Tethering Mobile Network Operator (MNO) by Feedback-based Competitive Hybrid Pricing (FCHP) and Time-Dependent Pricing (TDP) in Internet Service Provider (ISP)

Venugopal.A[1], Niranchana.D[2]

[1]Assistant Professor, [2]Research Scholar
[1,2]Computer Science
[1]Sri Krishna Arts and Science College, Coimbatore, India
[2]Sree Narayana Guru College, Coimbatore, India

Abstract: **Mobile Collaborative Internet Access (MCA) helps mobile users to share their Internet through flexible tethering agreements. This may boost the use of network resources. However, it can either reduce revenue or increase congestion from the viewpoint by a Mobile Network Operator (MNO), and therefore has in practice been blocked by certain MNOs. In this work, a Feedback-based Competitive Hybrid Pricing (FCHP) framework is proposed for MNOs who charge users individually for accessing and tethering. In this framework, the problem of necessity of Internet Service Provider (ISP) to over-provision capacity for demand at peak times of the day is solved by Time-Dependent Pricing (TDP) in consideration of how much data is being used when a user consumes. Finally, the experimental results demonstrated that the proposed FCHP framework achieves better performance than the state-of-the-art hybrid pricing techniques.**

***Index Terms*: Mobile collaboration access, tethering, mobile computing, Hybrid pricing.**

I. INTRODUCTION

Internet services and models have experienced a paradigm shift resulting from three main factors: i) widespread wireless technologies; ii) increasing the range of user-friendly and multimedia-enabled terminals and iii) the availability of open-source content generation tools. These factors have empowered the end user with a new role, a microprovider role1 and therefore the end user is both a provider and a consumer at the same time. Global mobile data traffic has grown explosively and is expected to reach 77.5 exabytes per month by 2022, roughly seven times higher than in 2017 [1]. Wireless Fidelity (Wi-Fi) is freely and transparently shared between end-users in a way that is technically and legally independent from providers of access or infrastructure [2]. Examples of such networks currently exist from a commercial perspective (e.g., Karma [3] and Open Garden [4]) as well as from a non-commercial perspective, e.g. providing Internet access to a few wireless devices at home without the need for a wireless router. These networks are called user-provided here, since they are "spreading" through the willingness of the end-user to share connectivity.

Mobile Networks:

A mobile or cellular network is a communication network where the final connection is wireless. The network is split into surface areas called sites, each of which is supported by at least one fixed transceiver, recognized as a cell site or base station. This base station provides the cell network range for the transmitting of speech, data and other content. A cell could use a frequency set other than neighboring cells to avoid interference and to guarantee the quality of service for each cell. Major providers for telecoms have deployed mobile voice & data networks across most of Earth's populated territories. It provides access to the publicly-connected internet and public Internet to Cellular telephones and mobile computing devices. For research purposes or for large organizations and floats, private cell phone networks such as dispatches to local public security agencies or taxi companies can be used.

Mobile Network Operators (MNO):

A mobile network operator or MNO is a wireless carrier, telecommunications business and mobile network carrier, is a provider of wireless communications services that owns and manages all the elements required to market and provide end-user services, including allocation of radio spectrum, wireless network infrastructure, back haul infrastructure, billing, customer car service. A MNO can also sell access to network services at wholesale rates to Mobile Virtual Network Operators (MVNO) in addition to generating revenue by providing retail services under its own name. A key feature of a mobile network operator is that an MNO must own or control access from a regulatory or government entity to a radio spectrum license.

II. BACKGROUND STUDY

[5] A comprehensive analytical study of the investment of two competitive secondary operators, i.e. spectrum leasing and pricing strategies, taking into account the heterogeneity of operators in leasing costs and the heterogeneity of users in terms of transmission power and channel conditions. The relationships between these operators and users are modeled as a three-stage dynamic game where operators make spectrum leasing decisions in Stage I and pricing decisions in Stage II at the same time, and then users make buying decisions in Stage III. Using backward induction, we can completely describe the balance of the dynamic game. Positive pure strategy balance exists for pricing only when both operators ' total spectrum investment is less than a threshold. In addition, given their heterogeneity in leasing costs, two operators always choose the same equilibrium value.

[6] It proposed an end-to-end TDP system called TUBE (Time-dependent Usage-based Broadband Price Engineering) architecture, implementation and user trial. TUBE provides a price-based control loop for feedback between an ISP and its end users. On the ISP side, it calculates TDP prices in order to balance congestion costs during peak periods with offering lower prices in less congested periods. It offers a graphical user interface on mobile devices that allows users to either respond on their own or using an autopilot mode to the offered prices. A pilot TUBE test was performed with 50 iPhone or iPad 3 G data users paid according to our TDP algorithms. However, it is difficult to compare the TDP usage of one group of users with another control group of TIP users unless they are matched properly.
Three well-known pricing structures introduced [7] for LTE mobile networks were studied by the researchers. Then a Realistic Per-category Pricing scheme (R2P) for LTE is proposed. This pricing scheme takes into account QoS parameters, utilization of physical resources blocks, user valuation, and categories of user prices: Gold, Silver and Bronze. However, the sensitivity of this scheme is not analyzed.
The researchers [8] studied the strategy of cost-based access control of the spectrum, which characterizes the allocation of heterogeneous and delay-sensitive Secondary Users (SUs) by the network operator by price strategies. The SUs can occupy the dedicated spectrum based on shared-use Dynamic Spectrum Access (DSA) without degrading Primary User (PU) operations. An arriving PU may interrupt the SUs transmission service, while the interrupted SUs join a retrial pool called an orbit, later attempting to use the spectrum to complete the service. The interrupted SU is competing fairly with other SUs in the orbit in the retrial orbit. As a retrial queue with service interruptions and general service times, such a DSA mechanism is formulated. In order to reconcile the conflicting objectives of MNO and Mobile Collaborative Internet Access (MCA) users, Zhang et al. suggested [9] a hybrid pricing framework for MNOs. The main idea is to distinguish between the price of dedicated internet and connected access. In general, each MNO sets for every user a usage-based access rate and an optional usage-based MCA-based tethering cost. If the price structure takes account of such MCA complexities and gives consumers the requisite opportunities to load mix appropriately through MNOs, both MNOs and users can have a mutual benefit.

III. SUMMARY OF THE BACKGROUND STUDY

In this FCHP technique, Time-Dependent Pricing (TDP), in addition to how much data is used, addresses this problem when a user uses data. The architecture, implementation and user experimentation of a FCHP technique is presented. It provides a feedback distribution system between an ISP and its end users based on prices. On the ISP hand, TDP costs are determined so that traffic levels are matched with lower rates in less congested cycles at peak periods.
Contributions of FCHP Technique:
The major contributions are focused such as:

- A fully functional mobile data TDP system: The implementation of TDP into an integrated system, from economic theory, requires a new mobile data pricing plan. We create a flexible TDP system that combines changing user behaviour, compile user interview template criteria, establish a supportive framework, deploy a prototype and eventually perform an actual user pilot trial.
- The feedback control architecture: FCHP provides a feedback loop which measures rates for customers and consumers reacting to the pricing that are delivered on the ISP site. The ISP delivers regular pricing: consumers will be aware of the rates for the next 24 hours at any moment. Day-ahead rates give such guarantees that consumers may plan ahead, enabling ISPs to change pricing each day according to changed customer behavior.
- A realistic user assessment. By deploying the FCHP technique prototype on server and participating devices, the participants are changed according to TDP. The results show that users actually react to their price, by changing demand from peak to off-peak periods if offered currency discounts, and consuming more even in off-peak times.

MNOs Hybrid Prices Optimization: Now, explain how to calculate time-dependent prices on the next day with the estimated waiting charges. In less congested times, an ISP would like to set prices matching two forms of expenses: the cost above peak potential and the value of incentives to consumers. The maximum capacity is used to indicate the total traffic volume which the networks can manage with a sufficient amount of congestion in that over a certain limit the response time of the consumer due to congestion is unacceptably high. The maximum capacity can therefore be exceeds ability. The Com-HP technique is combined with the feedback loop system between the MNOs' hybrid price computation and users to facilitate MNOs for implementing the adaptive and topology-based pricing. Also, it facilitates the MNOs to improve their profits for both tethering and no tethering cases.
Simulation Setup: In this experiment, the performance efficiency is analyzed for an MCA involving 2 MNOs, 10 users and their interactions for 10 minutes. Here, 5 users are randomly chosen as the subscribers of MNO 1 and the rest of 5 users are selected as the subscribers of MNO 2. Consider that user's utility parameters such as downlink capacities and operational costs follow the respective i.i.d. truncated normal distributions. Consider each user has the weighted α-fair utility function where $\alpha = 0.4$. A user is selected as a LTE user and a 3G user. LTE downlinks have relatively greater capacities and incur less computational costs than the 3G networks. The mean speed is chosen according to field experiments.
Logarithmic Utility Scenario: In this scenario, the user's payoff and MNO's profit are plotted similar to α-fair Utility for both CHP and FCHP schemes. It analyzes that the proposed FCHP scheme can increase the MNO's profit compared to the CHP. Similarly, the user's payoff for both FCHP and CHP are plotted. It shows that the proposed FCHP scheme achieves a relatively higher user's payoff than the CHP.
Downlink Capacity for LTE Users: The mean of LTE downlink is set to be s Mbps and the 3G downlinks to be 1 Mbps. It shows the MNO's profit benefits of the FCHP and CHP schemes as the capacities of the low-cost LTE channels increase. Clearly, when $s = 20$ Mbps, compared with the CHP scheme, the proposed FCHP scheme improves the MNO's profit efficiently. This is due to

the users prioritize the channels of low operational costs in the proposed scheme. Thus, the capacity increase of these channels will decrease the MNO's operational costs and thus the delivered prices to users.

IV. CONCLUSION

In this work, an FCHP framework is proposed for MNOs who charge users individually for accessing and tethering. In this framework, the problem of necessity of ISP to over-provision capacity for demand at peak times of the day is solved by TDP in consideration of how much data is being used when a user consumes. The design, deployment and application evaluation of a TDP system known as FCHP is presented. This framework creates a feedback loop between MNOs and its end users based on hybrid price. Finally, the experimental results demonstrated that the proposed FCHP framework achieves better performance than the state-of-the-art hybrid pricing techniques.

V. FUTURE ENHANCEMENT

In future, this FCHP framework could apply to real-world large-scale networks to increase the user's access performance and provide the maximum network capacity at peak intervals without any time delay. Also, an energy-efficient load-sharing competitive communication method could incorporate with the FCHP to reduce the energy consumption and balance the user's traffic.

VI. AUTHORS AND AFFILIATIONS

Venugopal.A[1], Niranchana.D[2]
[1]Assistant Professor, [2]Research Scholar
[1,2]Computer Science
[1]Sri Krishna Arts and Science College, Coimbatore, India.
[2]Sree Narayana Guru College, Coimbatore, India.

REFERENCES

[1] Jung, H. (2011). *Cisco visual networking index: global mobile data traffic forecast update 2010–2015*. Technical Report, Cisco Systems Inc. 2011.
[2] Sofia, R., & Mendes, P. (2008). User-provided networks: consumer as provider. *IEEE Communications Magazine*, *46*(12), 86-91.
[3] https://yourkarma.com/.
[4] http://opengarden.com/.
[5] Duan, L., Huang, J., & Shou, B. (2011). Duopoly competition in dynamic spectrum leasing and pricing. *IEEE Transactions on Mobile Computing*, *11*(11), 1706-1719.
[6] Ha, S., Sen, S., Joe-Wong, C., Im, Y., & Chiang, M. (2012). TUBE: Time-dependent pricing for mobile data. *ACM SIGCOMM Computer Communication Review*, *42*(4), 247-258.
[7] Belghith, A., Trabelsi, S., & Cousin, B. (2014, May). Realistic per-category pricing schemes for LTE users. In *2014 12th International Symposium on Modeling and Optimization in Mobile, Ad Hoc, and Wireless Networks (WiOpt)* (pp. 429-435). IEEE.
[8] Zhang, Y., Wang, J., & Li, W. W. (2019). Optimal pricing strategies in cognitive radio networks with heterogeneous secondary users and retrials. *IEEE Access*, *7*, 30937-30950.
[9] Zhang, M., Gao, L., Huang, J., & Honig, M. L. (2019). Hybrid pricing for mobile collaborative Internet access. *IEEE/ACM Transactions on Networking*.