A Rational Approach to Improve Performance Degradation in LTE Systems

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Abstract

An intense Radio Resource Management strategy for sharing traffic among cells is Mobility Load Balancing (MLB) to manage the uneven traffic distribution in mobile networks. The point of MLB is to lighten congestion issues by sharing traffic request among neighbor cells through the modification of handover parameters. However, in long term evolution (LTE), MLB may prompt to serious system execution corruption because of the tight frequency reuse and the non appearances of a soft handover conspire. In proposed work by implementing an advanced optimizes clustering algorithm to improve network lifetime in long term evolution (LTE).

Keywords: LEACH protocol, mobility load balance, handover and LTE.

INTRODUCTION

The recent improvements in making vitality effective Wireless Sensor Network is giving another course to convey WSN in applications like observation, industrial monitoring, traffic monitoring, habitat observing, cropping checking, crowd counting and so forth. The developing utilization of these systems is making designers to advance creative and proficient thoughts in this field. A lot of research in data routing, data compression and in network conglomeration has been proposed in recent years [1]. The remote medium may both of radio frequencies, infrared or whatever other medium, obviously having no wired association. These nodes are sent in an arbitrary
manner and they can convey among themselves to make an ad-hoc network. Fundamentally nodes are driven by batteries and in numerous applications it is difficult to supplant the batteries or once in a while not even recharge the batteries so every node has a constrained energy supply [2], [3].

LEACH is the most punctual proposed single-hop clustering routing algorithm in Wireless Sensor Network (WSN). It can spare network energy incredibly compared with the non-cluster routing algorithm. Numerous other clustering algorithms are proposed in view of LEACH, for example, TEEN (Threshold Sensitive Energy Efficient Sensor Network Protocol)[4], PEGASIS(Power Efficient Gathering in Sensor Information Systems)[5], HEED(Hybrid Energy-Efficient Distributed Clustering)[6], etc. In LEACH protocol, all clusters are self-sorted out, every cluster contains a cluster head and a few non-cluster head nodes and cluster head node expends more energy than non-cluster head nodes. With the reason for adjusting network energy utilization and drawing out the network life time, it chooses cluster head haphazardly and every node has an equivalent opportunity to be cluster head [7]. The cluster structure upgrade always in operation and one updating procedure is known as a round. The cycle of each round contains two phases: set-up stage and steady-state stage, set-up stage is the foundation period of the cluster; steady-state stage is the steady information exchange stage.

MOBILITY LOAD BALANCING

MLB is part of the wireless network concept, which has been presented in LTE. By applying MLB in the network, gains and energy as far as higher network performance and a diminishing number of unsatisfied users are the streamlining objective. This should be achieved by lessens network congestion in the wireless network. Normally the MLB monitors the cell stack values and disperse the traffic of highly stacked cells among less stacked neighboring cells in the network. This can be done by altering the (virtual) cell borders, e.g. including a cell individual offset which will be mulled over for handover decisions, or changing the transmit power of the cell. By doing this the range of exceptionally loaded cells will be made smaller, where then again the area of less loaded cells will be broadened.

Assume \( P_j \) is the probability that \( j \) channel exchanges are requested for traffic type \( i \) which is given by

\[
P_j = \frac{\rho_j^l}{\sum_{j=0}^{\infty} \frac{\rho_j^l}{j!}}
\]

The handoff blocking probability, \( P_{S_i} \) of MLB , is expressed by:

\[
P_{S_i} = \frac{\rho_i^s}{\sum_{j=0}^{\infty} \frac{\rho_i^s}{j!}}
\]

The handoff blocking probability, \( P_{S_i} \), can be dropped when the number of available channels increases. This means that the more bandwidth is available in a cell, the less
chance a handoff call is blocked. Suppose that a base-station switch in a wireless mobile network supports multiple-class traffic \( i \) in which each traffic type \( i \) may belong to cluster \( \{0,1, \ldots, n\} \). To handle different QoS requests for any type of traffic, assuming the network reserves bandwidths in the form of a frame.

MLB is a low congestion problem through the modification of handover parameters. So, this method easily assess downlink and uplink network performance might be used to detect problems accurately. In LTE, the signal level received by a user from an adjacent cell is much higher than that of the serving cell in MLB, which can be expressed as

\[
P_{rx}(j) + Ocn(i,j) - Hys(i) > P_{rx}(i) + Off(i)
\]  

where \( P_{rx}(i) \) and \( P_{rx}(j) \) are the pilot signal levels from serving and neighbor cells \( i \) and \( j \), respectively, \( Ocn(i,j) \) is an additional margin defined for the adjacency \( (i,j) \) involved in the HO, and \( Hys(i) \) and \( Off(i) \) are the hysteresis and offset values defined for the serving cell \( i \).

All variables in (1) are in dB. Basically, a user in cell \( i \) is handed over to cell \( j \) when \( P_{rx}(j) \) exceeds \( P_{rx}(i) \) by a margin, \( Margin(i, j) \), defined as

\[
Margin(i, j) = Off(i) + Hys(i) - Ocn(i)
\]  

A low/high value of \( Margin(i, j) \) determines how easy/difficult is to hand over a user from cell \( i \) to \( j \), or, in terms of distance, how close/far from cell \( i \) the user is when it is handed over to cell \( j \). Thus, the service area of a cell \( i \) is given by the value of \( Margin(i, j) \) in all its adjacencies \( (i,j) \).

**LEACH PROTOCOL**

Leach protocol contain two types. They are single hop leach and multi hop leach. In this paper, we consider multi hop leach. In LEACH protocol the data is transmitted from collector station to base station node through multi hop communication regardless of the between base station and receiver station. Energy utilization will be progressively if distance is far. This multi hop -LEACH protocol changes LEACH permitting sensor nodes to use multi-hop communication inside the user nodes in order to increase the energy efficiency of the protocol. This paper amplifies the current arrangements by permitting multi-hop inter nodes communication in LTE in which the direct communication between receiver stations or the sink is unrealistic because of the distance between them. Consequently, the main innovation of the arrangement proposed here is that the multi-hop technique is followed inside the cluster node and outside the cluster node. The receiver stations can likewise perform data fusion to the data receive, permitting a reduction in the total transmitted and sent data in the network.
This paper provides node energy and position information to improve the LEACH algorithm. The threshold of multi hop LEACH protocol is given by

$$T(n) = \frac{p}{1-p^*(r \mod p)} \cdot \frac{E_{cur}}{E_o}$$ \hspace{1cm} [5]

$E_{cur}$ is the current energy of node, $E_0$ is the node initial energy. When the node energy is very low, threshold $T(n)$ becomes very small, the probability of the node random number being smaller than the threshold becomes small, the cluster-head nodes in the network will be too little, the selected cluster-head consumes too much energy and thus affects the network life because of the untimely death. The improved threshold of multi hop leach protocol is given by

$$T(n) = \begin{cases} 
  f(E_{cur}) \cdot \left[ \frac{(1-\alpha)p}{1-p^*(r \mod p)} + \alpha \cdot p \cdot h(D_{toBS}) \right] & n \in G \\
  0, & \text{otherwise}
\end{cases}$$ \hspace{1cm} [6]

$f(E_{cur})$ is the function relevant to the current residual energy of the node, it reflects the influence of node energy to the elected cluster-head probability. $h(D_{toBS})$ is the $D(n)$’s impact on cluster-head election, increasing the probability of the near-by base station node becoming cluster-head, $\alpha$ is the influencing factor. $f(E_{cur})$ and $h(D_{toBS})$ are given by

$$f(E_{cur}) = \frac{E_{cur}}{E_{ave}}$$ \hspace{1cm} [7]

$$h(D_{toBS}) = \frac{D_{max} - D(n)}{D_{max} - D_{min}}$$ \hspace{1cm} [8]

The cost function of the normal node $p_i$ joins in the cluster with the cluster-head $c_j$ can be shown as

$$Cost(i,j) = \frac{d_{ij}}{d_{max}} \cdot \frac{E_{cur}(i)}{E_{ave}} \cdot \frac{D(j)}{D_{ave}}$$ \hspace{1cm} [9]

Where $d_{ij}$ is the distance from the node $p_i$ to cluster-head $c_j$, $d_{max}$ is the maximum of the distances from $p_i$ to the candidate cluster-heads, $E_{cur}(i)$ and $E_{cur}(j)$ is the current residual energy of node $p_i$ and cluster-head $c_j$, $D(j)$ is the distance from cluster-head $c_j$ to the base station, $D_{ave}$ is the average distance between cluster-heads and the base station.

The main advantage of leach protocol is reduce the traffic in the entire network, saving energy, increases the lifetime of the sensor network and reduces network congestion of each cell user in downlink and uplink networks.
RESULTS AND DISCUSSION

Fig. 1 shows the nodes which are represented by numbers are randomly arranged in x-y coordinates. The network is formed among the 8 nodes i.e., network topology as shown in Fig. 2. It can be noticed from Fig. 3 that node 1 is the source and node 5 is the destination. The possible path for handover or data transfer is from node 1 to node 7, 7 to 2, 2 to 3, 3 to 4 and from node 4 to node 5. Hence it is proved that any two nodes form as source and destination.

Fig. 4 shows the ECDF of average CQI for cells R and NSNR before and after MLB. It is observed that the CDF moves to the left after MLB in cells R, showing that cells receiving traffic experience worse average DL channel quality.

Fig. 5 shows the Empirical Cumulative Density Function (ECDF) of cells S before and after MLB, compared with cells NSNR. It is observed that UL interference in cells S increases after MLB.

Fig. 6 represents statistical data which is defined on the basis of empirical cumulative distribution function over continuous quality improvement & physical uplink shared channel. Fig. 6.1 specifies the optimized path in random distributed network on protocol based gives better improvement in minimizing traffic congestion. Fig. 6.2 indicates the transmission of data in sharing channels based on iterative operations performed to identify alive nodes to avoid congestion to define LTE. Fig. 6.3 shows the sum of energy at each node to be utilized in decreasing order.

![NODES IN TOPOLOGY FORMATION](image URL)

**Figure 1:** Nodes or cells of each user in topology formation
Figure 2: LTE network shows all the possible ways of forming a network among the nodes for better communication.

Figure 3: Possible paths from source to destination
Figure 4: ECDF of average CQI for cells receiving traffic.

Figure 5: ECDF of average PUSCH interference for cells sending traffic.
CONCLUSIONS
The paper introduces the confinement of LEACH convention and MLB in LTE (long term evolution) or wireless network system. It solved the network congestion and lifetime of the sensor network. It evaluates downlink and uplink network performance might be utilized to distinguish issues precisely. The results generate less network congestion of every cell user in downlink and uplink networks. As LEACH doesn’t
A Rational Approach to Improve Performance Degradation in LTE Systems

give an idea about the number of cluster heads in the network and if for any reason, the cluster head dies then the cluster would become useless because the data gathered by the cluster node would never reach its destination (base station). This may cause an increase in energy consumption and have an impact on performance of the network. So there is a need for new technique by dividing the clusters by specific angle resulting in even distribution to make optimal energy consumption and to increase the performance of the network.

**NOMENCLATURE**

$c_j$ Cluster head

$d_{ij}$ Distance from the node $p_i$ to cluster-head $c_j$

$D(j)$ Distance from cluster-head $c_j$ to the base station

$D_{ave}$ Average distance between cluster-heads and base stations

$d_{min}$ Minimum distance from node $p_i$ to cluster-heads

$d_{max}$ Maximum distance from node $p_i$ to cluster-head $c_j$

$D(n)$ impact on clusters for selection of cluster-head

$E_{ave}$ Average energy of node

$E_{cur}(i)$ Cluster residual energy of node $p_i$

$E_{cur}(j)$ Residual energy of cluster-head $c_j$

$E_{cur}$ Current energy of node

$E_0$ Node initial energy

$f(E_{cur})$ Function relevant to the current residual energy of node

$G$ Set of nodes that have not been elected as cluster-head in the last $1/p$ rounds

$h(DtoBS)$ Cluster head selection

$Hys$ Hysteresis defined for serving cell

LEACH Low Energy Adaptive Clustering Hierarchy

LTE Long Term Evolution

MLB Mobility Load Balancing

$n$ Node identification in the current sensor network

$off$ Offset values defined for serving cell

$Ocn$ Additional margin

$P$ Percentage of cluster heads

$p_i$ normal node

$p_j$ Probability of j channel

$P_{rx}$ pilot signal level from serving cell

$P_{sb}$ Handoff blocking probability

QoS Quality of service

$r$ current round number

$S$ Total number of available channels

$T(n)$ threshold

WSN Wireless Sensor Network
Greek symbols
\( \propto \) Influence factor in equation (6).
\( \rho \) Normal node

Subscripts
\( i \) Underutilized cell
\( j \) Congested cell

REFERENCES