

A Flexible Time-based Pricing Policy for Charging Internet Services

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Abstract. The integration of telecommunications and data networks enables Internet Service Providers (ISPs) to develop increasingly services to attract customers. Designing rational pricing plans is very important for ISPs to reflect actual cost and to promote different services. In this paper, we discuss the applicability of the duration-based pricing scheme for charging Internet services that constantly occupy the resources. Then, we present a flexible time-based pricing policy considering service rate and time factors to design various pricing plans. Finally, the implementation issues and the advantages of adopting the time-based pricing policy in the billing system are discussed.

1 Introduction

The integration of telecommunications and data networks fosters the increasing demand for multiple services on IP-based networks. Moreover, Internet Service Providers (ISPs) predict that they will not charge for transport but make their money by selling services in the near future [1]. Consequently, ISPs apparently necessitate rational and flexible pricing plans to reflect the cost and to promote different services.

Both service time and transmitted volume are able to reflect the usage of the network. Due to the expensive overhead costs of packet counting, adopting duration-based pricing is more practical for implementing the billing system. In this paper, we discuss the applicability of the duration-based pricing scheme. Then, we present a flexible time-based pricing policy considering service rate and time factors (e.g. time-of-day, day-of-week, holiday-of-year, per-call duration). We also suggest using eXtensible Markup Language (XML) to define the proposed time-based pricing policy. ISPs can charge the usage of resources, control the congested traffic and attract new customers as a result of the proper management in pricing plans.

2 Literature Review

The pricing schemes proposed on IP-based networks can be generally classified into flat-rate and usage-based. Flat-rate pricing schemes allow users to pay a fixed amount

of money independently of the traffic volume [2]. This type of scheme can be divided further into pure flat-rate and restricted flat-rate [3]. Pure flat-rate pricing does not add restrictions on the usage of resources. Restricted flat-rate pricing allows limited amount of services. A customer pays an annual fee to get a certain amount of services. The price can be set usually depending on the speed of the access link (e.g. POTS, ADSL) or the amount of the services (e.g. the connection time, the traffic volume).

Flat-rate pricing schemes are simple but unfair. Some research showed that the fixed fees have greatly contributed to the prevalence of Internet. However, they penalize light users and encourage waste of resources as a consequence of inability to exactly reflect the resources consumed by each customer.

Usage-based pricing schemes based on the level of resources used or reserved have been proposed to solve the problem of unfairness and inefficiency caused by flat-rate pricing. These schemes measure time duration or traffic volume as usage parameters [4]. The price per unit usage of resources can be static or dynamically varied depending on the state of the network. Many theoretical studies on usage-based pricing have been reviewed in the literature [5][6]. Some are service class-based models, such as Paris Metro Pricing and priority pricing. Others are auction-based models, such as smart market mechanism. In addition, responsive pricing models and reservation-based models are also discussed. Usage-based pricing schemes are more rational, but the significant disadvantage of requiring extra network protocols and infrastructure prevents most ISPs from adopting them.

3 Time-based Pricing Policy

Both service time and transmitted volume are able to reflect the usage of the network. Volume-based pricing schemes charge absolute usage of resources but necessitate complicated network protocols and infrastructure to schedule the packets and to capture the essential data for generating bills. The measurement and collection of the billing-related data have a large overhead that may make the cost of measuring the packets greater than the actual value of the packets themselves. Although duration-based pricing was considered only workable when resource demands per time unit are roughly uniform [5], we adopt it for the sake of feasibility and simplicity. The specific services that we prefer applying duration-based pricing are:

- Some services simultaneously occupy the resources of telecommunication networks and IP-based networks, such as voice over IP and fax over IP. The online expense in telecommunication networks is charged by connection time.
- The services constantly consume the processing capabilities of the servers, such as video on demand, video conferencing, radio over IP and TCP-based applications.
- The service with atomic content, such as a piece of software or a file, is only useful if it is complete. Verifying that the transmission of the content is successful and assigning a fixed service rate irrespective of the time duration is more appropriate.

According to the metering data, service start time S_{ST} and service duration S_D , we present a time-based pricing policy considering service rate S_R and time factors. The service rate can reflect the usage of the resources and the time factors can bring

various pricing plans. Services with more resources consumption or more valuable contents get higher service rates. The time factors considered in the pricing policy are:

- *Duration-of-Base-and-Incremental-Unit (DoBIU)*: duration of base unit and duration of incremental unit for calculating the charging duration of the service
- *Duration-of-PerCall (DoPC)*: the discount assigned to different charging duration
- *Time-of-Day (ToD)*: the discount assigned to specific time interval within a day
- *Day-of-Week (DoW)*: the combination of DoBIU, ToD and DoPC assigned to the specific day within a week
- *Holiday-of-Year (HoY)*: the combination of DoBIU, ToD and DoPC assigned to the specific holiday within a year

4 Implementation Considerations

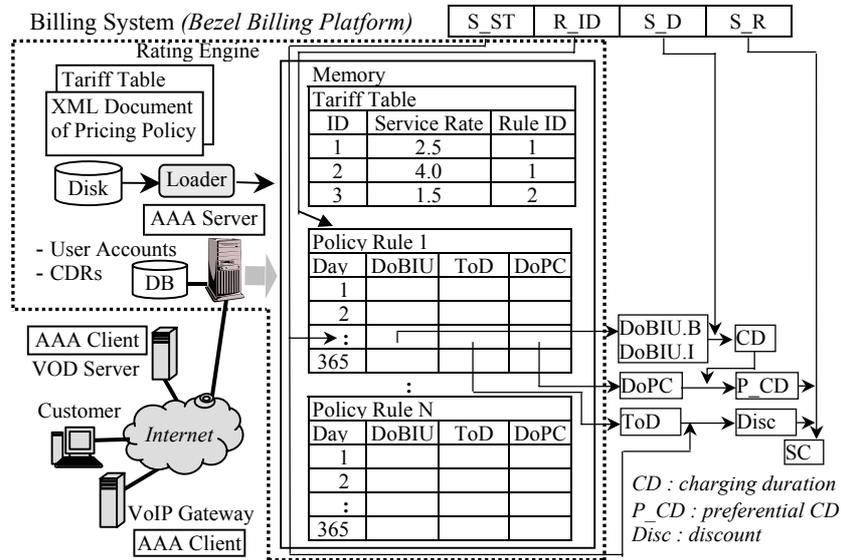


Fig. 1. The implementation of adopting the time-based pricing policy on Bezel Billing Platform

We have developed a multi-service billing system depending on the time-based pricing policy in Bezel Technologies [7]. The Bezel Billing Platform consists of Account administrator console, Authentication Authorization Accounting (AAA) server, Reports generator... etc. Fig. 1 demonstrates the implementation of the AAA server on Bezel Billing Platform. Herein we use XML to define the time-based pricing policy considering the flexibility of XML and the availability of XML parsers. ISPs establish their pricing plans by designing the tariff table and the XML document of the time-based pricing policy. AAA server loads the tariff table and the XML document from disk into memory indexed by day of year, as the memory of AAA server indicated in fig. 1. Therefore, AAA server can point out the data needed to calculate service charge without searching rows by rows.

5 Discussions and Conclusions

Key features and performance of Bezel Billing Platform and the general usage-based billing system are compared in Table 1. The main merits of adopting the proposed time-based pricing policy for charging Internet services are listed as follows:

- *Rational reflection on usage of the resources* enables ISP to offer adequate pricing plans for charging different services.
- *Low overhead* of charging the various services makes the proposed time-based pricing scheme economically feasible for the implementation of the billing system.
- *Flexible pricing plans* can be developed from grouping different settings of time factors by writing the XML document of the time-based pricing policy.
- *Real-time rating engine* gives ISPs the ability to offer prepaid and limited-credit services and to prevent fraud.
- *Better performance* of processing rating requests is achieved by loading the pricing information in rows indexed by day in the memory. Some billing systems query the prices from tables joining in general database systems. Most database systems are criticized for the poor performance of processing bursts of queries.

Table 1. Comparison between Bezel Billing Platform and general usage-based billing system

	Bezel Billing Platform	General usage-based billing system
Features	time-based, real-time	volume-based, batch-oriented
Network infrastructure	simple	complicated
Metering complexity	$O(K)$	$O(K*N)$
Rating complexity	$O(K)$	$O(K*M)$
Charging complexity	$O(K)$	$O(K*M)$

N: number of packets, M: number of tariff-related tables, K: number of usage records

The proposed time-based pricing with low overhead is more appropriate for charging specific services and is more practical for implementing the billing system. The service rate and the time factors can bring ISPs adequate pricing plans to promote a variety of services in today fast-changing IP communications environment.

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