LTE Pricing Strategies

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Abstract— **Pricing plays an important role to efficiently manage the cellular network resources, maintain user required QoS (Quality of Service) levels and to optimize the operator's revenue. In this paper, we analyze some previous pricing schemes proposed for general wireless multimedia systems and for WiMAX and adapt these methods within LTE (Long Term Evolution) networks. We also propose a dynamic pricing strategy for LTE. Most of these methods (including ours) are based on users' price categories: Gold (or high), Silver (or medium) and Bronze (or low). The price charged to these users may also vary with the QoS level. We compare these methods considering the LTE network context. Our proposed strategy provides high revenue for the operator as well as a smaller average price paid for the user, with regard to the flat-rate pricing strategy.**

Keywords- Pricing; LTE; radio resources; QoS; revenue

I. INTRODUCTION

LTE (Long Term Evolution) systems emerged as a part of 3GPP (3rd Generation Partnership Project) Release 8. It offers access to high data rate Internet services (including real-time streaming/gaming, voice of IP, etc.) and provides connectivity to mobile devices for these applications [1][2]. Recent advances in 3G/4G networks such as the research conducted by iDATE system [3] suggests that by 2016, a total of 830 million subscribers worldwide would have access to mobile data solutions via LTE networks. This perspective requires operators to develop efficient billing and pricing strategies in order to increase their revenue as well as providing high satisfaction levels to the costumers. As indicated in [4], the operators should add more dynamism in their pricing schemes thereby moving beyond the recently deployed flat-rate architectures in which a user is allowed to access its reserved share without considering network load or congestion.

The importance of developing dynamic pricing models has been recognized by several vendors. Different industrial research groups have conducted their studies regarding this issue. For example, the OPENET researchers [5], emphasize on providing smart and real-time pricing tiers (or levels) to 3G+ subscribers where a high paying costumer can get access to 50 GB of bandwidth with up to 50 Mbps of data rate in downlink and 20 Mbps on uplink while he pays a high price to operator. The prices for other users with smaller budgets vary according to their acquired bandwidth and speed. Similarly, the focus of [4] is to highlight a few control and policy management mechanisms based on the surveys conducted with several operators in order to develop beyond flat-rate pricing models. Summarizing these surveys, almost 57% of respondents agreed that for broadband-based services a flat-rate monthly fee approach is not a sustainable business model where as 43% did not agree with this statement. This means that a majority of operators are willing to improve their billing and charging patterns in order to increase the overall average revenue per operator. Further, operators are encouraging more and more broadband users for substitution to mobile broadband by offering them different speeds [6]. This requires attractive pricing strategies (variable with speed) to encourage the mentioned substitution.

Likewise, the author of [7] classifies pricing in static and dynamic categories such that in dynamic pricing the tariff varies with certain network conditions (e.g., congestion) while in static pricing the users are charged with a fixed price independent of the overall network load. Dynamic pricing is advantageous in a sense that it offers flexibility in reacting to changes in network traffic and allows operators to achieve high revenues. However, the costumers may find dynamic pricing policies difficult to understand, therefore these policies must be kept as simple as it can get. Moreover, the authors of [7] and [8] suggest that one way of simplifying things is to perform service (or user) differentiation according to priority levels, bandwidth, speed, etc., so that the subscribers can easily allocate the budgets according to their QoS needs.

Based on above, in this paper we propose a dynamic pricing strategy for LTE networks where the users are categorized in three different levels i.e., Gold, Silver and Bronze, starting from high to low priority, respectively. These users have distinct prices per LTE minimal allocation called PRB (Physical Resource Block) that vary according to the category they belong to. This categorization provides the users with a better management of their budgets while giving the LTE operators an efficient way to allocate their available PRBs. We compare our strategy with other proposed methods within the LTE network context.

The rest of the paper is organized as follows. In the next section an architectural overview of policy and charging in LTE network is given. Some interesting pricing strategies for high speed wireless networks are explained in Section III. In Section IV, the adaptation of these solutions for LTE networks along with our proposed approach is presented. Simulation results and comparisons are shown in Section V. Finally, conclusion and future perspectives are provided in Section VI.

II. POLICY AND CHARGING IN LTE NETWORKS: A GENERAL OVERVIEW

The core network of LTE architecture is the EPC

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(Evolved Packet Core). It is defined in 3GPP Rel. 8 in order to support LTE services. EPC is made of several key functional elements, including the Policy and Charging Control (PCC) architecture [9]. As specified in [10], the main function of PCC is to provide vendors and subscribers with an efficient charging and billing policy. This policy architecture is illustrated in Figure 1 [10]. The PCRF (Policy Control and Charging Rules Function) and the PCEF (Policy and Charging Enforcement Function) are the two important elements in order to provide an LTE (QoS) class to the subscriber. Generally, PCRF takes its policy and QoS decisions based on the information received from the Application Function (AF). This AF notifies the PCRF of the QoS requirements initiated by a UE (User Equipment). The PCRF may also consult the SPR (Subscription Profile Repository) to check whether the corresponding user has rights to access the required QoS treatment. The PCEF, located in the P-GW (Packet Gateway), performs policy enforcement. An implementation of this PCC architecture by Cisco is described in [11].

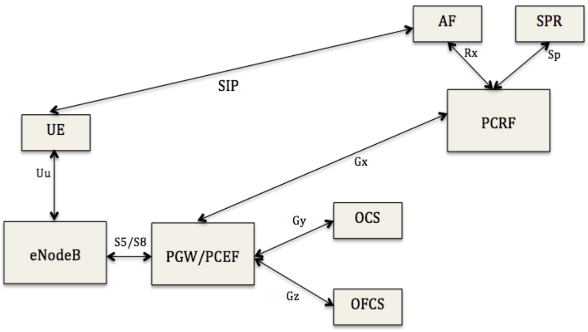

Figure 1. The policy and charging control architecture within LTE network context

Besides policy control, the mobile operators still need efficient ways to manage the network resources in order to guarantee service quality, to satisfy user requirements, and to provide flexible billing/tariffing schemes [10]. Therefore, combining PCC with online or offline charging empowers operators to figure out how they can leverage and monetize service quality and tariff management (for the subscribers) as effectively as possible [12]. The Online Charging System (OCS) charges subscribers with their utilized services on real-time bases. The Offline Charging System (OFCS) performs billing and charging functions in a manner that does not affect the real-time services.

III. PRICING STRATEGIES FOR HIGH DATA RATE WIRELESS SYSTEMS

Several research efforts have been done in the recent literature to address various aspects of pricing within high data rate wireless networks. In [13], a model for 3G/4G multimedia service pricing is presented which includes QoS guarantees. The QoS-aware pricing is considered where the parameters such as the basic rate for a default call P_{rij}, price change due to a QoS property change PQ_{pij}, the QoS (or 3GPP traffic) class i (e.g., streaming or conversational) and subscriber class j (Gold, Silver or Bronze) are used as inputs to the pricing module. This module then calculates the total price based on the following equation:

$$P_{cci} = P_{rij} \pm PQ_{pij} \tag{1}$$

where P_{cci} is the price for a call with known QoS such that the value for PQ_{pij} corresponds to the maximum value of the single QoS attribute. Later, it is mentioned that the price can be used with some predefined threshold values to optimize the overall network revenue. These values are in the form of minimum bandwidth, maximum delay and BER (Bit Error Rate) for each subscriber class j. Based on all these threshold values, continuous, discrete and volume dependent prices are calculated and through results it is shown that during large traffic situations the cost of the service remains at a higher side.

After [13], the authors of [14] mention that by charging costumers with a fixed pricing policy (assuming that they have the same minimum and maximum bandwidth requirements) may waste network resources thereby increasing the blocking and dropping probabilities. Therefore, their strategy charges the subscribers according to their bandwidth consumption, the dynamic Bandwidth Market Price (BMP) and the QoS levels (or preferences), all maintained in the form of a QoS profile. The BMP is the current price to transmit one Gbit of traffic using one kbps of bandwidth and it changes constantly with network bandwidth occupation. At a given instant, each costumer pays the same BMP for the same service. Evidently, the more bandwidth she uses, the more she pays. The possible variations of the BMP value during network congestion as proposed in [14] is an interesting research issue.

The authors of [15] and [16] have presented a pricing strategy for WiMAX networks. Considering the UGS (Unsolicited Grant Service) and rtPS (Real-Time Polling Service) WiMAX classes, the price per time unit of a service changes with the percentage of occupied OFDM (Orthogonal Frequency Division Multiple) symbols and the required data rate. For the Best-Effort (BE) users, an auction scheme is included ([16]). The simulation results show the behavior of the proposed pricing strategy in terms of operator's revenue and user satisfaction. Another pricing scheme for WiMAX users is presented in [17] where the operators assign a 'window' to each service class by defining the upper and lower price limits. Furthermore, a QoS 'satisfaction degree' metric is defined for all service classes as a ratio between achieved and requested QoS level. Through results it is shown that the proposed approach increases operator's revenue by selecting the incoming users according to system state.

IV. PRICING STRATEGIES ADAPTED FOR LTE

A. LTE system model

The OFDMA and SC-FDMA (Single Carrier Frequency Division Multiple Access) are used on downlink and uplink in LTE networks in order to provide flexibility and higher radio spectrum usage [19]. In OFDMA, the frequency spectrum is divided into blocks called the PRBs. A PRB is considered as the basic radio resource allocation unit of LTE.

It consists of a set of OFDMA sub-channels used during a fixed time interval. The allocation of a PRB for a specific price is associated to the choice of a modulation and coding scheme, i.e., the MCS. Each user's individual data stream is mapped to a PRB and modulated and coded using one of the following MCS: QPSK, 16QAM or 64QAM (2, 4 or 6 bits/symbol). An MCS is assigned to a user by the eNodeB (or LTE base station) based on the available channel conditions. This is the 'link adaptation mechanism'. Moreover, LTE systems support bandwidth ranges from 1.4 to 20 MHz, having each its number of PRBs (see Table 1).

Table 1. Number of PRBs for a given bandwidth in LTE networks

Bandwidth (MHz)	1 .4	3	5	10	15	20
Number of PRBs	6	15	25	50	75	100

B. Traffic or QoS class

In our system, we use several traffic classes for LTE networks such as conversational voice, interactive gaming, etc. These classes have a direct relationship with the LTE QCI (QoS Class Identifier). The QCI is a pointer to more detailed QoS attributes defining bit rates, packet delays and losses. For example, in LTE systems, a bearer can be assigned to QCI 8 with 300ms of delay and non-guaranteed bit-rate in order to satisfy the user requirements of a BE service.

C. User categorization

We characterize users into three priority levels (or categories) such as Gold, Silver and Bronze as depicted in Table 2. We include some information about this user categorization taken from [8][13]. Different speed and service types are suggested for each category and the corresponding delays and LTE QCI values are given. The high-price Gold or G-type users have easier access to High Definition (HD) streaming, real-time gaming and other TCP based services such as surfing, chatting, P2P file sharing. The service access of Silver 'or S-type' and Bronze 'or B-type' users is limited to a smaller number of services (expected low occupation periods) for that they could pay a lower price compared to G-type users. Corresponding maximum values of delay are given based on the standard LTE related information as provided in [18]. Furthermore, Table 2 shows the possible use of traditional flat-rate pricing strategy. The operators can also charge costumers based on the fixed price for a PRB unit. Both these methods are described below (under Section V).

D. Various pricing strategies for LTE

Here, we briefly present the adaptation of several pricing strategies [13][14][15] previously proposed for high data rate wireless networks (see Section III), within the LTE context. For simplicity we name these strategies as Network Load based Pricing (NLP), QoS Profile and Bid based Pricing (QPBP) and Traffic Differentiated Pricing (TDP), respectively. The TDP [15] is proposed for WiMAX networks, so most of the equations and parameters are already adapted to LTE, thus we only write some of the equations. At the end, we present our solution which we refer as Proposed Subscriber Class based Pricing (PSCP).

(i). Network Load based Pricing (NLP)

Beside the QoS-pricing proposed in [13] (and explained in Section III), the network load based pricing of [13] is equally important especially within LTE networks where the operators can increase their revenue by charging users with a high price when the network load crosses a specified level (or threshold). The proposed load based pricing can be divided in continuous and discrete categories as follows:

$$P_{cont} = F_{ij} \times (e - e^{-b\times x}) \times {L_t}/{100} \quad (2)$$

$$P_{disc} = \frac{1}{(F_{ij}\times(e-e^{-b\times x})\times {L_t}/{100})} \quad (3)$$

Such that

$$F_{ij} = \begin{cases} f_c & when\ 0 < L_t \le TH\% \\ f_v & when\ TH < L_t \le 100\% \end{cases} \quad (4)$$

- *P_{cont}: continuous price for an established user connection,*
- *P_{disc}: discrete price for an established user connection,*
  F_{ij}: linear price factor for each traffic class (or QCI) 'i' (ex. Conversational voice) and subscriber class 'j' (ex. Gold),
- *f_c: constant price factor having the same value for each i and j,*
- *f_v: variable price factor for each i and j,*
- x: *QoS attribute value such that $min_{QoS\_attri} \le x \le max_{QoS\_attri}$,*
- b: *linearity parameter and it must be defined in a way that the price ratio between minimum and maximum QoS does not raise to a very high position,*
- e: 2.71828,
- *L_t: traffic load,*
- *TH: traffic load threshold (or the highest value of L_t above which the price change occurs).*

The traffic load can be calculated as:

$$L_t = (n_{assd}/n_{tot})\% \quad (5)$$

Where

- *n_{assd}: PRBs already assigned to users,*
- *n_{tot}: total number of PRBs at the eNodeB.*

In the above equations, the parameters *i, j* and *x* will be more clear by looking at the information provided in Table 3. In this table, the only QoS attribute considered is the PRB (equivalent to data rate, although it depends on the choice of MCS), so it is represented as *x* here. The value of *x* will be $2 \le x \le 4$. Three different types of traffic class *i* are shown in Table 3 and the operators can easily choose between these *i* for each user belonging to *j* such that *j* can be either G, S or B type of user. For example, if a *G* user requires real-time gaming, then it is accepted with x=4. On the other hand, if the usage of *G* falls down to a voice service, then it will be awarded as x=2 and so forth.

Table 2. User categorization

Type of User	Maximum Speed (Mbps)	QCI	Authorized Services	Delay (ms)	Flat rate (FR) price	Fixed PRB price (P)
Gold or G-type	100	All available	• IMS signaling • Conversational voice • Real-time gaming and HD video • Live video • Buffered video • Interactive gaming • TCP and P2P	• 100 • 100 • 50 • 150 • 300 • 100 • 300	P_{GFR}/month	P_{GP}/PRB/s
Silver or S-type	25	1 and 3 not allowed	All above except IMS signaling, real-time gaming and HD video	All above (except 50) are possible	P_{SFR}/month	P_{SP}/PRB/s
Bronze or B-type	10	5 and above (only non-GBR)	Buffered video, interactive gaming, TCP and P2P	100 to 300	P_{BFR}/month	P_{BP}/PRB/s

Table 3. Possible values of a QoS attribute for different traffic classes

Traffic class 'i'	Conversational voice	HD streaming	Real-time gaming
QoS attribute (PRB)	2 (or min x)	3	4 (or max x)

(ii). QoS Profile and Bid based Pricing (QPBP)

In [14], a pricing solution is developed by taking into account the user bids which increases directly with high bandwidth occupation. Basically, the strategy is based on the QoS profile which represents the budgets a user assigns for the PRBs it needs. An adaptation of this type of profile within LTE networks is presented in Table 4, where a user can assign three different budgets for several QoS levels (or QCIs) represented here as Q3, Q5 and Q8, respectively. Likewise, based on the required values of PRBs and the associated budgets, the user bids are estimated. These bids are then submitted to the eNodeB which decides the charging criteria for the corresponding user. Normally, a user is charged according to the assigned PRBs and the new PGP (Price per Gbit per PRB). This new PGP is obtained by scanning the novel (or the latest) QoS level assigned to a costumer thereby recovering the associated bid. Then, the new PGP is set to the lowest bid found. The price P is thus calculated as follows:

$$P = n_{assdk} * (PGP) \qquad (6)$$

- n_{assdk}: number of PRBs assigned to a user k.

(iii). Traffic Differentiated Pricing (TDP)

The authors of [15] and [16] have included three WiMAX traffic classes in their system model: real-time with variable size packets, real-time with fixed size packets and non-real time or BE. We replace these categories with LTE Q3, Q5 and Q8, respectively. The adapted formulas for each mentioned category are as follows.

Table 4. An example of user's QoS profile for LTE

QoS level or QCI	Required PRBs	Budget	Bid = (Budget/Required-PRBs)
Q3	4	10	2.5
Q5	3	9	3
Q8	2	8	4

$$P_{Q3} = \begin{cases} P_{Q3\_low}.PRB, & if\ \frac{n_{resd\_Q3}}{n_{tot}} \leq TH \\ P_{Q3\_high}.PRB, & otherwise \end{cases} \qquad (7)$$

Where

- *P_{Q3}: price for Q3 users,*
- *P_{Q3_low}: price charged to Q3 users during no-congestion period,*
- *P_{Q3_high}: price charged to Q3 users during congestion,*
- *n_{resd_Q3}: PRBs reserved for Q3 users,*
- *n_{tot}: total number of PRBs per eNodeB,*
- *TH: congestion threshold to determine the network overload situation.*

$$P_{Q5} = P_{Q5\_min}.n_{min} + P_{Q5\_add}.(n_{resd} - n_{min}) \qquad (8)$$

Where

$$P_{Q5\_add} = \frac{C_{Q5}}{n_{rem\_Q5}} \qquad (9)$$

Such that

- *P_{Q5}: price for Q5 users,*
- *n_{min}: minimum PRBs for Q5 users in no-congestion situation,*
- *P_{S_min}: fixed price charged to Q5 users based on n_{min},*
- *P_{Q5_add}: additional price charged to Q5 users in congestion situation,*
- *C_{Q5}: pricing constant defined by the operator,*
- *n_{rem_Q5}: remaining PRBs after serving all the Q3 users and providing minimum PRBs to Q5 users,*
- *n_{resd_Q5}: PRBs already reserved for Q5 users.*

$$P_{Q8} = P_{fixed\_PRB}.\ PRB \qquad (10)$$

Where

- *P_{Q8}: price for Q8 users,*
- *P_{fixed_PRB}: fixed price for a PRB unit.*

(iv). Proposed Subscriber Class based Pricing (PSCP)

We propose a pricing strategy that varies with the type of user i.e., Gold, Silver and Bronze. For all these users, we define $P_{fixed(j)}$ as the fixed price associated to each PRB unit such that j can be any of G, S, or B type user. The unit of $P_{fixed(j)}$ is (mu/PRB) and this price is fixed by the operator based on the mobile market trends [20]. Likewise, $P_{variji)}$ is the variable price charged to a user j in congestion situations or when the user's traffic exceeds its threshold (see below).

Pricing for G-type users

The price $P_{(G)}$ charged to G-type users per PRB unit is as follows:

$$P_{(G)} = \begin{cases} P_{fixed(G)}.PRB, & if \ \frac{n_{assd(G)}}{n_{tot}} \leq TH \\ P_{vari(G)}.PRB, & otherwise \end{cases} \quad (11)$$

Where

- $n_{assd(G)}$: *number of PRBs already assigned to G-type users*,
- *TH*: congestion threshold (ex. 80%),
- $P_{vari(G)}$: *its unit is (mu/PRB)*, and

$$P_{vari(G)} = P_{fixed(G)} + P_{add} \quad (12)$$

Such that

$$P_{add} = \frac{K}{n_{tot} - n_{(rem\_PRB)TH}} \quad (13)$$

Where

- P_{add}: *additional price*,
- *K*: *pricing constant fixed by the operator*,
- $n_{(rem\_PRB)TH}$: *remaining PRBs from the number of PRBs reserved by the operator for serving G users in congestion or above threshold situations*.

Pricing for S-type users

The price $P_{(S)}$ charged to S-type users per PRB is given below:

$$P_{(S)} = \begin{cases} P_{fixed(S)}.PRB, & if \ \frac{n_{assd(S)}}{n_{tot}} \leq TH_{(S)} \\ (P_{fixed(G)} + P_{vari(G)}).PRB, & otherwise \end{cases} \quad (14)$$

Where

- $n_{assd(S)}$: *number of PRBs already assigned to S-type users*,
- $TH_{(S)}$: *threshold specified by the operator (e.g., 35%) and above this TH the S-type users will only be able to access the spectrum when all the G-type users are served.*

Pricing for B-type users

The pricing formula for B-type users is as follows:

$$P_{(B)} = \begin{cases} P_{fixed(B)}.PRB, & if \ \frac{n_{assd(B)}}{n_{tot}} \leq TH_{(B)} \\ (P_{fixed(S)} + P_{fixed(G)} + P_{vari(G)}).PRB, & otherwise \end{cases} \quad (15)$$

Where

- $n_{assd(B)}$: *number of PRBs already assigned to B-type users,*
- $TH_{(B)}$: *threshold specified by the operator (e.g., 45%) and above this TH the B-type users will only be able to access the spectrum when all the G and S users are served.*

We also define the revenue for an operator as the summation price received from users for the allocation of available PRBs. Mathematically:

$$R = \sum_{a=1}^{n_{tot}} P_a \quad (16)$$

V. SIMULATION RESULTS

We present the simulation results in this section and compare our solution (PSCP) in terms of revenue and paid price with various approaches (see Section IV), which have been adopted, for LTE networks. These solutions are referred here as NLP, QPBP, TDP, flat-rate and fixed PRB. With flat-rate pricing strategy, the bandwidth is pre-reserved for G, S and B users and none of these users is allowed to access the PRBs greater than the reserved threshold [4]. Considering fixed PRB pricing, the operators associate a price for a PRB unit and charge costumers based on their PRB utilization, i.e., the higher the number of PRBs used, larger the cost one has to pay. The simulation is realized in MATLAB.

The parameters selection is shown in Table 5. The simulation is conducted multiple times for a total of 100 PRBs (i.e., n_{tot}=100) and the average values are taken for plotting the graphs. We set the PRB reservation n_{resdj} or $TH_{(j)}$ (defined in Section IV) to 45%, 35% and 20% for B, S, and G users, respectively. The value of fixed price or p_{fixedj} is set to 8, 4, and 2 depending on user's high to low priority. The pricing constant K is fixed to 10 and the congestion threshold (or TH) is fixed at 80%.

Table 5. Parameter setting

Parameter	Value
n_{tot}	100
n_{resdj}	[45%, 35%, 20%]
p_{fixedj}	[8, 4, 2]
K	10
TH	80%

In Figure 2, the operator's revenue R is shown for PSCP, NLP, QPBP, TDP, flat-rate and fixed price/PRB strategies, respectively. Clearly, PSCP shows good performance because it categorizes users in several classes and charges them differently even when congestion occurs. The NLP and TDP perform better than QPBP as the costumers pay the price based on the overall network usage (or load) and they are charged with high prices when traffic exceeds the defined TH. However, when TH>80%, both NLP and TDP achieve a smaller R compared to PSCP because PSCP allows S and B users to share the PRB resources with G users with an expense of a high price value, thus increasing the operators revenue. As expected, flat-rate solution depicts constant behaviors for all n_{resdj} because each user (within its reserved threshold (ex. $TH_{(S)}$=35%) pays the same price no matter how many PRBs it acquires. Fixed PRB pricing strategy, on the other hand, allows users to acquire the PRBs whenever they want without any bandwidth reservation. As a result, mostly, the value of R increases (ex. from 20 to 80 PRBs) and it may also show a constant behavior (ex. 80 to 85 PRBs). Further in Figure 2, QPBP shows smaller values of R mostly because the costumers send low bids to their corresponding operators giving them fewer incentives to increase the price (no more than a certain amount) even under congestion situations.

In Figure 3, we have changed the value of TH to 50% to see its impact on the overall revenue R. Clearly, all three approaches with congestion control i.e., PSCP, NLP and TDP attain higher revenues compared to the revenues obtained in Figure 2. TDP even crosses flat-rate strategy showing advantage of efficient resource allocation under high traffic loads. This figure gives an idea that the operators can generate good profits first, by defining certain thresholds and then, by charging users differently based on the overall network usage.

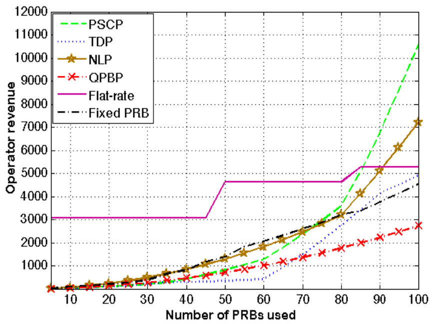

Figure 2. Total revenue with number of assigned PRBs when *TH*=80%

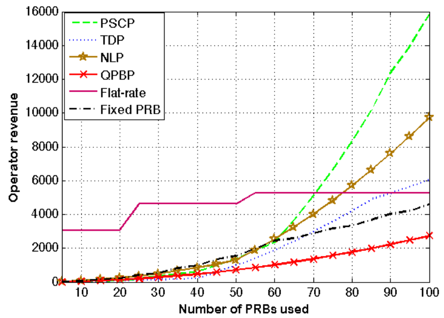

Figure 3. Total revenue with number of assigned PRBs when *TH*=50%

In Figure 4, the average price paid by G, S and B users (per month) is compared for PSCP, TDP, flat-rate and fixed PRB approaches. For this comparison, only the strategies that categorize users based on their subscriber class are considered allowing us to visualize the amount of share a certain type of user (ex. Gold) can get under various subscriber categorization schemes. The figure clearly shows that the flat-rate monthly fee strategy is a less sustainable option for mobile users. Note that (as extracted from [15] and [16]), the TDP approach only contains G and B type users for which the values of price paid are shown.

CONCLUSION

In this paper, we have highlighted several aspects related to pricing in modern day wireless multimedia 4G networks. First, the adaptation of different existing pricing strategies within LTE networks is presented. These adopted solutions are then compared with our proposed approach, which is based on charging users differently both under no-congestion and congestion situations w.r.t their radio resource usage. The simulation results verify the efficient working of our proposed pricing strategy which achieves high revenues for the operators. As a part of our future work, we will try to integrate scheduling within our pricing framework to improve operators charging and decision-making policies.

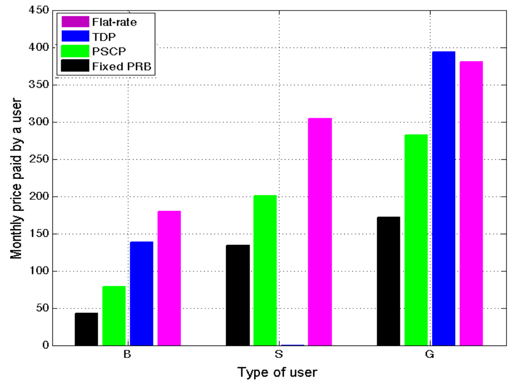

Figure 4. Price paid by a user (per month) for PSCP, TDP, flat-rate and fixed PRB strategies

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