Green radio approach towards energy efficient radio access networks for mobile communication

G.SATHISH KUMAR,
M.E. Communication Systems,
Loyola Institute of Technology,
Chennai, India.
g.sathishkumar10@gmail.com

PROF.A.MASILAMANI, M.E.,
Professor, ECE Department,
Loyola Institute of Technology,
Chennai, India.
amasimani@yahoo.co.in

Abstract:- **The number of users and the use of telecommunication systems are increasing rapidly and thus result in greater demands on energy usage. Based on the extensive Life-cycle assessment (LCA) conducted by various network operators, it is learned that energy consumption in the usage phase of its radio access networks is the most imminent factor relating to impact on the environment. The amount of CO_2 emission is increasing in communication systems, in parallel with the increase in mobile consumers. And it is also observed that current wireless networks are not energy-efficient, mainly the base stations (BS).**

This alarming growth in mobile users and increase in CO_2 emission forces us to use higher data rate mobile broadband. There is a need for restructuring of existing network architecture. We need to keep controlling system in every base station for switching purposes. This paper discusses the current energy consumption scenario in base station devices. It also describes innovative and promising method for enhancing the energy-efficiency of the wireless networks and developing solutions that reduce operating costs and effects on the environment.

I. INTRODUCTION

As part of the international efforts for energy conservation and CO2 reduction, migration to an energy-efficient mobile infrastructure is of high importance to the mobile communications industry. For network operators, energy efficiency is much more than a corporate social responsibility topic — it will be one of the key factors for successful operation of large-scale mobile communication services. Due to the tremendous upswing of mobile Internet access demand, the cellular wireless system is currently transitioning to LTE. This next-generation mobile infrastructure provides broadband access and enables new classes of applications for mobile users.

With the emerging traffic demand, mobile operators are under pressure to enhance their infrastructure in a competitive time frame. However, the investment to enhance the infrastructure does not always pay off because the average revenue per connection continues to decrease, as shown in Figure 1. To overcome such a price-pressure trend, energy saving is one of the key subjects for mobile operators' total cost of ownership reduction. Because the base station accounts for most of the energy consumption by mobile operators, improving the energy efficiency of base station key components, such as power amplifiers and air conditioners, is of great importance.

Another driver for an energy-efficient mobile infrastructure is corporate social responsibility for international efforts against climate change. By deploying energy-efficient base stations, operators can reduce the CO2 emission from their network. Vendors can contribute to the efforts against climate change by providing technologies that lower network equipment's power consumption. Into the Lifecycle of a base station, power consumption is more dominant in the deployment and operational phase than in the production phase. Therefore, ease of deployment and low-power operation are critical for an energy-efficient mobile infrastructure.

Independent of the actual energy source that is used for powering the access network achieving the highest possible energy efficiency is very important. This applies to conventional, grid-powered network elements in larger cities as well as (and often even more so) to, for example, solar-powered base stations in developing countries without reliable grid-based energy. Effective energy management is thus a key requirement for the successful and profitable operation of mobile communication networks.

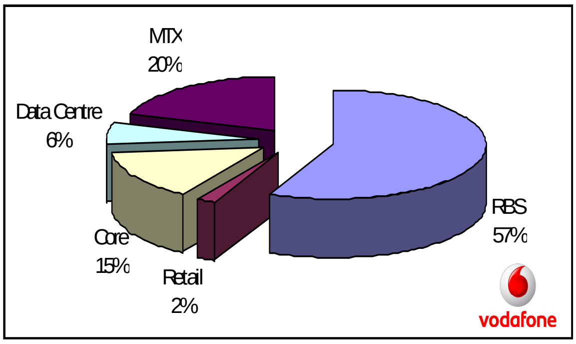


Fig 1: Power consumption in MCS

II. RELATED WORKS

In long-term-evolution-advanced (LTE-advanced), heterogeneous deployments of relays, femtocells and conventional macro cells are expected to provide coverage extension and throughput enhancement, while significantly lowering the energy consumption and total-cost-of-ownership (TCO) in cellular networks. This study presents a methodology for estimating the total energy consumption, taking into account the total operational power and embodied energy, and TCO of wireless cellular networks, and in particular provides a means to compare homogeneous and heterogeneous network (HetNets) deployments. The authors introduce realistic energy models and energy metrics based on information available from mobile-network operators (MNOs) and base station manufacturers. Additionally, up-to-date operational and capital expenditure (OPEX and CAPEX) models are used to calculate TCO of candidate networks. The authors evaluate two scenarios for HetNets, namely a joint macro-relay network and a joint macro-femtocell network, with different relay and femtocell deployment densities. The results obtained show that compared to macro-centric networks, joint macro-relay networks are both energy and cost efficient, whereas joint macro-femtocell networks reduce the networks TCO at the expense of increased energy-consumption. Finally, it is observed that energy and cost gains are highly sensitive to the OPEX model adopted.

Presents an insightful design framework for energy-efficiency-oriented mobile wireless networks, which consists of four fundamental trades-offs: deployment efficiency vs. energy efficiency, spectrum efficiency vs. energy efficiency, bandwidth vs. power, and delay vs. power. Within this article, the authors thoroughly analyze how to balance the deployment cost, throughput, and energy consumption in the network as a whole, how to guarantee the achievable rate while maintaining energy consumption of the system on a given available bandwidth, how to utilize the bandwidth and the power needed for transmission at a given target rate, and how to counterpoise the average end-to-end service delay and average power consumed in transmission, respectively.

And verify that adaptive communication techniques have degrees of freedom to potentially be exploited for energy saving; meanwhile, the target performance metrics can be satisfied as well, which depend on various system parameters such as the diversity technique, the energy partition between data and pilot symbols for channel estimation, and the constellation signaling. As a case study, the authors also investigate single-carrier as well as multicarrier communication systems applying both margin-adaptive and rate-adaptive pilot-assisted transmission to quantify the relevant energy savings opportunities

This provides an in-depth overview of the ongoing Mobile VCE Green Radio project, which aims to establish novel approaches to reducing the energy consumption of wireless links, especially improving the design and operation of wireless base stations. Through the project, it has been shown that base stations can have much higher operational energy budgets than mobile terminals; therefore, appropriate modeling of the energy consumption of base stations is an important issue for decreasing the energy consumption of whole mobile communications systems.

How the dynamic operation of cellular base stations, in which redundant low-traffic base stations are switched off, can generate significant energy

saving advantages. Based on real cellular traffic traces and information regarding base station locations, the authors discuss the first-order approximation of the percentage of power savings that can be expected by turning off base stations during low traffic periods while maintaining coverage and inter operator coordination. As we can see, the four articles selected above are mainly focused on typical scenarios of mobile wireless communications and access networks.

This illustrates a novel solution for linear scaling of energy usage with the traffic loads within the Internet, which involves aggregating traffic from multiple input links prior to feeding them to the switch interfaces, so as to maximize the number of interfaces put to sleep. The authors arrive at a promising result: energy consumption, measured as a fraction of awaking interfaces, scales linearly with load for all loads and the proposed algorithms are actually deterministic without any packet loss. How to construct energy-efficient reconfigurable router with a power aware routing mechanism through virtual networks with advanced rate adaptation processing inside the Internet router. In particular, by taking into account of the Internet behavior features and the modular architecture of routers, the G Rec Router (Green Reconfigurable Router) designed in this article takes advantage of various opportunities and means to greatly cut down the power dissipated at the network, node, and function level.

III. EXISTING SYSTEM

In the existing system all mobile towers are kept on in a particular locality irrespective of the number of users. As a result high power consumption occurs. A typical mobile phone network may consume approx 40-

50MW, even excluding the power consumed by user's handsets. When direct electrical connections are not readily available, these service providers use diesel to power their network. As a result, a polluted environment is established and a whole of about 1% of the total power generated is being consumed by the mobile networks itself. In addition to this the lighting and cooling units are always in one state thereby considerably increasing the power consumption rate day by day.

IV. PROPOSED SYSTEM

In the proposed system power consumption rate is lowered by keeping only one mobile tower in working state to take up all communications while the remaining towers stay in idle mode. When the no of users of the current tower reaches a predetermined value say 80% the responder frequency is sent to the nearby efficient tower to take up the remaining load by means of wireless sensor networks. Thus by keeping all the towers in idle state and by keeping only one in working state the power consumption rate is considerably decreased. Moreover with the help of ambient analyzer maximum power saving is achieved by means of the localized power controller where the lighting and cooling units are turned on as per the requirement. Fuel level monitoring unit is made available devoid of manpower. Thereby 1 KW power saved=2 KW power generated.

V. FUNCTIONAL OPERATION

In the overall block diagram the voltage and current sensing circuit senses the power from the power amplifier and feeds it to the monitoring system. The responder frequency which is received from the main server will activate the corresponding tower's base station components from idle state to charging state. When the responder frequency is received it is also displayed in the monitoring unit.

The temperature and light sensor senses the temperature and illumination level of environment and then through localized power control, corresponding relays for cooling and lighting units are operated. If the power amplifier output is found to be zero then there will be no users present in that particular instant.

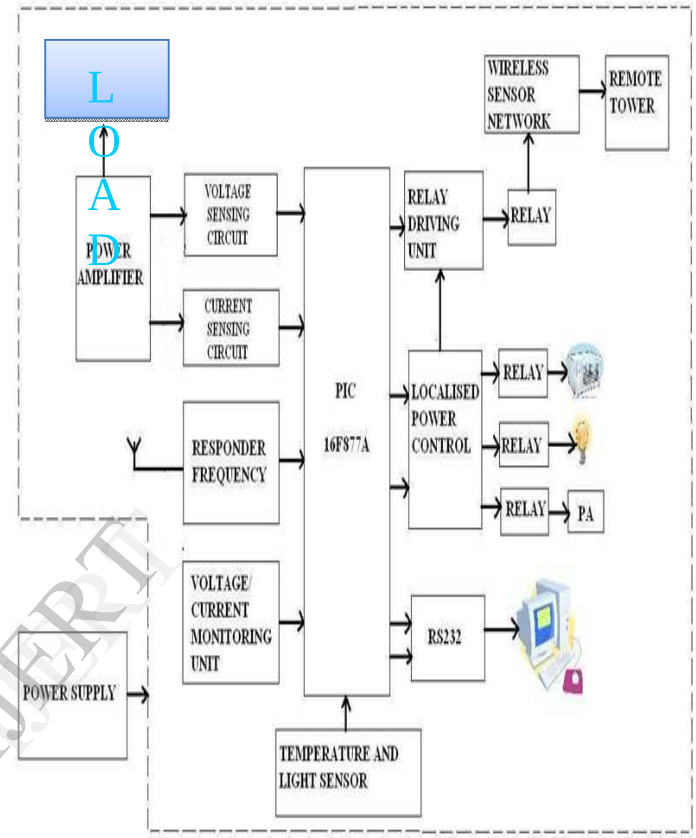


Fig 2:Overall block diagram of power consumption in mobile base station

VI. HARDWARE IMPLEMENTATION

From the circuit it can be seen that the reference analog supply after being regulated by the 9v regulator enters the Zener diode through the resistance R1 where it is again regulated to 5v since the Zener diode used here has a cut off of 5v. Thus we have a double regulated completely filtered analog reference source. R2 is a potential divider used for setting the dynamic response range of the reference supply. This means that the reference 5v can be used as it is or it can be made in a fraction of the 5v for example 1v so that readings in this range can be read with more precision. This is because the ADC has 10 bit resolution which can be totally used for representing the 1v rather than 5v.

The pins 2-5, 7-10, 35 and 36 are used as the 10 channels of the ADC. Two these pins the analog inputs to be processed by the ADC are given. Y1 is the crystal oscillator used. It is on 10 MHz and gives a baud rate of 9600 bits/s. The capacitors C2 and C3 are used as decoupling capacitors to remove the high frequency noise signals.

The capacitor C1 is in the off condition when power is switched off. When the power is switched on or reset then this capacitor gets charged through the resistor R2 and then through R1 this appears on the MCLR pin of the PIC. This is the memory clear pin and thus the memory is cleared and is ready for use as soon as power is switched on. S1 is the synchronous switch, which is also used for the same operation and for PC and PIC synchronous operation. The output of the voltage and current sensing circuit is given as input to the analog channels of the PIC. A thermistor is connected to analog channel to measure the substation temperature. The FM receiver connected with PORT B. Here PORT B configured as an input digital port.

VII. SIMULATION RESULTS

The objective of the project is to design, simulate and assemble a microcontroller based energy saving unit so as to reduce the power consumption in the existing mobile base stations. Since cooling unit is found to be most energy craving part in the BTS, its power consumption has to be reduced, this is done on our project by sensing the climatic condition and by using a relay to control the cooling unit. To amplify signals, power amplifiers are used, here we sense the power amplifier voltage and current and through this, a number of users utilizing a particular tower is destined. When there is no requirement of too many towers acting at the same instant, while a single tower itself can handle the load, the remaining towers are put into a power saving mode. This is visually brought in front end using the VB software.

A. *Visual Basic*:

Visual Basic is Easy to learn Programming language with Visual Basic you can develop Windows based applications and games Visual Basic is much easier to learn than other language (like Visual C++),and yet it's powerful programming language.

B. Advantage

1) Its simple language. Things that may be difficult to program with other language can be done in Visual Basic very easily.
2) Because Visual Basic is so popular, There are many good resources (Books,
Websites, News groups and more) that can help you learn the language.
You can find the answers to your programming problems much more easily than other programming languages.

C.Green Radio Simulation Result

Simulation result is shown in fig 3.

VIII. CONCLUSION AND FUTURE WORK

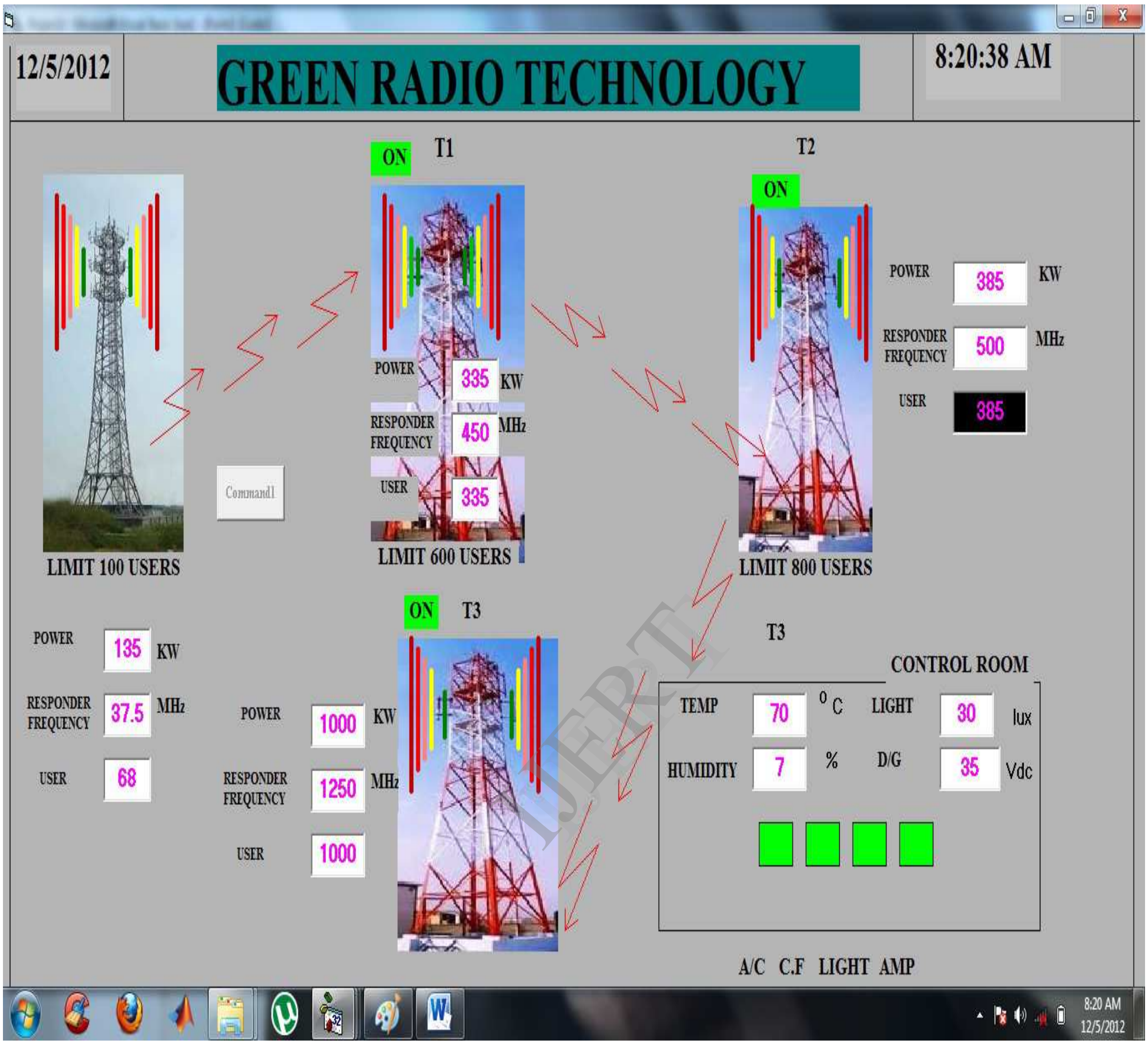
Our project proposes a comprehensive approach towards an energy efficient operation of next generation mobile communication. Green Radio includes efficient hardware and software platforms and careful integration into self organizing network functions. This technology is a key factor for operation expenditure reduction and endures an eco friendly

This is just a initial development stage of handling power consumption in mobile base station. Still researches are going on in the mobile communication field so as to reduce the power consumption and also to improve the quality of service to the consumers.

Renewable sources such as solar power and wind power may be available where cell sites are placed. Hence, Base station will get adequate power from either wind power and solar power generator. So we can operate Base station independent of the electric power.

Because of power getting from either wind and solar generator, Base station is always working condition even electric power goes off.

Fig 3: Green Radio Simulation Result



IX. REFERENCES

1. Nasir Faruk and Mujahid Y. Muhammad (2012) ‘*Energy Conservation through Site Optimization for Mobile Cellular Systems (Base Transceivers Station Optimization)* ’ Epistemic in Science, Engineering and Technology, Vol.2, No.1
2. C. Lubritto and A. Petragliaa (2011) ‘*Energy and environmental aspects of mobile communication systems*’ Energy, Volume 36, Issue 2, pp 1109-1114.
3. Pete Boyer, Milica Stojanovic, and John Proakis, October (2001) ‘*A Simple Generalization of the CDMA Reverse Link Pole Capacity Formula*’ IEEE Transactions on Communications VOL. 49, NO. 10 pp1719

4. Niranjan Balasubramanian, Aruna Balasubramanian and Arun Venkataramani '*Energy Consumption in Mobile Phones: A Measurement Study and Implications for Network Applications* 'Copyright 2009 ACM 978-1-60558-770-7/09/11 IMC'09, November 4–6, 2009, Chicago, USA
5. *Green Radio – Towards Sustainable Wireless Networks* 8th July 2010 Steve McLaughlin University of Edinburgh
6. *Study on Energy Efficient Radio Access Network (EERAN) Technologies*, 2009 Project Report of Technical University of Dresden, Vodafone Chair Mobile Communication Systems.
7. T. Edler, "*Green Base Stations — How to Minimize CO2 Emission in Operator Networks*," Ericsson seminar, Bath Base Station Conf., 2008.
8. P. Wright *et al.*, "*A Methodology for Realizing High Efficiency Class-J in A Linear and Broadband PA*," *IEEE Trans. Microwave Theory and Techniques*, vol. 57, 2009, pp. 3196–3204.
9. J. N. Laneman, D. N. C. Tse, and G. W. Wornell, "*Cooperative Diversity in Wireless Networks: Efficient Protocols and Outage Behavior*," *IEEE Trans. Info. Theory*, vol. 50, no. 12, Dec. 2004, pp. 3062–80.
10. Green Base Station Solutions and Technology - ZTE Corporation.htm