Available online 6 March 2015

Keywords
Base Station,
Energy Consumption,
Reinforcement Algorithm,
Transfer Actor Critic Algorithm,
Traffic Load

Abstract
The mobile telecommunication is one of the major contributors to energy consumption and greenhouse gas emission. In a typical cellular system, the base stations (BSs) contribute 60%-80% of the energy consumption of the whole network. Improving the energy-efficiency of the BSs can significantly reduce both the operational cost and carbon footprint. Therefore, to reduce the cost and the amount of energy conseved in cellular network, the reinforcement method is used. This project is mainly proposed for improving the energy conservation of base stations in cellular radio access networks by Markov decision process along with reinforcement learning approach. Here the traffic is calculated through the online processing by Markov decision process. To speed up the ongoing learning peocess, a transfer actor-critic algorithm is used. The process which is mentioned above is completed successfully. Further process of this project is to consider the influence of fast fading effect and noise.

1. Introduction

In information and communication technology (ICT) 80% of the power consumption takes place in the radio access networks (RANs), especially the base stations (BSs). The reason behind this is largely due to that the present BS deployment is on the basis of peak traffic loads and generally stays active irrespective of the heavily dynamic traffic load variations.

Recently, there has been a substantial body of works towards traffic load-aware BS adaptation and the authors have validated the possibility of improving energy efficiency from different perspectives. The possibility of energy saving achieved by actively adjust the working status of BS, contingent on the predicted traffic loads. Prediction is not sufficient for turn off/on base stations. Turning on/off some of the BSs will immediately affect the associated BS of a mobile terminal. At that time the base station consumes high power. On the other hand dynamic BS switching algorithms with the traffic loads a prior and preliminarily proved the effectiveness of energy saving.

A Radio access network is part of a mobile communication system. It implements a radio access technology. It resides between a devices such as a mobile phone, a computer. Depending on the mobile phones and other wireless connected devices are known as user equipment (UE), terminal equipment (TE), mobile station. The effective radio communication is developed by the cognitive radio technology.

A radio network, meaning a network device moves a radio signal to the access network then to the core Network. Architecture of radio access network is shown in Fig.1.In this network the radio signal goes from a base station to a base station that connects to the access network. For an example, When you make a call to your home via your mobile; the call goes to a radio/wireless base station that is connected to the access network via copper or fiber that goes to the POP.

Corresponding Author,
E-mail address: sugasini2705@gmail.com

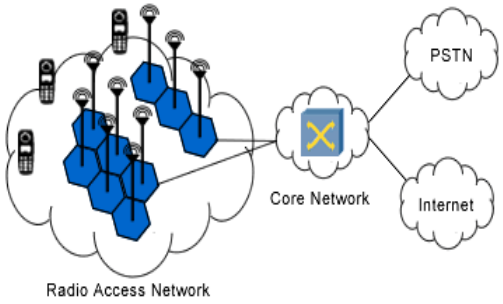

Fig: 1. Radio Access Network

2. Related Work

In existing system impact of RAN, Information and Communications Technology analyze the rate of emission of Carbon di oxide. Also it investigates the base station power consumption of Radio Access Network. A centralized greedy algorithm with complete traffic and channel information. Second they introduce decentralized algorithm especially for to know the local load information and user specific associate control. From this approach they dynamically turn on/off the base stations as our need. In this approach all the base stations are initially in active state when the algorithm is runs, so that unnecessarily we lose some amount of energy.

Many problems in finance, communication networks, energy saving, and other fields can be formulated as dynamic programming problem. Reinforcement learning and neuro-dynamic programming methods try to overcome these difficulties by combining simulation based learning and compact representations of policies and value functions. Here, we propose some actor-critic algorithms in which the critic uses linearly parameterized approximations of the value function, and we provide a convergence proof.

The energy consumption problem with optimal energy efficient user association policy and further presents a distributed implementation with provable convergence. Simple greedy-on and greedy-off algorithms that are inspired by the mathematical background of sub modularity maximization problem. Moreover, we propose other

experimental algorithms based on the distances between BSs or the utilizations of BSs that do not enforce any additional signaling overhead and thus are easy to implement in practice.

3. Proposed Work

We presented a new scheme named as TACT (Transfer Actor Critic Algorithm) in Radio Access Network. Variation of Traffic Load and Reinforcement Learning in TACT easily we can take a decision while Turn off/on base stations in Radio access networks. Markov Decision Process in Traffic Load variations helps to forecasting the traffic load in future. Based on this techniques clearly we can take a decision while turn off/on base stations in radio access network.

A. Network Formation

In this model, we have to create some mobile nodes and Macro base stations and Micro base station.

Macro Base Station

It will cover maximum range of the network, so it will emit large amount of greenhouse gases and it will consume high energy.

Micro Base Station

It will cover minimum range of the network, so it will emit fewer amounts of greenhouse gases and it will consume low energy. All the mobile nodes in the network choose their compatible BTS.

B. Markov Decision Process

MDP comes under the control of decision maker. S denotes state space, A denotes action and P denotes state transition probability function. Here state means state of the BTS, action means Traffic load increases per time. Based on these details it will control decision maker.

C. Reinforcement Learning

BS switching process needs reinforcement learning, especially for energy saving in RAN'S (Radio Access Networks). MDP can solve current Traffic Loads. Reinforcement learning approaches to solve the MDP problem without requiring the knowledge of traffic loads a prior and specifically adopt the actor-critic algorithm.

D. BS Switching Control

BS Switching control, this is the system to take the decisions such as which base stations are necessary and which base stations are unnecessary based on MDP process and transfer actor critic algorithm. Operation of base station switching control is shown in fig.2. From this controller we can improve the energy awareness and reduce the radiations. In the TACT algorithm, the overall policy to select an action and it is divided as a native one and an exotic one. Without loss let's assume that the traffic load state is chosen action. Exotic policy is obtained from learned knowledge transfer.

E. Transfer Learning Framework For Energy Saving

a. Base station controller checks the traffic level in each base station

b. If the traffic level is low it will turn off the base station otherwise it turns on the base station.

c. It makes use of markov decision process to discover the traffic level in every base station.

d. In markov decision process the dynamic programming problem can be occurs. So that the reinforcement learning and transfer actor critic algorithm is used to overcome the problem.

e. Transfer actor critic algorithm is used to maximize the energy saving in current active base station by transfer actor critic algorithm is used to overcome the problem.

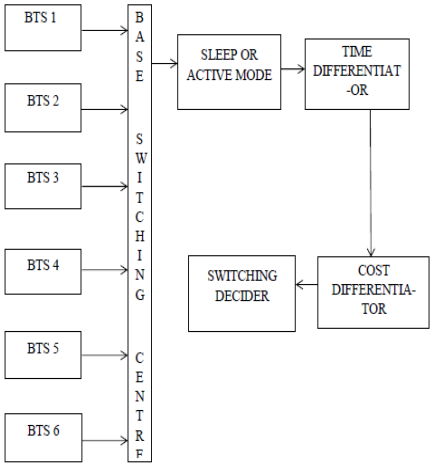

Fig: 2. Base Station Switching Operation

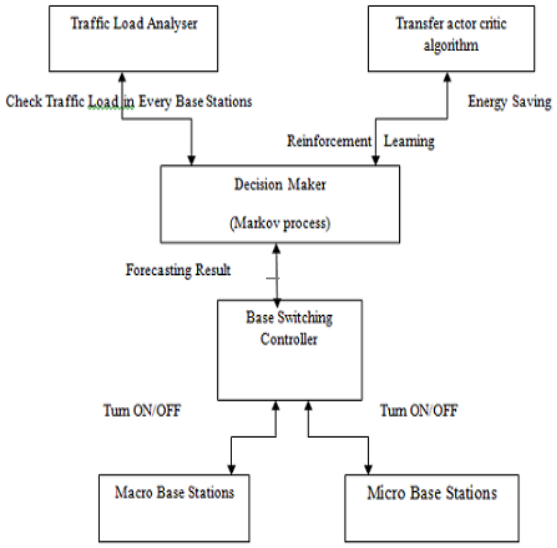

Fig: 3. Energy saving by using TACT

4. Simulation Results

Energy saving in cellular radio access network is achieved by network simulator 2. Here the tool command language (TCL) is used.

Number of nodes - 35
Mac type - 802.11
Antenna type - Omni antenna
Routing protocol - AODV protocol
Energy saving - 70%

A. In Peak Hours

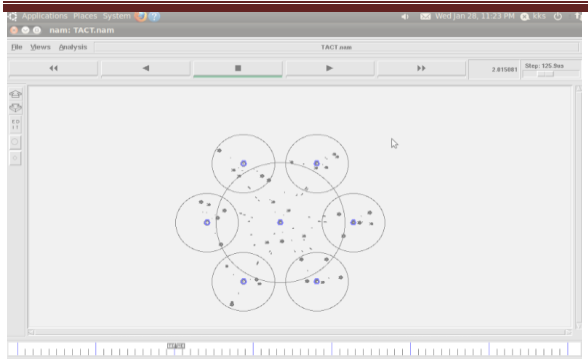

Fig: 4. Energy Consumption in Peak Hours

In this scenario (Figure 4. Energy consumption in peak hours) shows all the base stations are in active mode due to the heavy traffic loads.

B. Other Than Peak Hours

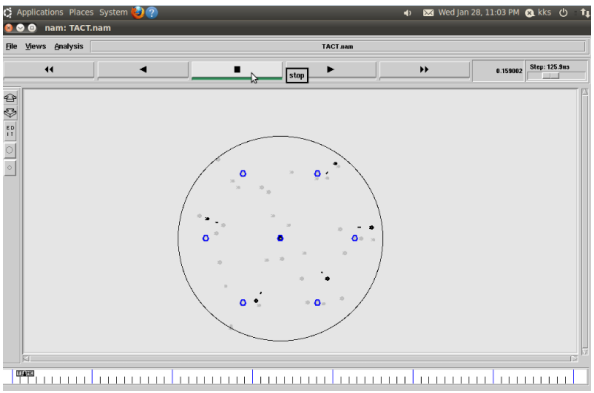

Fig: 5. Energy Consumption in other than Peak Hour

In low traffic load variations, the minimum number of users in each base station. Due to the low traffic load the base stations are in sleep mode only the centralized base station in active mode. It controls all of the base station by using transfer learned frame work approach. Here, the base station energy consumption is minimized.

C. Graph

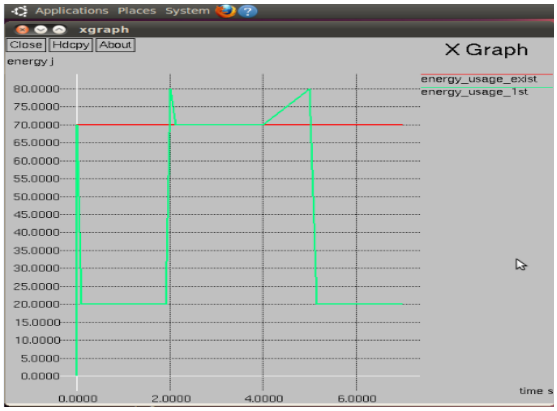

Fig: 6. Energy Usage Graph

5. Conclusion

In this paper base station energy is limited by reinforcement learning framework. Here markov decision process is used to find the traffic load level of each base station and also transfer actor critic method is used to reduce the overall energy consumption of base station. Efficiency of TACT algorithm is improved by reinforcement learning algorithm. Saving energy consumption of the base stations in cellular radio access networks elaborately explained in this paper.

References

[1] G. P. Fettweis, E. Zimmermann, ICT energy consumption-trends and challenges, 2008 WPMC, 4

[2] S. Zhou, J. Gong, Z. Yang, Z. Niu, P. Yang, Green mobile access network with dynamic base station energy saving, 2009 ACM Mobicom

[3] V. Konda, J. Tsitsiklis, Actor-critic algorithms, SIAM J. Contr. Optim., 42(4), 2000, 1143–1166

[4] K. Son, H. Kim, Y. Yi, B. Krishnamachari, Base station operation and user association mechanisms for energy-delay tradeoffs in green cellular networks, IEEE J. Sel. Areas Commun., 29(8), 2011, 1525–1536

[5] Ivo Grondman, Lucian Bus¸ oniu, Gabriel A.D. Lopes, Robert Babuˇska, A Survey of Actor-Critic Reinforcement Learning: Standard and Natural Policy Gradients

[6] Hao Zhu, Guohong Cao, A Power-aware and QoS-aware service model on wireless networks

[7] Michimune Kohno, Yuji Ayatsuka, Jun Rekimoto, TACT: Mobile Wireless Terminal for Digitally-Enabled Environments

[8] Kateˇrina Dufkov´a_, Milan Bjelicaz, Byongkwon Moony, Luk´aˇs Kencl_, Jean-Yves Le Boudec, Energy Savings for Cellular Network with Evaluation of Impact on Data Traffic Performance