Demand for Quality of Service on the Internet

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The INternet Demand EXperiment Project (INDEX) is a field trial investigating the structure of user demand for quality-differentiated Internet access. Demand can be measured in terms of bandwidth, transmitted bytes and connect time, as a function of price and application. Several experiments have been conducted, each running between six to eight weeks. Each experiment is defined by a different pricing scheme for accessing the Internet. Pricing schemes will range from flat rate pricing to detailed usage-based pricing.

In order to attract subjects, who are affiliates of the University of California at Berkeley, monthly costs for the provided ISDN access are waived. The ISDN line is continuously connected to the UCB Internet and subjects always get Internet access at 8kbps for free.

However, if subjects access the Internet at a higher bandwidth, they are charged real money depending on their usage of the Internet and the current pricing scheme they are facing. For example, they might be charged for the time they are connected to the Internet (per-minute pricing) or for the number of bytes they have transmitted (per-byte pricing).

To date, three different pricing schemes were explored: per-minute pricing with the choice of 8kbps, 16kbps, 32kbps, 64kbps, 96kbps, or 128kbps ('symmetric per-minute pricing'), per-minute pricing with the choice of capacities for in-bound as well as for out-bound traffic ('asymmetric per-minute pricing'), and per-byte pricing at a speed of 128kbps ('per-byte pricing').

The first results based on aggregate data from those experiments compare the three usage-based pricing schemes in respect to traffic generation, QoS selection, and expenditure. The change in service usage from free service to priced service is also discussed. In particular, we compared the connection utilization, the bytes transmitted, and the connect time (see ***http://www.index.berkeley.edu***).

The overall conclusion we can draw is that our subjects are sensitive toward different pricing structures. For example, our subjects were able to increase the connection utilization in the asymmetric per-byte pricing experiment although it required some knowledge about in-bound and out-bound traffic. (See the Utilization Experiment in the table below.)

Another example is the result of the connect-time investigation. In this case, the subjects reduced the time being connected at priced services (i.e. better than 8kbps service) in the per-minute pricing experiments significantly compared to the per-byte experiment. (See the Connect Time Experiment in the table below.)

The impact of usage-based pricing on user's behavior is also observed in the average number of bytes transmitted per user during a day. In the free service, on average 12.9 mbyte are transmitted at bandwidth higher than 8kbps. The average number of bytes transmitted dropped to 6.7 mbyte in the per-byte pricing experiment and to about 4.5 mbyte in the per-minute pricing experiment (See the Bytes Transmitted Experiment in the table below).

In order to prove that usage-based pricing is fairer than flat rate pricing, we calculated the cumulative expenditure over all users and the cumulative distribution of traffic. The latter investigation showed that, under flat rate pricing, 70% of our subjects would have to pay for the traffic generated by the remaining 30%. Those 70% are better off under usage-based pricing.

The expenditure investigation compared the subjects' actual expenditures with an assumed flat-rate expenditure. We imputed a flat-rate expenditure per user by dividing the total expenditure by the number of subjects. The comparison revealed that 67% to 76.5% of all subjects are better off in the usage-based pricing experiments, i.e., they had to pay less than the imputed flat-rate.

In the future, the analysis of INDEX data seeks to estimate individual user preferences. We also plan to estimate user preferences for pricing structures by conducting experiments offering our subjects a choice between different pricing schemes (info contact: Jörn Altmann, altmann@eecs.berkeley.edu).

Experiment	free service	symmetric per-min.	asymmetric per-min.	per-byte
Utilization	2.0 %	7.5 %	10.4 %	1.2 %
Connect time	20,100 sec	4,100 sec	2,700 sec	16,600 sec
Bytes transmitted	12.9 mbyte	4.3 mbyte	4.8 mbyte	6.7 mbyte

ISDN Signaling on the Net

There is an excellent ISDN resource on the Internet for those people who want to understand how ISDN works at:

http://veda-home.com/Blackshaw

Bob Blackshaw, an ISDN pioneer, has assembled an excellent reference that covers BRI, PRI, Rate Adaptation, differences between different versions of national ISDN, and a list of ISDN equipment vendors.

This is a good place to learn about ISDN protocols and services. This can help you to understand what is going on when the service is not doing what you expect.