A Heuristic Energy Efficient Scheduling Scheme for VoIP in 3GPP LTE Networks

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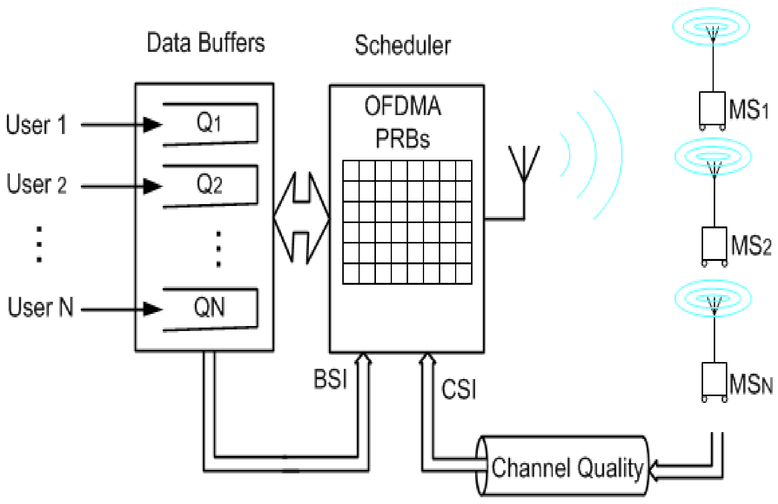
Main Points

- We focus on energy efficient scheduling scheme for LTE networks while system is operating in low load.
- We evaluate energy efficiency of well known and principal scheduling schemes, Round Robin (RR), Best Channel Quality Indicator (BCQI), and Proportional Fair (PF).
- We propose a novel energy efficient scheme in low load traffic conditions. The proposed scheme trades off bandwidth for energy whenever possible depending on the load of the network.
- By applying this approach on the principal schedulers, three relevant energy efficient schedulers for Voice over IP (VoIP) traffic, namely, Energy Efficient Round Robin (EERR), Energy Efficient Best Channel Quality Indicator (EE-BCQI), and Energy Efficient Proportional Fair (EEPF) are introduced.
- The results of performance analysis demonstrate the superior performance of the proposed scheme in terms of energy consumption of the network, while providing required Quality of Service (QoS) for the users.

System Model

- Single base station that serves multiple mobile user is considered.
- An Orthogonal Frequency Division Multiple Access (OFDMA) scheme is used by the BS in downlink to serve multiple users.
- The concept of radio resource allocation is based on assigning available Physical Resource Blocks (PRB) among users.

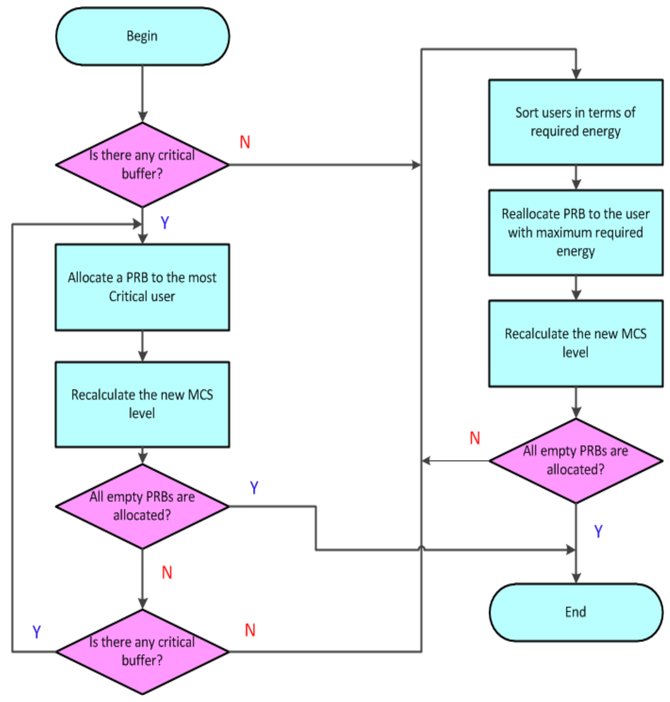


Proposed Scheme

-The basic idea of the proposed scheduling scheme stem from the fundamental trade-off between bandwidth and transmission power in light traffic conditions.

- The proposed energy efficient scheduling schemes in this paper implement strategies based on observation of the outstanding demands in the data buffers. They exploit the random fluctuations of the demand to adapt the actual number of information bit transmitted per TTI from the station. Whenever the empty resource (PRB) is found in each TTI, the schedulers operate to reduce the payload of the transmission, reducing the coding rate. This allows the transmitter to reduce energy per TTI.

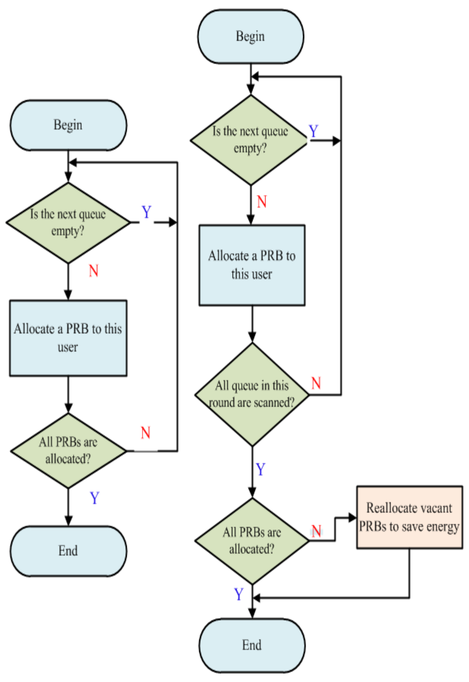
Coding Schemes	Modulation	Required SNR Threshold(dB)	Coding Rate	Spectral Efficiency (bit/s/Hz)
MCS15	64QAM	17.6	11/12	5.55
MCS14	64QAM	16.8	5/6	5.12
MCS13	64QAM	15.6	3/4	4.52
MCS12	64QAM	13.8	3/5	3.9
MCS11	64QAM	13	1/2	3.32
MCS10	64QAM	11.8	1/2	2.73
MCS9	16QAM	11.4	3/5	2.41
MCS8	16QAM	10	1/2	1.91
MCS7	16QAM	6.6	1/3	1.48
MCS6	QPSK	3	3/5	1.18
MCS5	QPSK	1	1/2	0.88
MCS4	QPSK	-1	1/3	0.6
MCS3	QPSK	-2.6	1/6	0.38
MCS2	QPSK	-4	1/9	0.23
MCS1	QPSK	-6.5	1/12	0.15



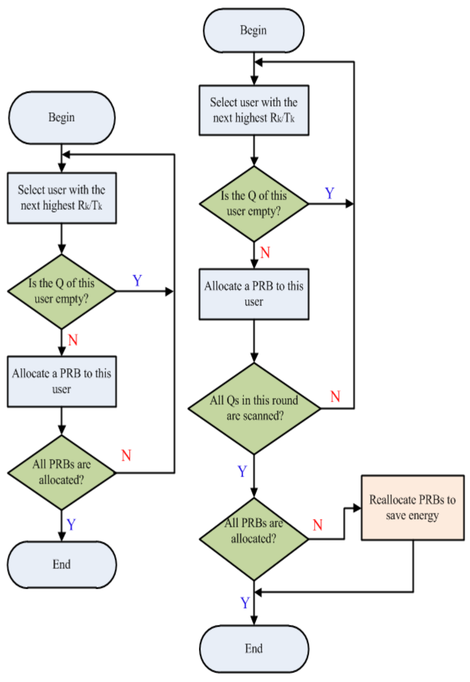
Principal Schedulers and Modified EE Schedulers

- After assigning maximum one PRB to each user based on principal schedulers, the proposed scheme is applied to assign more PRBs that are vacant to propose three energy efficient schedulers: 1) Energy Efficient Round Robin (EERR); 2) Energy Efficient Proportional Fair (EEPF); 3) Energy Efficient Best Channel Quality Indicator (EEBCQI).

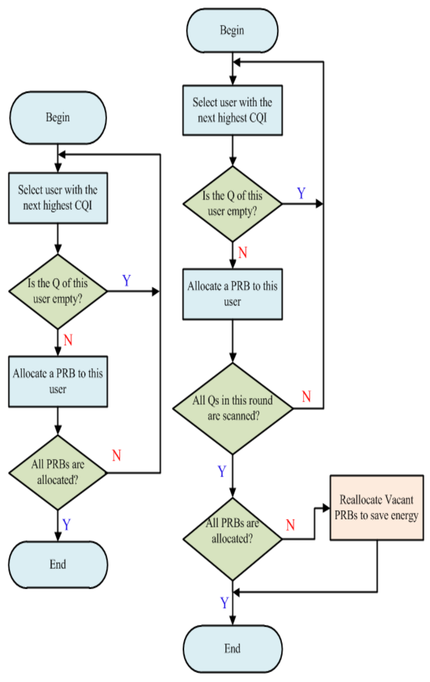
❖ *RR and EERR Schedulers*



❖ *PF and EEPF Schedulers*

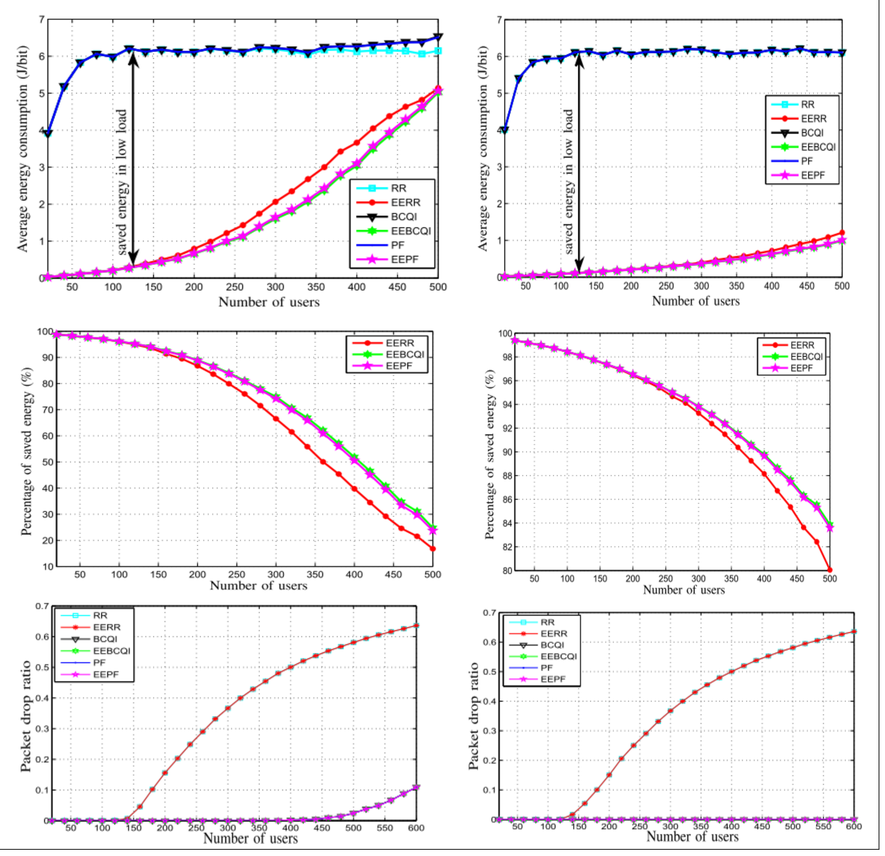


❖ *BCQI and EEBCQI Schedulers*



Simulation Results

- Simulation results are presented in terms of energy consumption , energy saving gain , and packet drop ratio for 25 and 50 PRBs as follows:



Basic Conclusions/Contributions:

- We investigated energy efficiency of three well-known principal schedulers, namely, RR, BCQI, and PF for VoIP traffic scheduling over an OFDMA system in low load situations.
- We also proposed novel scheme by applying on the three principal schedulers as an example to reduce energy consumption of base station. The heuristic scheme can be applied to any other types of schedulers in order to prevent wasting of the available resources in light traffic conditions while guaranteeing the QoS in terms of packet drop ratio.
- The advantage of this scheme is that both buffer status and energy consumption values besides the channel conditions are taken into account to serve the empty resources in each TTI.
- According to the aforementioned results, significant energy saving and superior performance during low traffic situations are achieved.