An Green And Energy Efficient Anonymous Routing Protocol With Multiple Hops For Communications In Highly Dynamic Hetrogenious Networks

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ABSTRACT

Mobile ad hoc networks (MANETs) are increasingly adopted in both military and civilian uses due to its self configuration and self-maintenance capabilities. MANETs are higly vulnerable to security threats due to inherent charateristics as wireless transmission , lack of fixed infrastructure , dynamically changing topoly, etc. The broadcast nature of the wireless medium makes MANETs susceptible to various malicious attacks. Traffics annalsis is one of the most serious security attacks in MANETs. For instance , in a battle field the enemy can physically destroy the important mobile nodes if they can identify and locate such nodes by traffic analysis . In order to thwat such attacks , ananymous communication protocols are developed. For the purposes of security and robustness , an ideal anonymous routing protocals as in the route, in particular , those of the source and the destination. Multiple routes should be established to increase the difficulty of traffic analysis and to avoid broken paths due to node mobility . Existing schemes either make the unrealistic and undesired assumption that certain topological information about the network is known to the nodes , or cannot achieve all the properties described in the above .

Similarly with the continuous increase of user requirement, the Information and Communication Technology (MASK) has developed rapidly. As a result, both capacity and coverage performances have been improved, and at the same time, the communication networks have been more energy-intensive. In order to improve the energy efficiency of net-works, thus we need to develop energy-efficient and eco-sustainable communications and networking technologies and systems, so as to contribute to global emission reduction and energy savings of communication networks.

In the paper , we propose an Green and Energy Efficient anonymous routing protocol with multiple routes called GEARMR, which can satisfy all the required properties. In addition, the protocal has the flexibility of creating fake routes to confuse the adversaries , thus increasing the level of anonmity. In the terms of communication efficiency and energy saving, extensive simultion is carried out Compared with AODV and MASK, CoMP , our GEARMR protocol gives a higer route request success rate under all situations and delay of our protocol, Global emmission reduction, is comparable to the best of these three protocols
Keywords:- GEARMR, MASK, ICT

I.   INTRODUCTION

In the last several decades, due to the continuous increase of communication requirement, the Information and Communication Technology (ICT) developed rapidly focused on the higher capacity and larger coverage [1]. And correspondingly, the energy consumption is also growing at an amazing speed: the ICT is responsible for about 3% of energy consumption and 2% - 4% of CO_2 emission all over the world [2,3], and the energy consumption will increase at a rate of 15% - 20% per year and will double after 5 years [4]. Within the wireless cellular networks, the Base Station

(BS) occupies a significant portion of energy about 60% - 80%, which means a breakthrough point to decrease the energy consumption [5]. In order to reduce the energy consumption, several organizations or projects, such as the Energy Aware Radio and Network Technologies (EARTH), have been founded, and many workshops have been organized at international conference [6,7]. Due to the endeavor and attempt for several years, various significant methods have been proposed. In this paper, we present a survey on energy-efficient technology within the cellular

network. The technologies can be classified into three categories according to their application scenarios. And for each aspect, the representative technologies are introduced and discussed further After that, a prospect forecast of the energy-efficient wireless cellular network is presented. The rest of this paper is organized as follows. In Section 2, the energy-efficient architecture is introduced. The energy-efficient resource management is discussed in Section 3. In Section 4, some Radio Technologies are discussed. Within Section 5, the prospect forecast is presented. Finally, Section VI concludes this paper.

II. ENERGY-EFFICIENT ARCHITECTURES

A rational architecture is very important to reduce the energy consumption since it has a comprehensive influence on networks. In order to optimize the network architecture, a mass of methods based on some technologies, such as the heterogeneous network, CoMP and relay, have been proposed. With deploying some special cells, such as microcells, picocells and femtocells, to assist the conventional macro cells, the heterogeneous network will increase coverage of the cellular networks as well as EE [8]. In [9], the authors analyze the energy consumption of heterogeneous network, and obtain a higher EE based on a balance point they found between coverage range and outage probability. In [10], the trade-off between SE and EE within the heterogeneous networks is studied, and in [11], the tradeoff between capacity and EE of heterogeneous network isstudied deeply and the authors obtain a result that the small cell has a good potential to improve the EE and network capacity at the same time. In [12,13], the foremost trade-off between the deployment efficiency (DE) and EE within heterogeneous network is investigated. With their analysis of deployment density, the proper cell size and number of BSs have been presented as a reference for future design. With the cooperation of multiple nodes, CoMP can increase the coverage and throughput of cellular networks, and the mobile users can be served with a relatively stable performance and quality even located at other cells [14]. In [15], the capacity and EE of an idealized CoMP system are analyzed by assuming the perfect

backhauling and cooperative processing. In [16], the authors study the trade-off between EE and SE within the uplink of CoMP system and drive their power consumption models for both idealized and realistic scenario. And in [17], the authors investigate the realistic measurement method of EE for various downlink CoMP methods in LTE-A, and their results indicate that the coordinated beamforming and joint transmission could be the more suitable techniques to improve the EE. In [18,19], the ideas of switching off scheme and sleeping mode are combined with CoMP respectively to reduce the energy consumption further, and the switching off scheme and sleeping mode will be introduced primarily in the next section. In [20], the authors present a stochastic predictive control algorithm to optimize the BSs grouping for EE in CoMP. And in [21], a cooperative framework is proposed to dynamically decide whether to perform CoMP transmission or not. Except the researches above, in [22], the authors present a transmission mode selection scheme to save energy within the CoMP system using Semi-Smart Antenna. Within the transmission mode selection scheme, the conventional transmission mode, CoMP communication, transmitting with SSA, and the transmission with both CoMP and SSA are involved. As same as CoMP, the relayed technology can also provides extra coverage and throughput to the conventional cellular networks and improve the communication quality within the cell edge. In [23], the energy-saving performance of CoMP and relay, affected by the traffic intensity and network density, are compared based on the typical parameters setting. The comparing result is varying with different intensity. In the authors verify thebeneficial effect on EE by deploying the fixed Relay Stations (RS). The result within this paper shows that the energy minimization will not decrease the Signal to Interference Noise Ratio (SINR) of cellular relay network. In [23], the EE of cellular network with Realistic system characteristics and Amplify and Forward (AF) relay is investigated, and by using the convolution coding before transmission, the EE will be increased at high Signal to Noise Ratio (SNR) scenario. In [23], the scenario of Decode and Forward (DF) relay and Direct Transmission (DT) are also investigated. For a given outage

probability, the network coding is beneficial for the situation with higher cell radius. In [20], the relay selection characterized on EE, such as taking the optimal locations of nodes to minimum transmitting power, and the instantaneous channel state obtained by channel estimation into account respectively in [23], has been investigated to reduce the energy consumption further. Moreover, the research result within [23] shows that the dynamic time allocation and increasing the cooperative relays within the transmitting procedure properly are also beneficial to EE. In addition, based on the relay selection, the selection of transmission modes can improve the EE further. In [23], a self-adaptive energy-efficient transmission scheme is presented to choose the most suitable transmission mode based on the EE calculated before. Furthermore, the number of relays deployed in cells is also important to the EE. In [20], the authors investigate the trade-off between EE and deployment density deeply. The analysis shows that a proper deployment density of relays will satisfy the requirement both of EE and DE. Too many relays will lower the EE and increase the deploying cost as well. In the next generation cellular networks, CoMP will play a crucial role in improving the communication quality and EE at the same time. Therefore, the joint consideration of CoMP and other technologies needs to be put into more attention. And the optimized deployment of small cells and relays for energy efficiency is still an open issue needed to be studied further.

III. ENERGY EFFICIENT RESOURCE MANAGEMENT

Although the improved architecture can bring some benefits, the corresponding resource management is also indispensable to realize the green communication. For this reason, several technologies have been taken into account the energy efficient resource management, such as the switching off scheme, cell zooming, the using of renewable energy and so on. In traditional cellular networks, the operators deployed many BSs to cover the communication blind district and improve the communication quality. Although it really works sometimes, plenty energy has been wasted due to the low utilization of BSs. For this reason, many switching off schemes based on the variation

of traffic load have been proposed. Except the common criterion presented above, the distance between the User Equipments (UEs) and the BSs mentioned in [23], the additional load increments transferred to the adjacent BSs considered in , the maximized coverage provided by active BSs and the coverage overlap of BSs adopted in respectively are also the important criterions that should be taken into account. Besides the operation in BS, the switching off scheme can also be applied in relay networks. Although the transmitting power of RSs is much lower than BSs, RSs with lower utilization will also cause the energy wastage. In, the relays are dynamically switched off according to the variation of traffic loads. And in , the throughput and energy consumption are treated with the criterions simultaneously to decide which RSs should be switched off to improve EE of the network. As a power control technology, the cell zooming is used to satisfy the demand of traffic load in general, but can also increase EE of cellular networks. And in most instances, cell zooming is adopted as an assistant technology to improve the EE with other technologies. In, the authors put the low utilization BS into sleeping mode (operating with a low energy level) and cover the uncovered area by using cell zooming. And , the cell zooming is combined with the switching off scheme to minimize the energy consumption. Except the technologies introduced above, the usage of renewable energy can also reduce the electric energy consumption more directly. In, a handover method is presented to guide the users to access the BSs powered by green energy. In, the authors propose a scheme to enable more users to be served by the green energy through cell zooming. In, the authors investigate a system model with BSs powered by the combination of electronic and renewable energy. And In , the authors combine the BS switching off scheme with hybrid power to further increase the EE. Although the renewable energy can reduce the electric energy consumption directly, the study of this aspect is beyond our research. For this reason, to our best knowledge, the switching off scheme is considered as the most effective method to manage the resource within futurenetworks. Moreover, the switching off scheme can also be combined with CoMP, cell zooming and/or other technologies to maintain a better coverage and improve the EE at the same

time. Therefore, the joint switching off scheme needs further investigation.

IV. ENERGY-EFFICIENT RADIO TECHNOLOGIES

The green radio technology can effectively reduce the energy consumption within the transmitting procedure, and then improve the EE of total network. In this section, MIMO and OFDM will be introduced as representatives. Due to the noteworthy improvement on average data rate and SE, MIMO has drawn many attentions within cellular networks. And pushed by the trend of green communication, the EE of MIMO is also becoming a research hotspot. In [23], the trade-off between energy and bandwidth efficiency is studied within a MIMO multihop wireless networks. And the analysis results show that the number of transmit antennas, receive antennas and communication hops are responsible to improve EE. In [23], the EE of different MIMO transmission schemes, such as the Open Loop Spatial Multiplexing (OLSM) and Close Loop Spatial Multiplexing (CLSM), have been investigated and compared with the traditional SISO mode. And in [20], the authors prove that the feedback information is very important to improve the throughput and EE especially in the CLSM which utilizes all available feedback information. In addition, for the case of the UE has only one antenna in general, the energy-efficient MUMIMO has been investigated. In [20], the authors devote themselves to balance the cell-edge EE and the average EE within cell. And, the emphasis is put on the balance between EE and capacity by improving the power allocation. As same as MIMO, OFDM also has a good potentiality to reduce the energy consumption. Some important trade-offs are studied in the OFDMA downlink. In [20], the authors prove that the relationship between EE and SE is quasi-concave and they find the upper bound and lower bound on the EE-SE curve for general scenarios. In [21], the authors propose an algorithm to increase the EE and reduce the computation overhead properly at the same time. Except these fundamental researches, OFDM is often combined with the power and resource allocation to improve EE further. In [22], the authors improve EE by optimizing the number of sub-carriers. And in [23], the overhead of CSI feedback is reduced to achieve

higher EE. Although the research aimed at improving EE of MIMO and OFDM systems have been continued for years, there are many aspects, such as the MU-MIMO and multi-cell OFDM, need to be investigated more deeply.

V. PROSPECT FORECAST

Based on the introduction and discussion of the energyEfficient Technologies above, to our best knowledge, an optimized energy-efficient wireless cellular network can be conceived. According to the fact that the BSs occupy a significant portion of energy consumption, the heterogeneous network can be used to reduce the energy consumption while providing a better communication performance. Besides, the combination of heterogeneous network and switching off scheme will further increase the EE. In order to avoid the frequent switching, the low utilization BSs or RSs can be turned into a sleeping mode first. If the low utilization lasts for a long time, the sleeping nodes will be switched off completely. And as the important supplement, the cell zooming and CoMP can be adopted to cover the communication blind district. For a more optimized consideration, the OFDM and MIMO should be introduced into the signal transmission due to their better performance of balancing the EE and other criterions such as SE and capacity.

VI. CONCLUSION

In this article, we present a short survey on energy-efficient technologies of cellular networks. Many hotspot technologies such as the CoMP, MIMO and switching off scheme are introduced as the representatives, which are divided into three categories according to their application scenarios. For each part, the current research situations of technologies are introduced and discussed in detail. And to our best knowledge, a prospect forecast of energy efficient network is presented.

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