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DATA- DRIVEN CELL ZOOMING FOR LARGE-SCALE MOBILE NETWORKS

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Abstract:

In recent years Green Communication, an energy efficient communication in cellular networks is of more concern to network operators because of the rising energy costs and carbon foot print on earth. This trend stimulated the interest in researchers to design, develop and investigate the various metrics, models and associated science needed for combined energy efficiency and network optimization. Nowadays, the whole world of telecommunications and information communities is facing a more and more serious challenge, namely on one side the transmitted multimedia-rich data are exploding at an astonishing speed and on the other side the total energy consumption by the communication and networking devices and the relevant global CO_2 emission are increasing terribly. Research shows the importance of energy efficiency metrics which are indicators of efficiency, understanding those metrics provides us a better view on how energy efficiency can be achieved in wireless systems/networks. Learning these metrics will help us build a better understanding on energy consumption problems. The study of green communications will require investigation in several areas such as power efficient RF hardware, efficient MAC protocols, networking, and integration of renewable energy with communications equipment, frequency reuse deployment strategies, and spectrum policy. While each area individually contributes to energy consumption, researching the interaction across separate layers will provide the truly transformational discoveries

Keyword: ***Data-driven, cellular network, cell zooming, energy saving, green communication.***

Introduction:

Today, with the enormous growth of communication and wireless technologies, energy consumption has increased globally to a great extent. The unexpected increase in energy consumption and mobile communication made the cellular industry to deploy more than 4 million base stations for mobile users, each consuming about 25Mwh per year and the number of base stations are expected to be double by 2012 [1]. Research shows that 3% of the world's annual electrical energy consumption and 2% of CO_2 emissions are caused by the information and communication technology (ICT) infrastructure [2].

Studies show that for the first time in history worldwide data traffic was more dominant than the voice traffic. In 2020, mobile data is expected to dominate all mobile traffic with a decreasing share of voice and is predicted to account for more than 10 percent of all IP traffic in 2020, mostly due to the smart phones [3]. In addition to the environmental costs, energy costs increases the overall operational costs for the network operators. Typically to connect a base station to electrical grid will cost about $3000 per year to operate [4]. In 2010, it corresponded to 60 billion kWh of electricity usage and about 40 million metric tons of CO_2 emissions each year. Most of the cellular operators focus on fulfilling the needs of the consumer, exploiting the available energy resources. An increase of the global number of mobile subscribers will increase the energy consumption of the networks. In recent years with the growth in new technologies such as Android and iPhone devices, the use of iPad and kindle demanded for increase in data usage. By designing energy efficient base stations, an economical solution to the energy shortage problem is provided while contributing to a greener environment simultaneously. Prior research has focused on energy efficiency of electrical power generators and other supporting systems for Base Stations such as cooling and heating systems. It has been estimated that every year, about 120,000 new Base Stations are deployed to serve millions of new consumers around the world which significantly increase the carbon footprint even more on earth [2] given that Base Stations contribute to about

60%-80% of the total energy consumption. Moreover, it is estimated that ICT energy consumption is rising at 15-20% per year, thereby doubling every five years [5]. A significant portion of the operational expenditure of a cellular network goes to pay the electricity bill. It has been estimated that the mobile network budget for electricity globally is more than 10 billion dollars today [6]. Implementation of green communication protocols globally at base stations not only plays a vital role in energy conservation but it is also an economically significant issue. Hence cellular network operators have been exploring ways to increase energy efficiency in all components of cellular networks, including mobile devices, base stations and core (backhaul) networks. The need to develop green wireless communication systems turns out to be more and more urgent as wireless networks are becoming ubiquitous [3]. This realization has led to a push towards "green" wireless

communications that strives for improving energy efficiency as well as reducing environmental impact. Network planning, cell size and capacity are usually fixed based on the estimation of the peak traffic load. However traffic nature in the network can vary by both spatial and temporal fluctuations and bursty in nature for many data applications. The traffic load in the network depends on the time of the day, location and many other factors. If the cell size is fixed, then some cells will always operate under heavy or light load. on three different cell zooming algorithms: continuous, discrete and fuzzy methods. We compare and contrast the power efficiencies of these three cell zooming techniques.

After Zooming Cell:

Now let us consider a specific traffic scenario during off-peak hours. Let us especially focus on cell site E which has only two voice users in its cell, located as denoted in Figure 2.1. Let us further assume that BS 'A' and 'D' have adequate resources to accommodate a voice user each. Moreover, from an energy perspective, if BSs 'A' and 'D' need to hike up their transmission powers to serve these users and if the total increase in power (not just in terms of increased coverage but also in terms of QoS) is less than the power required to keep BS 'E' active and of service to these users then it is justified to make BS 'E" shrink its cell size to zero (thereby consuming very low power) and have BSs 'A' and 'D' increase their cell size and capacity to accommodate these users. This scenario helps us recognize the potential for energy saving when employing cell zooming.

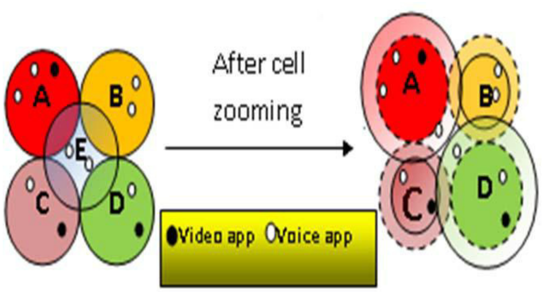

Figure 2.1. Scenario with BS 'E' supporting two voice users and the corresponding optimal network reconfiguration after cell zooming

On the other hand, BS 'B' which currently serves only voice users might have resources available to support both the video and voice users originally covered by BS 'E'. Thus the network will be reconfigured in a way where BS 'B' would expand its cell size to accommodate the users of BS 'E' who can then shrink its cell size to zero. The other BSs might also shrink their cell sizes to various degrees so that the network can operate with the minimal possible energy.

One appropriate way of accounting for these complex effects is via an empirical model [6]. To create such a model, an extensive set of actual path loss measurements is made, and an appropriate function is fitted to the measurements, with parameters derived for the particular environment, frequency and antenna heights so as to minimize the error between the model and the measurements.

SIMULATION RESULTS AND ANALYSIS

The proposed cell zooming methods were evaluated in a scenario with Poisson distributed user traffic for both voice and data users. The inter arrival time, which is the average time between the arrival two successive users, is varied dynamically based on the average number of users per hour. The hold time of the users is assumed to be Gaussian distributed with mean μ and standard deviation σ and it is the time duration during which the user stays in the network. For the fuzzy algorithm, it is assumed that the BS can extend its coverage by 10% or 20% of the specified range. The maximum cell radius of the BS and the various simulation parameters are summarized in Table 4.1.

CONCLUSION

In this project, we proposed a novel concept called cell zooming which dynamically adjusts the transmission power and hence coverage area of the base station depending on the location of the farthest user. From an implementation perspective, cell zooming is much simpler to implement in existing systems than base station switching off/on to conserve energy. The base station can quickly return to full coverage and capacity when demand increases. Three different cell zooming methods were suggested and compared for performance and complexity. Our results showed that nearly 40% reduction in power consumption can be saved at the base stations with cell zooming which can achieve green efficient communication in cellular networks.

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