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# PRICING SCHEME FOR TARIFF PACKAGES FOR MOBILE OPERATORS UNDER MONOPOLY CONDITIONS

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**Introduction**

Mobile Internet has grown significantly due to the intensive development of information and communication technologies. Today, approximately 70% of traffic is projected to be for bandwidth-sensitive services such as video [1, 2]. On the other hand, as the mobile Internet market has grown, many Internet companies have launched their own application services. Number of apps on Google Play and APP Store reached 5.0 million [3]. In such conditions, users and Internet organizations cannot rely on traditional traffic packages from telecom operators. For example, the US, South Korea and Japan are offering new unlimited data packages for Internet access for a fee. The traffic package increases market share due to the heavy load on telecom operators. For certain types of applications, telecommunications companies and Internet service providers offered packages with unlimited traffic. The benefits of this type of customized package extend to both users and Internet providers, and also reduce the burden on mobile network operators. Users can benefit from such a package by reducing their own tariffs and improving the physical consumption experience. It is beneficial for Internet providers to gain an advantage in mobile Internet competition by increasing their influence and connection with users. Operators charge service fees to Internet providers, which allows them to increase their own profits. There are some challenges, however, including how to develop free streaming content for the package and how to set its price. Therefore, this study attempts to explore the mechanism of telecom operator data packets based on the behavior of Internet users. It can be noted that pricing is an important factor in analyzing the demand for telecommunication services through regulatory processes, consumer welfare and operator behavior [4].

**Previous works** .

There is a technology for determining user identity that analyzes the properties of human behavior on the Internet. In a user profile, the user's online behavior properties are divided into three categories: properties, function, and tag information. Using this approach makes it possible to separate different groups of users on different sides of the platform, which belong to different market segments [5]. Additionally, research has shown that users' use of repetition tools to introduce

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themselves and shape their online presence [6]. Also, other researchers analyzed the behavior of the trading system, as well as the behavior of users [7, 8].

Machine learning algorithms such as Latent Dirichlet Allocation (LDA) are common methods for extracting features from user profiles. The traditional factor model describing user characteristics cannot be applied to user time analysis. The accuracy and diversity of the user profile is influenced by how the characteristics of online time are described using a Markov model. Since this paper is devoted to the development of pricing approaches, it requires a time series study of the characteristics of Internet user behavior using the Markov model and factor model to obtain a typical model of Internet user behavior. In this area, researchers have carried out significant work on the analysis of online user behavior and have proposed many effective methods for describing the Internet properties of users, including collaborative filtering, factor models [9] and Markov models [10]. Such models can be used to a certain extent to build user profiles, but they typically take into account the degree of similarity between user characteristics and item characteristics, while other information such as time and location is ignored. To create user profiles, many researchers propose context-based analysis methods. In the eigenvalue model proposed in [11], the eigenvectors of the user's transfer matrix are able to provide detailed information about the user's movement behavior.

The relationship between Internet providers, Internet users and mobile operators in many economic theories resembles a two-sided market. As a basic model, a two-sided market model was first proposed to describe an intermediary market [12]. In addition, different studies analyzed the pricing strategy based on different approaches [13, 14]. But there were also works devoted to the existing problems of information disclosure in a two-sided market [15, 16]. Within the framework of the two-sided market theory, based on the analysis of demand and supply of transport services, an intermediary pricing model for the transport services market was proposed [17]. Research shows that there are many possibilities for constructing price structures for two-sided users within a two-sided market economy, considering free mechanisms, attention economics and supply-side economics, but the two-sided market remains an evolving economic model, the shortcomings of which are obvious in quantitative analysis [18].

## System model

This section proposes the joint use of machine learning technologies and economic methods for the development of tariff plans. Key challenges include online user behavior characterization and pattern extraction; selecting package contents; design of utility functions of the user, Internet provider and mobile

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operator; and a model under various target conditions for optimizing the solution method. The design pattern is divided into two groups: package content and package cost. The contents of the package include extracting behavior properties and extracting behavior patterns. At the same time, the cost of the package includes the design of utility functions, a two-sided market model .

To develop a traffic plan, a factor model analyzes the user's Internet characteristics. This model is usually expressed as follows [21]:

$$\Re \cong PQ^T \qquad (1)$$

Where $P \in \mathbb{R}^{M\times K}$ And$Q \in \mathbb{R}^{N\times K}$ are a matrix of factors for the user and the content being accessed, consisting of a vector of factors for the user or the content being accessed. $M$ represents the number of users.$N$ represents the amount of content available. $K$ - the number of factors, which is usually much less than$N$ And $M$. Matrix $\Re$ is a matrix of ratings for different users for different content, which can also consist of a vector of ratings for all content accessed by different users, as shown in formula (2).

$$\Re = \begin{pmatrix} r_{11} & \cdots & r_{1n} \\ \vdots & \ddots & \vdots \\ r_{m1} & \cdots & r_{mn} \end{pmatrix} = \begin{pmatrix} R_1 \\ \vdots \\ R_m \end{pmatrix} \qquad (2)$$

The original factor model does not take into account changes in user interests and loses some information in the data. People's behavior on the Internet has similarities. This ensures that the user $U$ It has$k$ distinct and independent characteristics of Internet synchronization, written as $Pattern_k$. Each template has a different weight $w(Pattern)$, which affects user behavior. A higher weight indicates a stronger influence. The user transfer matrix consists of $Pattern_k$and $w(Pattern)$. Timing and current content $A_t$work together to determine upcoming content access $A_{t+1}$. Meaning$Pattern_k$ this is supposed to be $f(Pattern_k, A_t, A_{t+1})$. A higher value indicates that the access preference$A_{t+1}$ under the preceding condition is stronger [21].

### Package pricing scheme based on a two-sided market model.

Unlike traditional manufacturing enterprises, platform enterprises are not directly involved in the production of goods, but create a "platform ecosystem." The system connects consumers of goods with producers of goods and receives the corresponding benefits from the trading process of the two groups. In a two-sided market model, the consumer and platform form one side, and the producer and platform form the other. Researchers refer to the market architecture of platform enterprises as two-sided markets. The mobile operator, as a platform enterprise, connects to hundreds of millions of users and provides information and

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communication services; on the other hand, it connects to a number of service providers who offer certain additional services to users through the platform [21].

In the package pricing (PP) problem: users, ISPs and mobile operators. The three participants design a utility function and solve the pricing problem based on the optimal conditions of social welfare and utility of the platform.

In the package pricing problem, the platform is mobile operators , and the two-sided market consists of Internet providers and user groups. Utility is defined as the benefit received by participants in a two-sided market model, which is usually expressed using a utility function [21].

User utility function

$$u_1 = a_1 n_2 - P_1 \quad (3)$$

ISP utility function:

$$u_2 = a_2 n_2 - P_2 \quad (4)$$

MNO utility function :

$$\pi = P_1 n_1 + P_2 n_2 - f \quad (5)$$

here $u_1$ And $u_2$ represent the utility of the user and the ISP, respectively. $a_1$ and $a_2$ represent user requirements and ISP network externality parameters, respectively.$n_1$ And $n_2$ represent the number of participants on the demand side and on the producer side under normalized conditions, respectively. $P_1$ And $P_2$ represent the cost of the two parties submitting a request to the platform, and $f$ this is the cost of the platform.

***Pricing scheme under monopoly conditions.*** **In a monopoly, operators offer only one package and users can only choose whether or not to use a plan. Since there is usually a logarithmic correlation between network performance and elasticity, a logarithmic function is used to describe the relationship between Internet traffic and utility [21].**

User utility is Internet revenue minus package fees. In this paper design user utility functions using formula (6).

$$u_1 = \alpha_1 \times \ln(1 + F \times n_2) - P_{s1} \quad (6)$$

Likewise, the utility of online providers is equal to the profit from serving users minus the fees paid to the platform; utility function

$$u_2 = \alpha_2 \times \ln(1 + F \times n_1) - P_{s2} \quad (7)$$

Notably, mobile operators were normalized in this model. $n_1$ and $n_2$ can be used to express the probability that a user or ISP participates in this packet.

$$\begin{cases} n1 \in [0,1] \\ n2 \in [0,1] \end{cases} \quad (8)$$

The operator's utility function looks like this:

$$\pi = (P_{s1} - C \times F - f) \times n_1 + P_{s2} \times n_2 \quad (9)$$

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Where $C$ — cost per unit of traffic provided by the operator; This document assumes that $C = 0.01/M$.this is the cost of serving each user, as well as the cost of serving $f = 5$.

In practice, the number of users increases as the user's utility increases. User number$n_1$ has the following connection with the user utility $u_1$:

$$n_1 = \phi_1(u_1) \quad (9)$$

$$u_2 = \alpha_2 \times \ln(1 + F \times n_1) - P_{s2} = \alpha_2 \times \ln(1 + F \times \phi_1(u_1)) - P_{s2} \quad (10)$$

Similarly, the number of online sellers$n_2$ and the usefulness of online sellers $u_2$ have the following relationship:

$$n_2 = \phi_2(u_2) \quad (11)$$

$$u_1 = \alpha_1 \times \ln(1 + F_{1u} \times n_2) - P_{s1} = \alpha_1 \times \ln(1 + F \times \phi_2(u_2)) - P_{s2} \quad (12)$$

Assuming that the user will receive the desired benefit from the plan, the user selects the plan. For $N_1$ users, $n_1$ can be obtained using formula (13).

$$n_1 = \frac{\sum_{i=0}^{N_1} sign(u_{1i})}{N_1} = \frac{\sum_{i=0}^{N_1} sign(\alpha_1 \times \ln(1+F_i) - P_{s1})}{N_1} \quad (13)$$

Likewise, for $N_2$ Internet producers, the number of Internet producers participating in the package is calculated by formula (14):

$$n_2 = \frac{\sum_{i=0}^{N_2} sign(u_{2i})}{N_2} = \frac{\sum_{i=0}^{N_2} sign(\alpha_2 \times \ln(1+F_j) - P_{s2})}{N_2} \quad (14)$$

Where $F_1$ represents the traffic used by the user, $i$ and $F_j$ represents traffic used by Internet companies. When describing unknown functions $\phi_1(u_1)$and $\phi_2(u_2)$in this paper, we use a machine learning model to approximate the unknown functions $\phi_1(u_1)$and $\phi_2(u_2)$. To the main reasons choice given models Can attribute the following :

- The output signal is between 0 and 1;
- The model is mathematically smooth and conductive.

A logistic regression model is used to fit functions $\phi_1(u_1)$and $\phi_2(u_2)$:

$$n_1 = \phi_1(u_1) = \frac{1}{1+e^{w_1 \times u_1}} \quad \mathbf{(21)}$$

$$n_2 = \phi_2(u_2) = \frac{1}{1+e^{w_2 \times u_2}} \quad \mathbf{(22)}$$

$w_1$ And$w_2$ are parameters associated with the logistic model.

**Conclusion**

In conclusion, the study highlights the importance of operator aggregation strategies and entry models in pricing determination. Currently, there are problems associated with carrier packages in the rapidly developing mobile Internet market. Future research should cover more application scenarios to improve comprehensive analysis of user behavior and facilitate the development of appropriate services. In addition, improvements in data processing techniques are needed to enable analysis of larger data.

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