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LTE Based Traffic Management

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Abstract

LTE is a new technology that uses a packet-switched network for the support of any type of services, including real time services, e.g., telephony, instead of using a circuit-switched network. The LTE cellular network consists of two main parts, which are the Evolved UMTS Terrestrial Radio Access Network (E-UTRAN) and the Evolved Packet Core (EPC) network. The typical E-UTRAN consists only of evolved Node-Bs (eNode-s), which represent the Base Stations (BSs) used to provide radio access to all User Equipment (UE) that are within its radio coverage. Currently mobile cellular networks are highly centralised and therefore they are not optimised for high-volume data applications, which will evolve with 4G (e.g., LTE) and beyond technologies. Using shared distributed mobile network architectures bottlenecks can be avoided by better utilizing available resources and minimise delay. In this paper, modify the existing technique in heterogeneous LTE network to handle the traffic management. Modification is done by using NS2 and analyzes the results. Implement the existing technique using NS2.

Keywords*: LTE, WSN, GPS, Sleep Protocol.*

I. Introduction

Wireless Sensor Networks (WSNs) can be defined as a self-configured and infrastructureless wireless networks to monitor physical or environmental conditions, such as temperature, sound, vibration, pressure, motion or pollutants and to cooperatively pass their data through the network to a main location or sink where the data can be observed and analysed. A sink or base station acts like an interface between users and the network. One can retrieve required information from the network by injecting queries and gathering results from the sink. Typically a wireless sensor network contains hundreds of thousands of sensor nodes. The sensor nodes can communicate among themselves using radio signals [1]. A wireless sensor node is equipped with sensing and computing devices, radio transceivers and power components. The individual nodes in a wireless sensor network (WSN) are inherently resource constrained: they have limited processing speed, storage capacity, and communication bandwidth. After the sensor nodes are deployed, they are responsible for self-organizing an appropriate network infrastructure often with multi-hop communication with them. Then the onboard sensors start collecting information of interest. Wireless sensor devices also respond to queries sent from a “control site” to perform specific instructions or provide sensing samples. The working mode of the sensor nodes may be either continuous or event driven. Global Positioning System (GPS) and local positioning algorithms can be used to obtain location and positioning information. Wireless sensor devices can be equipped with actuators to “act” upon certain conditions. These networks are sometimes more specifically referred as Wireless Sensor and Actuator Networks [2]. This paper deals with the optimization of the energy consumption of LTE base stations or relay nodes by using sleep modes. The algorithms and protocols that will be put forward are inspired from Wireless Sensor Networks (WSN) sleep algorithms which deal with coverage and connectivity criteria. This means that in WSN, which are dense networks, sensors might be put to sleep after it is verified that every point in their surveillance area is covered by at least one other sensor that remains awake and that all the sensors are connected to a gateway in order to be able to forward their information [3]

Figure 1: LTE Relay Network Architecture

Another way to achieve energy efficiency in WSN is the use of topology control algorithms. While sleep scheduling algorithms are closely related to the evaluation of coverage and connectivity of the network, topology control for energy savings can be done via the adjustment of the transmission power of each sensor with the constraint of keeping the network connected at a certain degree. This parallel between cellular networks and WSN is possible mainly because of the coverage redundancy present in heterogeneous cellular networks and the development of LTE-Relay, whose standardization is still in course. In order to judge the feasibility of this convergent approach, several points should be considered carefully [4]:

- The strategies of WSN algorithms dealing with coverage and connectivity when sleep modes and topology control are used;
- the energy model used in WSN;
- the description of the energy efficiency of LTE eNodeBs(energy model, parameters etc.);
- the context differences and the adaptations that need to be done in order to apply WSN algorithms to LTE networks;
- the performance evaluation.

Moreover, it is important to highlight:

- The sensing model of WSN does not take into account any resource constraint, in other terms, coverage studies do not include, in their calculations, the capacity parameter. This is very important in cellular networks as it is the main focus of radio access networks which are designed with regard to a user density constraint.
- The difference between the energy models of WSN and LTE eNodeBs. The energy expenditure of a node can be considered constant while the node is on and null when the node is off. LTE eNodeBs have a high fixed operating cost added to a cost proportional to their emitting power level.
- In cellular networks, total energy consumption is more important than low communication overhead or lifetime of the network which are crucial in the case of WSN.

Also, existing work assume that messages between eNodeBs use a reliable transmission thanks to the RRC layer, which is not the case in WSN where algorithms are strongly influenced by message losses.

II. Distributed and Localized Algorithms For Energy-Saving in LTE

In this two different approaches for switching off eNodeBs. Both are designed to take as input parameter the downlink data traffic repartition over 24h. The presented solutions consist of slightly different communication protocols, both inspired from the WSN literature. In the general case, without any algorithm, all the eNodeBs work independently and consume an amount of energy corresponding to their own traffic pattern and coverage areas. When applying a sleep algorithm, there is coordination between base stations, so that some of them could switch off. So, after a switch off, eNodeBs that stay awake recalibrate their traffic demand and are expected to consume slightly more. Nonetheless, overall network energy gains are expected from the important load-independent costs that will be saved by switching off some eNodeBs [42].

1. Network Architecture Requirements

We consider a heterogeneous LTE cellular network as those deployed in urban area. The heterogeneity of these networks comes from the various scales of access points. Classical macro eNodeBs are strengthening by micro eNodeBs in streets, indoor etc for capacity and coverage issues. In this work, focus is on outdoor macro with several micros. Any two eNodeBs with overlapping coverage are connected through a X2 interface. This is in particular the case for any micro eNodeBs with their macro eNodeBs.

2. Distributed Sponsor-based Switch off Strategy

At first sight, a relevant strategy is a sponsor-based approach in which every eNodeBs monitors its average traffic load and, once this measurement drops below a given threshold, asks its neighbors for permission to sleep. On receiving such a request, each eNodeBs calculates its available "sponsoring" capacities that are how much of the load of the requesting eNodeBs it is able to take on. If the neighbor considers that it is capable of "sponsoring" the eNodeBs, it acknowledges it. After receiving all the answers, the eNodeBs can estimate if its load can be managed by its neighboring cells. If not, it cancels the procedure, otherwise it forces the handovers of its clients to its sponsoring neighbors and switches off after that. A eNodeBs remains asleep until the traffic increases and one of its neighbors asks for help.

3. Local rating-based switch off strategy

In order to cope with the aforesaid issues, the main idea is to localize the decision making of the sleep procedure. The start-up is based on the average load computation done periodically, after a certain delay. The delay computation for the average traffic load is inversely proportional to a local rating, which encodes the priority for a eNodeBs to go to sleep. This parameter is initialized by the network operator, evolves during the day, as described in the following, and is reset every 24h or after a sleep period [5].

III. Implemenation

The research implements the proposed work by using NS2.34 which is installed over fedora 17. The simulation is analyzed over different scenarios having nodes 20,30,40,50 respectively.

Parameter Analysed

1. **Packet Delivery Ratio (PDR):** The number of delivered data packet ratio to the destination and this also illustrates the level of delivered data to the destination.

∑ Number of packet receive / ∑ Number of packet send

2. End-to-end Delay

The average time taken by data packets to arrive in the destination. It also includes the delay caused by route discovery process and the queue in data packet transmission. Only the data packets that successfully delivered to destinations that counted.

∑ (arrive time – send time) / ∑ Number of connections. The table 1 to 2 shows the performance of existing and proposed work for the parameters defined above. The performance is calculated by varying number of nodes. The analysis is done on 20,30,40,50 number of nodes.

Table 1: Parameter Analysis of Proposed Algorithm

Number of Nodes	PDR	End 2End delay(ms)
20	84.9543	0.00171643
30	80.9686	0.00164999
40	79.5096	0.00124025
50	77.7255	0.0011805

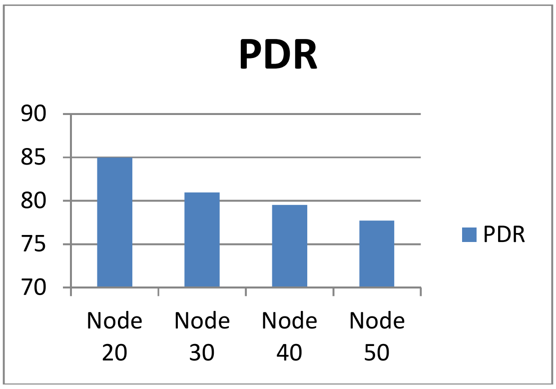

Figure 2: Comparison of PDR on Different Nodes

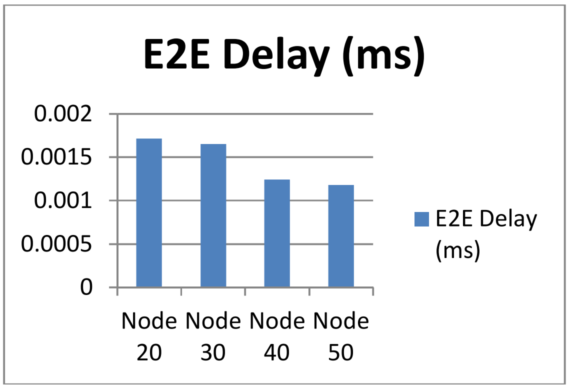

Figure 3: Comparison of E 2E Delay on Different Nodes

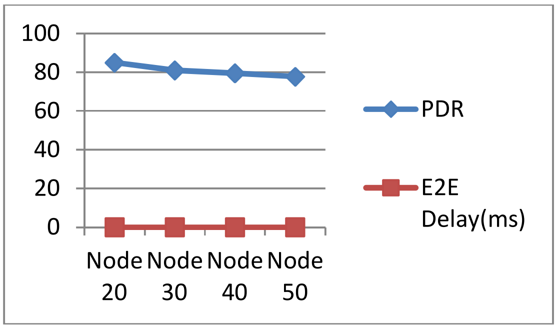

Figure 4: Comparison of PDR And E2E Delay on Different Nodes

IV. Conclusion

Life without ubiquitous possibilities to connect to the Internet is hard to imagine nowadays. Cellular networks play a central role in this global networking and communication infrastructure. To ensure and even enhance availability, the standardization process of new communication systems is governed by concerns about reliability, interoperability and security, besides trying to improve the performance of current technology. Still, the ever-increasing demand for higher data rates forces the consideration of novel research results during standardization. For good reason, however, standardization experts are reluctant about innovative results: Often assumptions made by researchers are too simplistic and idealistic to reflect the performance under practical conditions. Numerous bandwidth availability prediction models have been proposed for cellular networks in the past. How-ever, none of these prediction models were designed to work with virtualized Long Term Evolution (LTE) cellular networks. This research investigates the possibility of adapting WSN sleep strategies to heterogeneous cellular networks. The algorithms and protocols design takes care of several key aspects of the parallel between WSN and cellular networks. This dissertation improves the existing LTE network. Simulation is performed by using NS2. Various parameters like Packet delivery Ratio, E2E delay are analyzed on various nodes.

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