Energy Efficient Adaptive LTE Selection Model for Improved QoS Performance in Wireless Networks

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Presence of LTE (Long Term Evolution) devices in modern networks supports higher QoS achievements. The QoS of any modern network is about achieving higher throughput performance. In this case, number of approaches available, but providing seamless transmission in urban network where there is poor network connectivity is a challenging task. Number of approaches is presented in literature, which involve in handover when there is poor connectivity which works according to the signal strength and other factors. The methods suffer to achieve higher performance in QoS in wireless networks. To handle this issue, an Energy Efficient Adaptive LTE Selection Model (EEA-LTE-SM) is presented in this paper. The proposed method monitors the data rate currently available and identifies the list of LTE available around the corner. At each time stamp, the method computes the value of Data Rate Support (DRS) available. Based on the value of DRS, the method performs LTE selection to maintain the QoS of WSN. For each LTE identified, the method computes Future Data Support (FDS) according to the data rate available, energy, mobility speed. According to the FDS value, the method discovers the list of LTE around the node and selects a optimal LTE to perform further transmission. The proposed method improves the QoS performance of wireless networks.

Keywords: WSN, LTE, EEA-LTE-SM, QoS, FDS.

1. Introduction

Wireless networks are the most dominant one being used by recent informatics world. It has been used to provide many network services and the devices use the same wireless communication to access such services provided. The mobile users access various network services through their devices. The modern mobile devices has LTE (Long Term Evolution) devices which support the data communication. The mobile nodes access various services on the fly, which requires specific data rate at each fraction. Obtaining required data rate for the service access, requires exact connectivity and signal strength. To maintain the data rate, the mobile nodes look for the qualified LTE at all the time. The choose the optimal LTE to maintain the data rate and connectivity.

The selection of LTE plays vital role in maintaining the Qos of the environment. The LTE selection is performed according to various factors like data rate, signal strength, and so on. Towards this, there are number of approaches available, which consider energy, data rate and signal strength as the key, in the selection of LTE. Such approaches do not consider what the future data availability. By considering the future data availability, an optimal LTE can be selected. The LTE comes with the MIMO device which supports the higher data rate communication. This research article focused on the selection of optimal LTE towards maintaining the quality of service of wireless networks.

The quality of service of wireless network is depending on the latency and throughput. When the nodes does not have enough energy, it loses the data rate and affects the throughput performance. Similarly, when the mobility speed of the devices is higher, then the node looks for the required LTE and if not supporting that, then it would affect the same. When the LTE has no coverage and number of LTE around the device is less, then it has minimum chance of using other LTE, which affect the throughput performance. All these have direct impact on the QoS performance of the network. By considering all these, an Energy Efficient Adaptive LTE selection Model (EEALTESM) is presented in this article. The method monitors the network conditions with energy, signal strength and other factors like data rate obtained. Based on that, the method computes the future data support (FDS) to choose an optimal LTE to achieve higher QoS performance. The approach has been briefed in detail in the next section.

2. Related Works:

Number of LTE selection schemes is described in literature; this section briefs set of methods around the problem.

A priority based flipping based low complexity fair scheduling is presented in multi traffic classes in[1], towards minimizing the scarcity of bandwidth on low traffic conditions. A low profile broadband dual polarized omnidirectional antenna model is presented for LTE applications in [2], which handles both horizontal and vertical polarization. A sensing based semi persistent scheduling is presented in [3], to support LTE-V2X systems. The method uses SPS towards scheduling according to the characteristics of network. TDM-PON and LTE-A Based Cost-Efficient FiWi Access Network Deployment is presented in [4], which identifies network architecture and user mode dynamically. A Fat-Proxy is defined in [5], which identifies the available service access through number of proactive event execution in LET networks. A multi-antenna multi-user transmit precoding and power control scheme is presented in [6], to support LTE networks. The method uses multiple MIMO to support the data transmission. A spectrum orient user and QoS aware resource allocation scheme is presented in [7], which uses QoS aware resource allocation scheme to support uplink transmission. A signal tracking with adaptive multipath mitigation scheme is presented in [8], which uses signal tracking algorithm and uses adaptive multipath estimating delay lock loop (AMEDLL) algorithm to perform effective transmission. A channel quality indicator based interference detection and resource allocation is presented in [9], which uses a cluster based algorithm to find the interference using channel quality indicator (CQI) feedback and location information. Synthetic aperture beamforming based multipath mitigation is presented in [10], to support deep urban navigation. The method uses motion of single antenna to synthesize a geographically separated antenna array to support navigation. A game theory based QoS aware uplink scheduling (GTQoS) is presented in [11], which uses a Quality-of-Service aware uplink packet scheduling scheme and uses time domain and frequency domain scheduling. The performance measure of LTE in multi floor building in [12], which analyze performance of methods in various metrics. A multi ban time of arrival estimation is presented in [13], to support LTE signals. The method estimates the correlation between the channels impulse response to measure the time of arrival using space-alternating generalized expectation-maximization (SAGE) algorithm.

A Low-Profile Dual-Polarized Omnidirectional Antenna is designed [14], which uses a special feeding scheme to measure the antenna achievement. An adaptive handover algorithm is presented for LTE-R systems in [15], which establish elliptic function relation with threshold and train speed.

Energy Efficient Adaptive LTE Selection Model (EEALTESM):

The Energy Efficient Adaptive LTE Selection Model (EEA-LTE-SM) method monitors the data rate currently available and identifies the list of LTE available around the corner. At each time stamp, the method computes the value of Data Rate Support (DRS) available. Based on the value of DRS, the method performs LTE selection to maintain the QoS of WSN. For each LTE identified, the method computes Future Data Support (FDS) according to the data rate available, energy, mobility speed. According to the FDS value, the method discovers the list of LTE around the node and selects a optimal LTE to perform further transmission.

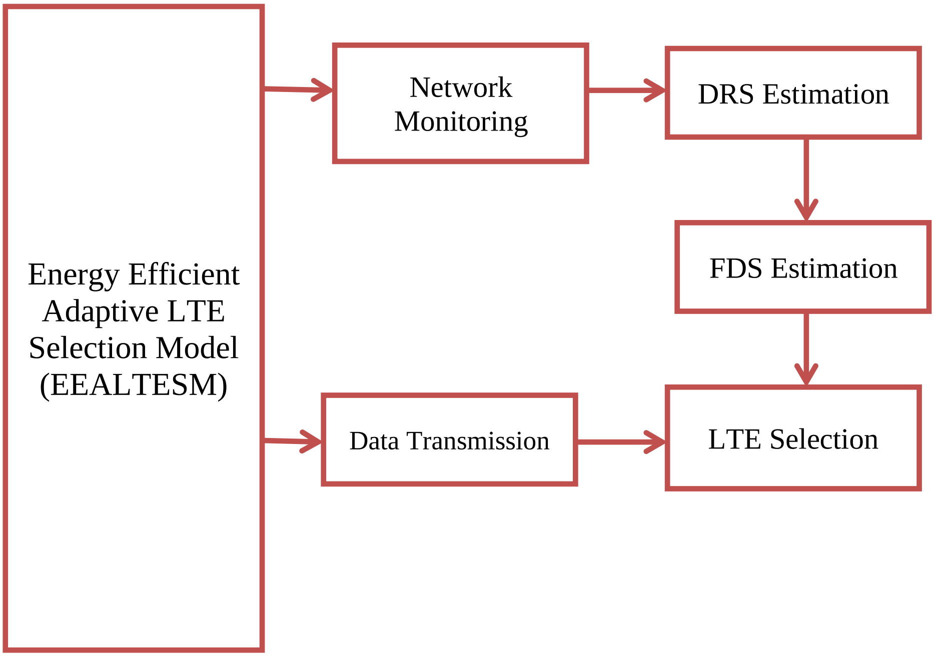

Figure 1: Architecture of Proposed EEALTESM model

The architecture of proposed EEALTESM model is presented in Figure 1, and functions of the model is detailed in this part.

Network Monitoring:

The proposed method monitors the network conditions at all the moment. At each duty cycle, the method monitors the energy, mobility speed, data rate, and number of LTE around the node. Such monitored data has been added to the Network table to support further analysis. The data rate is measured based on the number of bytes being received per second and number of bytes being sent on any duty cycle. Using these two information, the method compute the data rate to support further LTE selection.

Algorithm:

Given: Network Table NT

Obtain: NT.

Start

Read NT.

While true

Energy E = Node.Residual Energy

Mobility speed Ms = $\frac{\sum \text{Meters Displaced}}{\text{second}} \times 60$

No of LTE Nl = $\overset{\text{size(Ls)}}{\underset{i=1}{\text{Count}}}\ (\text{Ls}(i).\text{location} < \text{Node.location} >)$

Compute data rate Dr = $\sum \text{BytesReceived/Second}$

NT = $(\sum \text{Entries} \in \text{NT})\ \cup \{\text{E}, \text{Ms}, \text{Nl}, \text{Dr}\}$

DRS = Perform DRS Estimation.

If DRS < Th then

For each LTE l

DFS = Perform FDS Estimation

ENd

LTE = Choose LTE with maximum FDS

Perform data transmission through selected LTE.

End

End

Stop

The working of network monitoring process is presented in the above algorithm which estimates DRS value at each cycle and based on that the method performs LTE selection to maintain the QoS performance of wireless network.

DRS Estimation:

The data rate support is the measure which represents the network support provided by any LTE. Any wireless node performs transmission through the LTE device to perform any communication with another node or accessing any service. To perform efficient communication and to achieve higher QoS, the current LTE should support the required data rate support. It has been measured based on the energy, bytes received per second, number of LTE around the node, signal strength and traffic constraints. Using all these features, the method computes the value of DRS to decide on the shifting the connection with another LTE for further transmission.

Algorithm:

Given: Network Table NT and LTE l

Obtain: DRS.

Start

Read NT and l.

Collect traces of LTE as LT = $\sum_{i=1}^{Size(NT)} NT(i).l.id == l.id$

Compute Energy Drain Factor Edf = $\frac{\sum_{i=1}^{Size(LT)} LT(i).BytesReceived+LT(i).Bytestransfered}{size(LT)} \times \frac{\sum_{i=1}^{Size(LT)} LT(i).Energyspent}{size(LT)}$

Compute Communication Factor CF.

$$CF = \frac{\sum_{i=1}^{size(LT)} Traffic(LT(i))}{\sum LTE \in TransmissionRange(Nodeid)} \times \frac{\sum_{i=1}^{size(LT)} LT(i).signalstrength}{size(LT)}$$

Compute DRS = Edf×CF

Stop

The DRS estimation algorithm computes Edf and CF measures to compute DRS to support LTE selection.

FDS Estimation:

The feature data support is the measure represent the data rate support would provide by any LTE in future. The FDS is depend on the residual energy and the LTE devices around the region which provides required data rate with less energy consumption. The value of FDS is measured based on the signal strength provided by LTE at least energy consumption. Based on the value of signal strength and data rate maintained by the LTE, the method estimates the FDS value.

Algorithm:

Given: LTE l, Network Table NT.

Obtain: FDS.

Start

Read l, NT.

LTE Trace Lt = = $\sum_{i=1}^{Size(NT)} NT(i).l.id == l.id$

Compute average data rate Adr = $\frac{\sum_{i=1}^{Size(Lt)} Lt(i).Bytes}{Size(Lt)}$

Compute average signal strength Ass = $\frac{\sum_{i=1}^{Size(Lt)} Lt(i).Signalstrength}{Size(Lt)}$

Compute FDS = Adr×Ass

Stop

The FDS estimation algorithm computes the average data rate and average signal strength provided by the LTE to compute FDS value.

LTE Selection:

The proposed method performs LTE selection according to the FDS measure being computed for different number of LTE available around any node. To choose the LTE, the method estimates the FDS measure for different LTE devices nearby. According to the FDS value, a device with higher FDS is selected to continue data transmission.

3. Results and Discussion:

The proposed Energy efficient adaptive LTE selection model has been implemented and evaluated for its performance under various scenarios. The model has been simulated with Network simulator 2 with number of nodes and LTE devices. Obtained results are compared with the result of other schemes.

Parameter	Value
Tool used	Network Simulator 2
Number of nodes	200
Number of LTE	30
Duration	10 minutes

Table 1: Evaluation Details

The evaluation details used for performance analysis of various methods are presented in Table 1.

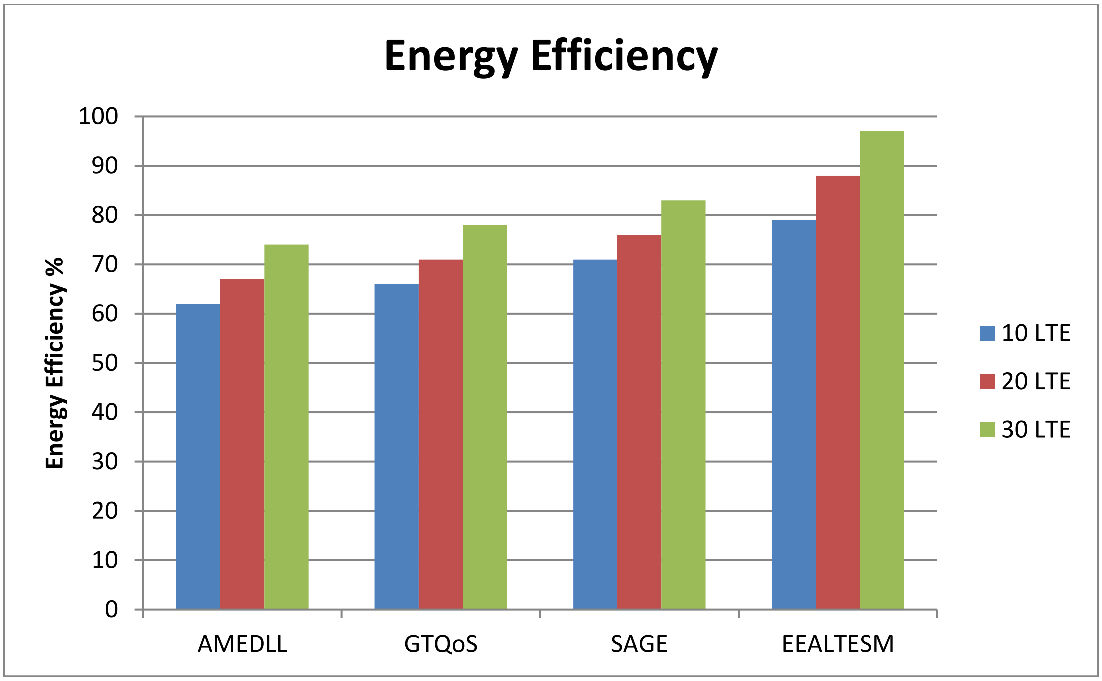

Figure 2: Analysis on energy efficiency

The value of energy efficiency produced by various approaches are measured and presented in Figure 2. The EEALTESM model introduces higher energy efficiency than others.

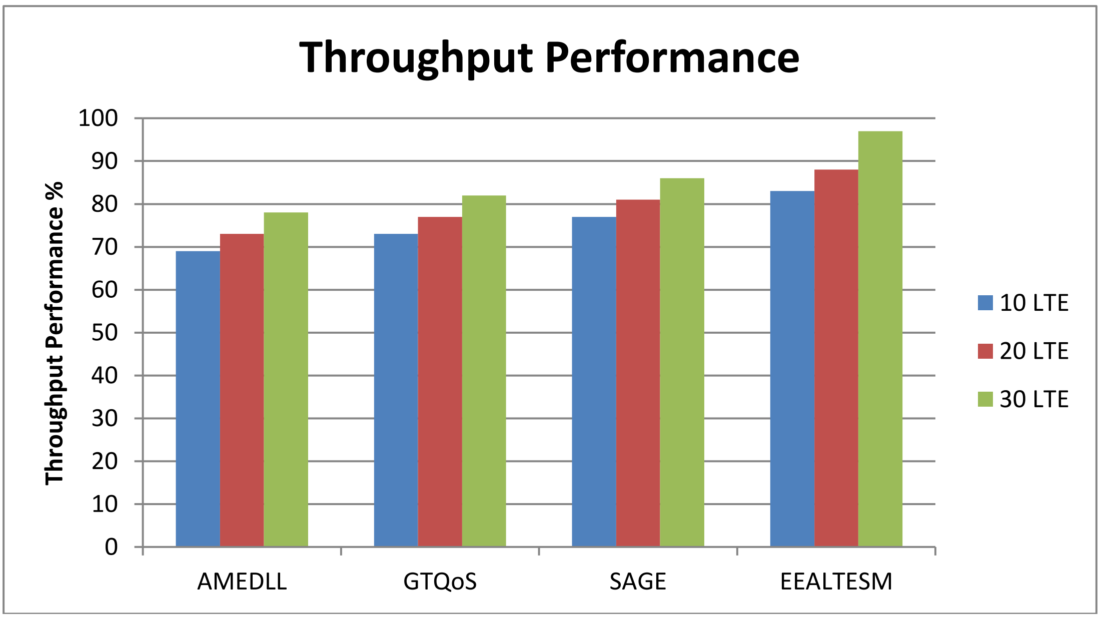

Figure 3: Throughput Performance

The throughput performance introduced by various approaches are measured and presented in Figure 3. The EEALTESM model introduces higher throughput performance than others.

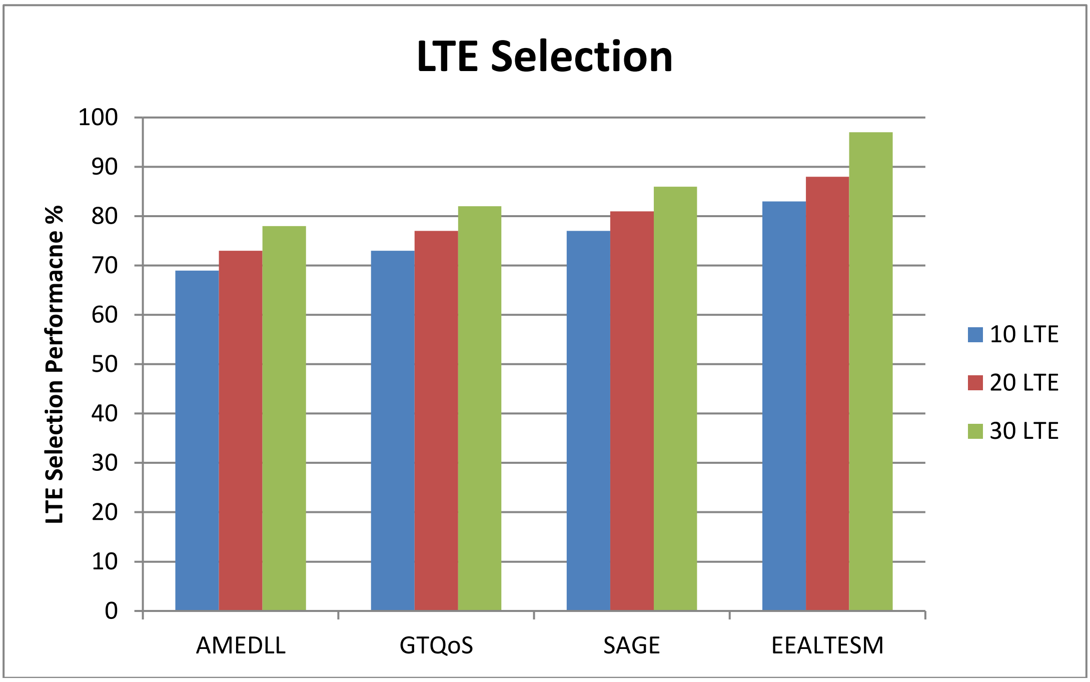

Figure 4: LTE Selection Performance

The performance of methods in selecting LTE device is measured and compared in Figure 4. The proposed EEALTESM model introduces higher LTE selection performance than others.

4. Conclusion:

This paper presented a energy efficient adaptive LTE selection model towards QoS development of wireless networks. The method monitors the data rate currently available and identifies the list of LTE available around the corner. At each time stamp, the method computes the value of Data Rate Support (DRS) available. Based on the value of DRS, the method performs LTE selection to maintain the QoS of WSN. For each LTE identified, the method computes Future Data Support (FDS) according to the data rate available, energy, mobility speed. According to the FDS value, the method discovers the list of LTE around the node and selects a optimal LTE to perform further transmission. The method introduces higher performance in throughput, energy efficiency and LTE selection.

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