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Charging Models in ATM Networks

The network operator needs a reliable estimate of the customer's service usage pattern in order to make a fair contract offer to the customer. The customer needs to know the implications of his or her contract choice in terms of the fulfilment of the requirements for a service/application and the cost for a given level of fulfilment.

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The network operator is concerned with the overall network and its capabilities whereas the customer is only interested in his or her services and the related costs. It is assumed that in the beginning both parties "operate in the unknown". The network operator does not know what service level could be suitable for the customer and the customer does not know what it will cost. The essence of this paper from CASHMAN project is: Given a considerable but limited amount of network resources, how the network operator and the user work together in order to benefit the most from each other.

Charging for Guaranteed Services

This section presents a summary of a usage-based charging algorithm for guaranteed quality services (DBR and SBR ATC's) based on an effective bandwidth model for on/off sources. The main deviation of this charging scheme from traditional charging for telephony is that it charges for transferred volume as well as time. This is very important for the statistical bit rate (SBR) of ATM transfer capability (ATC). Charging for volume is essential if the network operator is to recover the cost of installing new bandwidth.

The essence of the charging mechanism is as follows: the charge for a call is given by the expression: a(x) T + b(x) V + c(x); where T is the duration of the call, V is the volume of the call, and x describes tariff choices allowed to the user by the network at the time of call set-up. This tariff choice information includes the service class (for example variable bit rate or available bit rate), the traffic contract parameters (such as the peak cell rate and cell delay variation tolerance), and further choices which allow a user to lower the "per unit time" rate a(x) at the cost of raising the "per unit volume" rate b(x). The charge per connection is c(x). The natural choice of units for T and V will depend upon whether connections are permanent, semi-permanent or switched, and is likely to change as the project progresses. Thus "per unit time" may mean per second, or per hour, or per month, while "per unit volume" may mean per cell, or per Mbit, or per Gcell. The charging parameters a(x), b(x) and c(x) are static contract parameters, i. e., they are chosen at the beginning of a connection and remain constant during the connection or until the contract is renegotiated during the connection, while time and volume are dynamic parameters. Static parameters are policed, while dynamic parameters are measured. In the case of deterministic bit rate (DBR), only a(x) and c(x) apply, since a constant bandwidth is dedicated to the user. All three parameters apply to the SBR case.

Given a peak cell rate and a set of parameters describing the conditions for buffer overflow in the network, it is possible to estimate the maximum possible effective bandwidth which guarantees that the probability that the sum of the loads on a resource exceeds the total capacity of that resource stays below a certain limit [4]. This maximum bandwidth will be a concave, i. e. bounded, function of the expectation value of the mean rate. All one has to do in order to calculate the optimal tariff parameters is take a tangent to the effective bandwidth curve at the point of the expected mean rate.

To illustrate this point, let us consider two cases with the same peak cell rate but different predicted mean rates. Then the graph in figure 1 shows the calculated effective bandwidth as a function of mean rate (or the charge as a function of transferred volume). Choosing a pre-

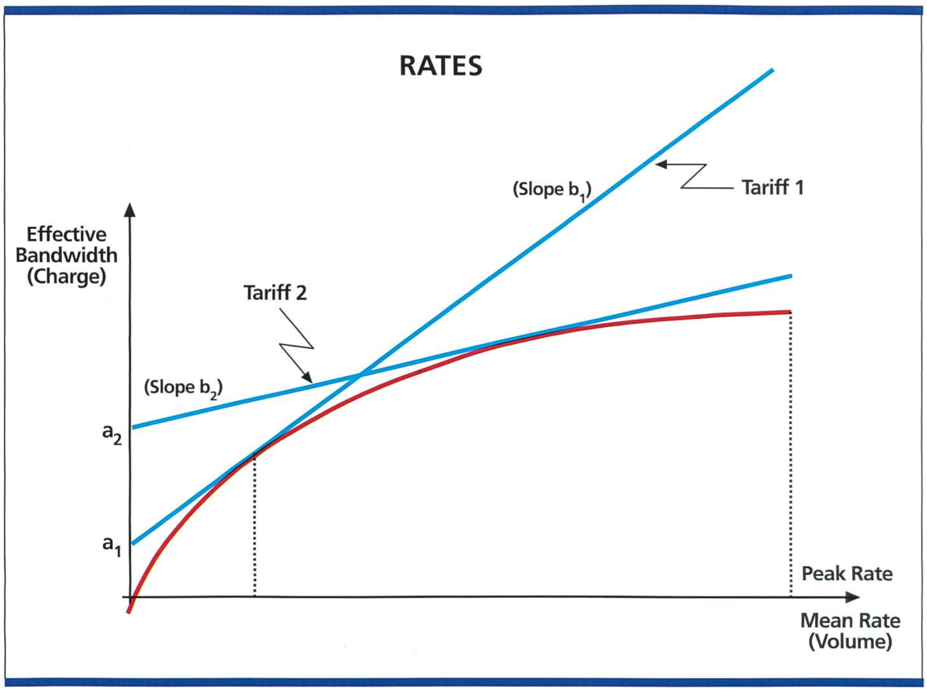

Fig. 1. Same peak rate, different mean rates.

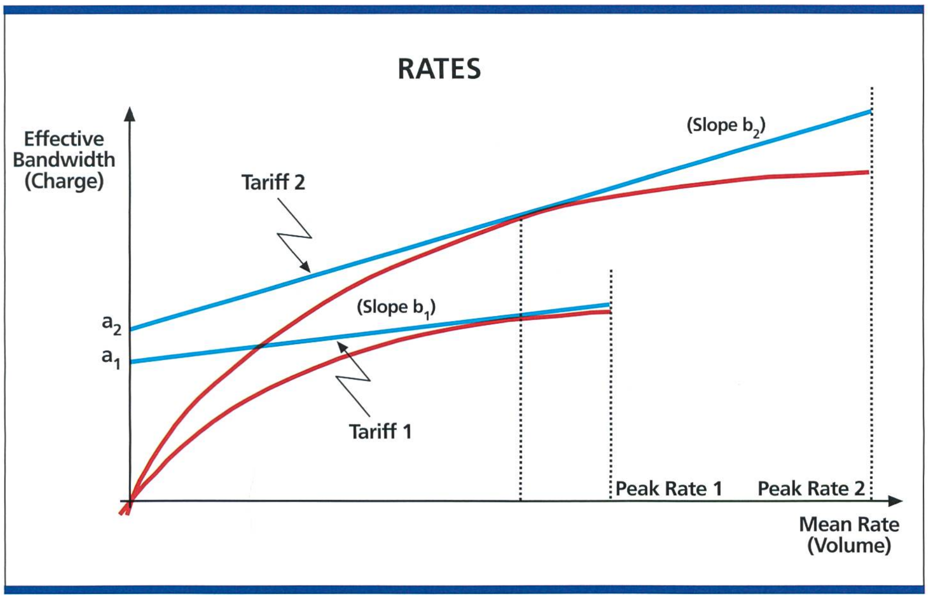

Fig. 2. Different peak rates, same mean rate.

dicted mean rate and forming the tangent to the bandwidth curve at that point gives a straight line which determines a(x) and b(x) in the charging formula. The tariff resulting from the lower predicted mean rate (tariff 1) gives a lower charge for lower rates (and a higher charge for higher rates) than the tariff resulting from a higher predicted mean rate. There is as a result a very strong incentive for the user to predict his mean rate as well as possible.

Figure 2 shows a different comparison: Two different peak rate choices for the same mean rate. The result is the intuitively obvious: If the user chooses a higher peak cell rate, more resources are reserved so he ends up being charged more. Again there is an incentive for the user not to tie up any network resources he does not need.

The prediction of the mean rate can be based on past history of the user's network usage, or if renegotiation of the traffic contract is possible during the connection, the mean rate can be measured during one phase of the connection and used as the predicted mean rate for the next phase of the connection. As the duration of the phases becomes smaller this process becomes asymptotically a feedback mechanism.

The above scheme minimises the possibility of congestion and gives an incentive to the user to monitor and regulate his traffic. It involves a complex calculation for the charging parameters, but one should not be quick to judge it as user-unfriendly. These calculations are performed by the network provider. The user specifies his ATC, his expected traffic parameters, and the required quality of service and the network in turn presents him or her with the resulting charging parameters.

Notice that the above formula gives the same charge for two connections if they have the same value of T and V, despite the fact that longer bursts are more difficult for the network to carry. One way to differentiate between these calls is to define a charging interval, say t, over which the cells carried are counted. A charging interval will be classified as being of type I or II as the total volume of cells the source produces during that interval is either $\leq k$ or $> k$ (i. e. $k = 2ht/3$, where h is the peak rate). A possible charging function could take the form $a_1(x)\,T_1 + a_2(x)\,T_2 + b_1(x)\,V_1 + b_2(x)\,V_2$

Here T1 and T2 are the total duration of intervals of types I and II respectively; so $T_1 + T_2 = T$. Similarly, V_1 and V_2 are the total volumes of cells generated by the source during intervals of types I and II respectively; so $V_1 + V_2 = V$. Also note that the above expression implicitly assumes that the charging parameters a_1, a_2, b_1, b_2 are again selected according to user declaration of certain traffic parameters, hence the dependence notation (x).

Note that the concept of distance has not been mentioned so far. There are a number of reasons to ignore distance from an ATM charging scheme: The cost of transmission has decreased dramatically in the past few years and switching technology has become the limiting factor [6]. There is a diminishing influence of distance in tariffing. The Internet and satellite communications are the strongest cases. Services provided over low altitude satellite feature flat rate global tariffs. The Internet has brought world wide web and E-Mail services which do not have any distance element. While some ATM service providers may wish to exploit the aspect of distance in a charging scheme if possible, it is reasonable to assume considering the globalisation of the telecommunications market that the diminishing influence of distance in tariffing will continue.

Contract Issues

Contracts are central to negotiations for service provision, and provide the basis for billing the customer. However, customers do not always receive their bill from the network provider to which they are connected; instead, they may receive it from a service provider or another network provider with whom they have a contract. In addition, some operators may subcontract the billing process to another organisation.

There is a number of different types of contract involved in providing ATM Services, so when we speak of contracts in the context of ATM services, it is important to be clear on whether we are speaking of service contracts, usage contracts, or traffic contracts. This can only be answered by having clear definitions of the various kinds of contracts for telecommunications services.

Contract Definitions

Three broad types of contract (Provisioned Service Contract, Session Contract, Traffic Contract) have been identified within accounting chain, and defined in the sequence.

Provisioned Service Contract

A Provisioned Service Contract is a commercial agreement between two or more parties relating to the provision of telecoms services. This type of contract specifies details of the service provided as well as the rights and obligations of the parties. These rights and obligations include those related to usage, although there could be a separate contract (the session contract) for each individual usage. This definition of service contracts includes nothing about duration, though it is sometimes useful to distinguish between longterm and shortterm service contracts. A longterm service contract is for the provisioning of telecoms services over a long period of time, say months or years, and it is necessary for services that require time-consuming and expensive provisioning which would not be economically justified for a shortterm contract. A shortterm service contract can be made possible by fast service provisioning. It is particularly suitable for supplementary services (e.g. call diversion), and may ultimately be negotiated on-line.

Session Contract

A Session Contract is an agreement between two or more parties for the duration of continuous usage of a service. Such a session could consist of several virtual path connections (VPC's) or virtual channel connections (VCC's) and thus of several traffic contracts. A session is equivalent to a call for simple services (e. g. a telephone or videophone call) but could represent, for example, a login session to an on-line Service provider in which a number of different types of activity is included, or a multi-party video conference in which a number of connections to different individuals are made and terminated as the conference goes on. Thus usage of the term session contract is preferable to call contract. In many cases, the session contract is not a contract in the strict sense of a negotiated commercial agreement; rather it is often implied at set-up, and is under the term of the provisioned service contract. It can thus be viewed as the exercising of a right under the service contract. The session contract may coincide with a shortterm service contract in some cases where no longterm arrangement exists, and the user just requires once-off access (with payment by credit card, for example).

Traffic Contract

A Traffic Contract is an agreement between a customer and a network operator across a User Network Interface (UNI) regarding the following interrelated aspects of any VPC or VCC ATM cell flow

- the quality of service (QoS) that the network is expected to provide
- the traffic parameters that specify the characteristics of the cell flow
- the conformance checking rule used to interpret the traffic parameters
- the definition of a compliant connection

There are some important issues related to charging and the traffic contract. The reason that the charge can not be accurately determined is because the contract confines the user traffic to lie in a specific set determined by the leaky buckets, which serving as a policing mechanism affecting the traffic only if it violates certain conditions. An important proposal is that the charging of a connection should be a function of the initial contract, of the prediction of the user about his traffic and of the actual traffic sent.

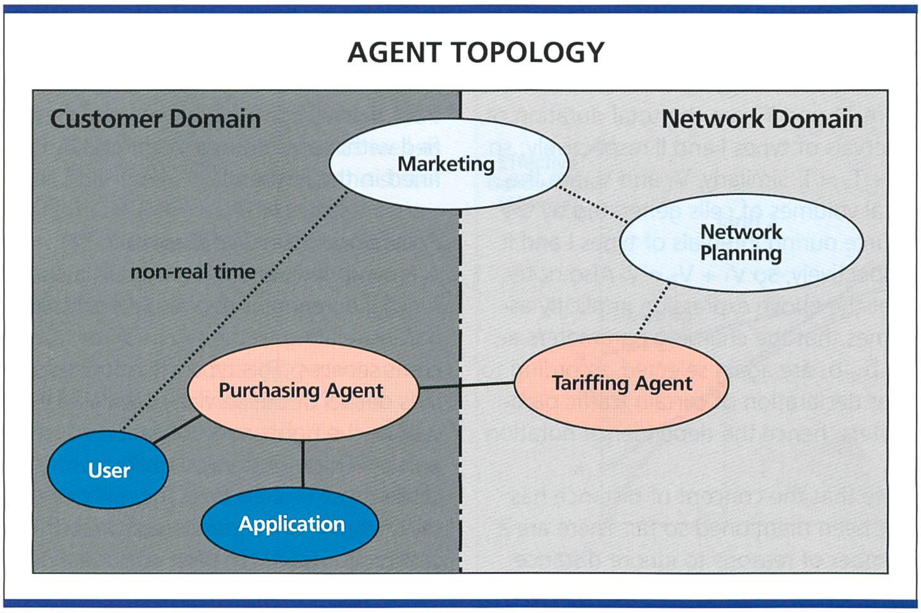

Fig. 3. The Tariffing and Purchasing Agents topology.

References

[1] The ATM Forum, Uni Spec., Version 4.0, June 1996.

[2] C. Courcoubetis, V. A. Siris, and G. D. Stamoulis, Integration of Pricing and Flow Control for Available Bit Rate Services in ATM Networks, IEEE Globecom '96, London, 1996.

[3] ITU Recommendation I371. Traffic Control and Congestion Control in B-ISDN, 1995

[4] F.P. Kelly, Charging and Accounting for Bursty Connections, In Internet Economics, L.W. McKnight and J. P. Bailey Eds, MIT Press, 1996.

[5] F. P. Kelly, Charging and Rate Control for Elastic Traffic, European Transactions on Telecommunications, Vol. 8, pg. 33, 1997.

[6] -D. Walker, F. Kelly, J. Solomon, Tariffing in the New IP/ATM Environment, to be published in Telecommunications Policy May 1997.

Contract Elements

In order to generate a framework for generic contract design, it is necessary to establish categories of elements that are present in the majority of contracts. The following are the principal categories of interest for all contracts, with relevant subcategories:

- parties to the contract
- service (incorporating provisions of the service level agreement)
  - provisioned service
  - special features
  - quality of service
  - restrictions
  - control and protection of the parties
- payment
  - tariffing arrangements
  - billing procedures
  - penalties and rebates
  - ease of auditing the above

It is important to note that this categorisation only relates to those elements that have a clear impact on charging and automation technology. In addition, contracts always contain other requirements relating to, for example, non-disclosure of the contract details, confidentiality of personal information and procedures for disputes.

The Interface between Network and User

An interface is envisioned which is decomposed into two parts: in the network domain there is a tariffing agent, and in the customer domain there is a purchasing agent. The tariffing agent accepts as input from the purchasing agent or elsewhere an ATM traffic class and its traffic parameters (as defined in ITU Recommendation 1.371 [3]), and returns a defined mechanism for charging such a connection. The purchasing agent mediates between the user's applications and the choice of ATM connection.
Thus a user's workstation will have a purchasing agent that interfaces to the ATM application. This agent takes tariff data from the network (provided by the network's tariffing agent) and presents it to the user in a highlevel way, relating tariff choice to impact on the quality of the connection. This concept is illustrated in figure 3, in the context of the higherlevel functions of marketing and network planning. The tariff rates that are incorporated in the tariffing agent are altered only over timescales that reflect substantial overall changes to network capacity and configuration (e. g. months.). The inclusion of the marketing function represents information flows between users and network over similar timescales, and reflects the impact on tariffs of factors such as business planning, aggregate user demand and regulation.

Conclusions

A unified charging mechanism for guaranteed quality services is an important issue which charges according to measured usage and the user's prediction of his or her usage at call set-up. For new charging schemes, the level of dependence on distance should be reconsidered. A scheme is considered in this paper includes duration of a connection, volume transferred during the connection and an access charge. The constants of proportionality and access charge reflects the user's choice of quality of service and traffic parameters that are calculated in such a way as to minimise the probability of network congestion and maximise the utility of the network to the user.
The service contract between the user and the network operator as well as the negotiation of the tariff for individual connections occur in a transparent and auditable manner, in the mechanism proposed. The ability to renegotiate the contract during the connection will allow the user to give the network operator more "educated" predictions of his or her usage thus reducing the cost of the successive parts of the connection. 9.4

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Zusammenfassung

Gebührenmodelle bei ATM-Netzen

Um dem Kunden ein faires Vertragsangebot unterbreiten zu können, muss der Netzbetreiber in der Lage sein, dessen «Benutzungsmuster» zuverlässig zu beurteilen. Der Kunde muss sich seinerseits über die Konsequenzen seiner Vertragswahl bezüglich Erfüllung der Anforderungen für einen bestimmten Dienst oder eine Applikation sowie über die für einen bestimmten Erfüllungsgrad anfallenden Kosten im Klaren sein. Während für den Netzbetreiber das Gesamtnetz sowie dessen Leistungsfähigkeit im Vordergrund stehen, interessiert sich der Kunde lediglich für seine Dienstleistungen und die damit verbundenen Kosten. Es wird davon ausgegangen, dass beide Seiten zu Anfang mit «unbekannten Grössen» operieren. Der Anbieter weiss nicht, welcher Servicelevel für den Kunden geeignet sein könnte, und der Kunde weiss nicht, was die Dienstleistungen kosten. Die Quintessenz dieses Beitrags aus dem Projekt CASHMAN: Wie können der Netzbetreiber und der Benutzer angesichts der umfangreichen, dennoch aber begrenzten Netzwerkressourcen zusammenarbeiten, um optimal von einander zu profitieren?