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Control Energy and Throughput Tradeoffs by Base Station Switching in Mobile Network

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Abstract--- **In this paper proposed The information and communication technology (ICT) sector is estimated to be responsible for around 2% of the global CO2 emissions. Within ICT, cellular networks are one of the biggest contributors. Base stations (BSs) operations consume up to 80% of the energy required for the operation of a cellular network.LTE cellular systems are typically designed for providing full coverage and good performance for a given (nominal) user density. The objective of a base station switching (BSS) framework is to achieve the best possible energy versus throughput trade-off while maintaining full coverage when user equipment (UE) density decreases. When a BS is switched off, it affects all its neighboring BSs, which have to take over the region no more covered by that BS, making coverage more difficult. We consider that the operator switches off BSs using predefined global BSS patterns (motivated from the frequency re-use patterns typically used in cellular networks) that have been designed off-line to offer full coverage with suitable scheduling schemes on the uplink and the downlink. We present performance-energy trade-off results, for a given user density, for uplink and downlink in urban as well as rural macro-cell environments and quantify the gain obtained from the proposed schemes with respect to the state of the art.**

Keyword: Base station switching, cellular network, coverage, downlink, energy, LTE, throughput, uplink

I. INTRODUCTION

The information and communication technology ICT sector is estimated to be responsible for around 2% of the global CO2 emissions. Within ICT, cellular networks are one of the biggest contributors. Base stations BSs operations consume up to 80% of the energy required for the operation of a cellular network. Hence, schemes that can possibly switch off some BSs, when demand is lower, are important from the perspective of saving energy, money, and reducing the carbon footprint. LTE cellular systems are typically designed for providing full coverage and good performance for a given nominal user density. However, as shown in, significant time periods can occur when the user density drops far below this nominal density for example, during the nights or public holidays. As BSs consume the majority of the energy in a cellular network, significant gain in operational expenditure OPEX is possible by suitably turning off some BSs and expanding the coverage of the remaining BSs when user density is low.

II. RELATED WORKS

A. O.Eunsung et al Energy and throughput optimization occupies an important place in the research area of Wireless Sensor Networks (WSNs). These networks are a class of useful but challenging networks. Combining Network Coding (NC) and efficient scheduling in the MAC layer of such networks gives more efficiency and copes with the problem of energy waste and inefficiency management as well as transmission's lose and collision. Our work's concern is to assess the contribution of the network coding technique's introduction to improve the efficiency and optimize the energy consumption in the MAC layer of IR-UWB based WSNs. Therefore, tested this new technique using Wide Mac Protocol; which is a relevant MAC protocols dedicated to WSNs based on IR-UWB. Furthermore, they are used XOR coding to fit low computational capabilities requirement in such networks. The obtained results are very encouraging and the proposed MAC scheme's improvements have demonstrated the positive impact of using NC in terms of both used metrics. consider an energy harvesting for cooperative wireless sensor networks with a nonlinear power consumption model.

B. W.Guo et al Energy constrained wireless powered communication networks are powered by fixed energy sources, such as batteries, which have limited operational time and it can be extended by replacing or recharging the batteries, it may be costly, dangerous, inconvenient or impossible. As an Alternative solution to prolong the network's lifetime, energy harvesting has recently introduced. Since it potentially gives unlimited power supplies to wireless powered communication networks by harvesting energy from the environment using harvest then transmit protocol. This implies an interesting doubly near-far problem due to both the DL and UL distance dependent signal attenuation. Thus resulting in unfair rate allocation among different nodes.

C. S.kim et al Providing high data rates with minimum energy consumption is a crucial challenge for next generation wireless networks. There are few papers in the literature which combine these two issues. to focuses on multi-hop wireless mesh networks using a MAC layer based on Spatial Time Division Multiple Access (S-TDMA). Develop an optimization framework based on linear programming to study the relationship between throughput and energy consumption. Our contributions are two-fold. First, formulate and solve, using column generation, a new MILP to compute offline energy-throughput tradeoff curve.

Use a physical interference model where the nodes can perform continuous power control and can use a discrete set of data rates. Second, highlight network engineering insights. show, via numerical results, that power control and multi-rate functionalities allow optimal throughput to be reached, with lower energy consumption, using a mix of single hop and multi-hop routes.

D. K.Son et al High data rate is a challenge for the next generation cellular networks. This objective needs a significant densification of relay nodes within macro cell. In the LTE-Advanced network, multi-hop relaying has been taken as a promising key technique to provide high throughput to the users and to improve the area coverage. Besides, minimizing the energy consumption and electromagnetic pollution is an economic challenge for the operators. This paper is focused on relay based heterogeneous cellular network like LTE-Advanced. investigate the problem of throughput and energy consumption optimization.

E. Y.Chen et al In this propose provides an accessible analytical framework that can be used to compare the energy consumption and throughput characteristics of different RAN configurations based on the Long Term Evolution (LTE) family of standards. The technical approach is useful for exploring how an LTE RAN may be upgraded in an energy efficient manner to meet the expected growth in mobile data traffic. The approach also allows particular energy saving techniques to be evaluated, such as deployment techniques and power state techniques. The analysis uses accurate energy consumption models of base station and access point equipment which account for the load independent as well as load dependent energy consumption effects.The Energy Consumption Gain (ERG) and Throughput Gain (TPG) figures of eminence are used together with a new figure of eminence called the Energy Throughput Gain (ETG) which reliably accounts for the discrepancy in activity consumption and throughput between two distinct RAN configurations. The energy consumption and throughput performance of a green field RAN deployment scenario that uses different cell sizes and base station types is evaluated. The chapter then explores energy savings obtained from sleep modes and HetNet deployments.

II. METHODOLOGY

A BS is switched off, it affects all its neighboring BSs, which have to take over the region no more covered by that BS, making coverage more difficult. consider that the operator switches off BSs using predefined global BSS patterns motivated from the frequency re-use patterns typically used in cellular networks that have been designed off-line to offer full coverage with suitable scheduling schemes on the uplink and the downlink. Scheduling is critical to the efficient operation of a cellular network with BSS. Providing non-zero data rate to the UEs on the downlink.

- The user performance on the uplink of a realistic cellular system will lie in between the results of the proposed scheduler assuming an upper bound on interference and the results obtained by assuming zero interference.
- It is observed that as the number of switched off BSs increases, the gap between the results with and without interference decreases.
- This can be attributed to the fact that switching off BSs results in larger ISD and the uplink moves from an interference limited to a noise limited system.

The issues of coverage, scheduling, power per channel and interference are highly inter-dependent and they need to be studied jointly both on the uplink and the downlink to enable a large range of energy/performance trade-offs in BSS. This is the motivation of this work. A framework to study the energy versus performance trade-offs that takes into account uplink and downlink, and models interference properly. The framework is based on a detailed system model and predefined global BSS patterns. Show that the BSS patterns feasibility in terms of coverage is determined by the uplink.

- A firstorder approximation of the percentage of power that can be saved by switching off BSs in an urban macrocell environment during low traffic periods while maintaining coverage is presented.
- A practical BSS algorithm that takes into consideration the incremental impact of switching off BSs one by one on the downlink performance in an urban macro cell is proposed in, but the uplink performance and uplink coverage issues are not considered.
- In heterogeneous networks composed of cellular and wireless local area networks WLANs, a joint UE association and BSS algorithm is presented in.
- In a novel antenna beam tilting based dynamic cell expansion technique is proposed for the downlink. The proposed technique is utilized for compensating the coverage loss due to switched off BSs resulting in energy savings.
- A cell zooming based load balancing and BSS framework is presented.

➢ Base station switching

➢ cellular network Frame

➢ Coverage Area

➢ Downlink Promotion

➢ Energy Evaluation

3.1 SYSTEM ARCHITECTURES

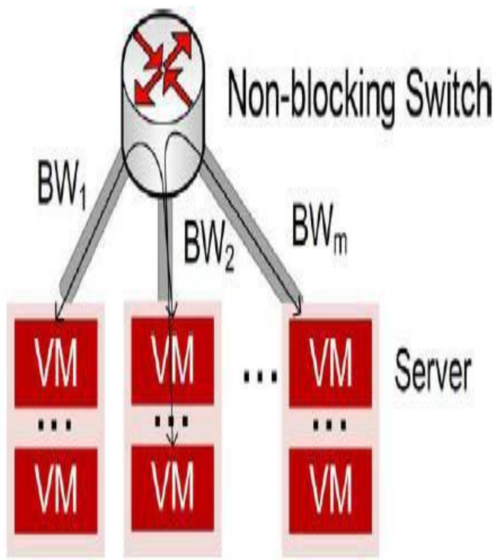

Fig 3.1.1 System Architecture

3.1 BASE STATION SWITCHING

Typically, the objective of a base station switching BSS framework is to achieve the best possible energy versus throughput trade off while maintaining full coverage when user equipment UE density decreases.

This can be achieved by minimizing the energy consumption while maintaining the throughput performance as in the nominal system. Alternatively, can maximize the throughput performance for a given energy consumption.

The past works that have tried to address this problem have the following limitations.

3.2 CELLULAR NETWORK FRAME

When a BS is switched off, it affects all its neighboring BSs, which have to take over the region no more covered by that BS, making coverage more difficult. consider that the operator switches off BSs using predefined global BSS patterns motivated from the frequency reuse patterns typically used in cellular networks that have been designed off-line to offer full coverage with suitable scheduling schemes on the uplink and the downlink.

Scheduling is critical to the efficient operation of a cellular network with BSS. Providing non zero data rate to the UEs on the downlink uplink depends on the downlink uplink scheduler which is in charge of allocating resources e.g., time, channels1, power per channel to the UEs.

3.3 COVERAGE AREA

The issues pertaining to coverage, throughput, and energy tradeoffs in BSS are discussed in. A first order approximation of the percentage of power that can be saved by switching off BSs in an urban macrocell environment during low traffic periods while maintaining coverage is presented in. A practical BSS algorithm that takes into consideration the incremental impact of switching off BSs one by one on the downlink performance in an urban macro cell is proposed in but the uplink performance and uplink coverage issues are not considered.

In heterogeneous networks composed of cellular and wireless local area networks WLANs, a joint UE association and BSS algorithm is presented in. However, the focus of is only on the downlink transmissions.

In a novel antenna beam tilting based dynamic cell expansion technique is proposed for the downlink.

3.4 DOWNLINK PROMOTION

When a BS is switched off, it affects all its neighboring BSs, which have to take over the region no more covered by that BS, making coverage more difficult.

Consider that the operator switches off BSs using predefined global BSS patterns motivated from the frequency reuse patterns typically used in cellular networks that have been designed off-line to offer full coverage with suitable scheduling schemes on the uplink and the downlink. Scheduling is critical to the efficient operation of a cellular network with BSS. Providing non zero data rate to the UEs on the downlink uplink depends on the downlink uplink scheduler which is in charge of allocating resources power per channel to the UEs. By switching off BSs, the system becomes more power limited and hence it is important that, whenever required, the schedulers should be flexible enoughto allow power to be focused on the right number of channels.

3.5 ENERGY EVALUATION

Typically, the objective of a base station switching BSS framework is to achieve the best possible energy versus throughput trade off while maintaining full coverage when user equipment UE density decreases.

This can be achieved by minimizing the energy consumption while maintaining the throughput performance as in the nominal system. Alternatively, we can maximize the throughput performance for a given energy consumption.

The past works that have tried to address this problem have the following limitations.

IV. FUTURE ENHANCEMENTS

Further, a low complexity high-performance heuristic is proposed for the uplink scheduler. Altogether, base station switching is a simple yet effective technique which can provide significant energy savings without compromising on coverage while maintaining reasonable throughput as long as scheduling is performed carefully. Our study is an offline study that does not address the problem of deciding when to change from one BSS pattern to another or back to the nominal scenario. However, BSS switching cannot be done online without pre-computing beforehand which pattern is feasible or not.

Thus, the next step would be to decide on-line when to switch from one BSS pattern to another based on user density measurements. This is a possible area of future research.

V. CONCLUSION

Have to show that there is a complex interplay between coverage, power management, scheduling, and interference and that this interplay has to be taken into account carefully to enable base station switching to save energy. We have shown thatthe limiting factor for switching off BSs, while maintaining coverage, is the uplink. We have proposed flexible schedules for both uplink and downlink that allow coverage extension by focusing the transmit power on fewer subchannels. To have also proposed several BSS patterns that offer full coverage when using our schedulers in both urban and rural macrocell environments.

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