Watch Ads, Earn Data: Economics of Mobile Data Rewards

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Although global mobile traffic has been growing rapidly, the service revenue is estimated to have nearly reached a saturation point. Strategy Analytics predicts that the global mobile service revenue will peak in 2021 at a value that is only 3% above that in 2018 [1]. This has led mobile operators to seek new revenue streams, and one effective approach is to offer *mobile data rewards* to mobile users. Specifically, the users are rewarded with free mobile data after viewing the mobile ads delivered by the operators, and the corresponding advertisers pay the operators based on the ad viewership.

The data rewarding scheme can achieve a "win-win-win" outcome for the operators, users, and advertisers. First, the operators can monetize their mobile service via the mobile advertising (it was estimated that the mobile advertising market's worldwide revenue reached $80 billion in 2017). Second, the users get free mobile data to support the data-hungry mobile applications. Third, the advertisers can improve their ads' effectiveness when the users are rewarded for viewing ads (this advertising type is known as *incentivized advertising*). Moreover, since the advertisers allow the users, who want to earn rewards, to have the control over whether and when to view ads, the users can better engage with the ads.

There has been a growing number of businesses entering this market. Some companies (e.g., Unlockd, Aquto, SOCIFI, and ClickWings) offer technical support for data rewarding, including the development of mobile apps which display ads and record the amount of rewarded data [2]. Some leading mobile network operators, such as Verizon (in the United States), Tesco Mobile (in the United Kingdom), Telefonica (in Spain), and Lebara Mobile (in Australia), have collaborated with these companies to offer data rewards.

In our work, we study a capacity-constrained operator's optimal data rewarding design, considering its existing data plan. The users can obtain data by either subscribing to the data plan or viewing ads. The operator's total revenue consists of the users' subscription fee and the advertisers' payment for purchasing the ad slots. We analyze the operator's optimal strategy that maximizes its total revenue. In particular, we answer the following two questions: (i) *How does the operator choose the unit data reward (i.e., the amount of data rewarded for viewing one ad) for the users?* (ii) *How does the operator choose the ad price (i.e., the price for purchasing one ad slot) for the advertisers?*

Note that a few references, e.g., [3] and [4], studied markets in which providers offer both a fee-based service and an ad-based service. In these references, the two types of service are exclusive, and each user chooses between these two service types. In our study, a user may subscribe to the data plan and meanwhile view ads for more data. Hence, the supplementary relation between the fee-based service (i.e., subscription) and ad-based free service (i.e., data rewards) is novel.

We model the interactions among the decision makers in the data rewarding ecosystem by a two-stage Stackelberg game. In Stage I, the operator decides the unit data reward and the ad price. In Stage II, the users choose whether to subscribe to the data plan and how many ads to view. The users have heterogeneous valuation for the mobile service. Meanwhile, the advertisers choose the number of ad slots to purchase. We analyze the subgame perfect equilibrium of the two-stage game, and characterize the operator's optimal unit data reward and ad price.

Suppose only the data plan's subscribers are eligible to view ads for rewards. When the unit data reward is small, the users with medium and high valuation for the service subscribe, and only the users with high valuation view ads. In this case, increasing the unit reward can increase the number of users viewing ads but does not change the number of subscribers. When the unit reward exceeds a threshold, all the users choosing to subscribe will view ads. In this case, increasing the unit reward improves the number of users viewing ads, which is also the number of subscribers. On the other hand, increasing the unit reward may reduce the average number of ads that each of these users views. Our analysis shows that this negative effect is dominated by the former positive effect in terms of the operator's total revenue. Therefore, the operator should set the largest unit data reward without exceeding the network capacity.

The ads can alter the users' attitudes towards the corresponding advertisers' products (see *persuasive advertising* [5]). Such advertising may exhibit a *wear-out effect*, i.e., a user's attitude first increases and then decreases with the number of ads displayed by an advertiser to the user. Our analysis shows that only if the wear-out effect is small, it will affect the operator's optimal ad price. Under a small wear-out effect, the operator will sell all slots, and the optimal ad price will decrease with the wear-out effect. Under a large wear-out effect, the operator will not sell all slots, and the optimal ad price will be independent of the wear-out effect.

We refer the readers to [6] for more details.

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