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Connection Retry Schemes For LAN Interconnection Over B-ISDN Using Switched Virtual Circuits

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Abstract

A connection has to be opened before data can be transmitted over an ATM network. The connection can be permanent, semi-permanent or switched. Depending of requirements, switched virtual circuits are dynamically set up and torn down using signalling. When a connection has to be reestablished, the network may reject the connection or may offer a connection with a reduced bandwidth. The aim of this paper is to decide whether a user should accept the call with reduced bandwidth or retry for a connection after a waiting period.

1 Introduction

Asynchronous Transfer Mode (ATM) is a connection-oriented network which is being developed to carry different types of real and non-real time services over a Broadband ISDN network. A connection has therefore to be established between a source-destination pair before any data transmission can occur. LAN interconnection is expected to be the first service to be offered by Broadband ISDN networks. In this case, a number of LANs are connected together by ATM networks. Since LANs use a connectionless protocol for data transmission, several methods for implementing connectionless service over a connection-oriented network have been described in [1]. The methods are broadly divided into a *direct* approach and an *indirect* approach. The direct approach [2] is based on a connectionless virtual overlay network consisting of Connectionless Service Function (CLSF) nodes in the network. The indirect approach can use one of the following three methods [1, 3].

1. *Semi permanent end-to-end path establishment* where a semi permanent Virtual Path (VP) (or Virtual Circuit (VC)) is established between every pair of Interworking Units (IWU) of every pair of LANs. This results in a mesh of VPs (or VCs) between LANs, resulting in a scalability problem for large number of LANs. Since most data applications are bursty in nature and can not adequately describe their traffic behavior, this method results in an inefficient use of bandwidth.

2. *VC connection establishment on a frame basis* where a VC connection is established for every frame to be transmitted from a LAN to another LAN. Although the bandwidth utilization is high in this method, the processing overhead for establishing and tearing down a VC on a frame basis may result in unacceptable delays in transferring the data. This delay might result in buffer overflow and frame loss in the IWU.

3. *Switched VC connection establishment (SVCCE)* where a VC is opened when an IWU has a frame to send. However, the VC instead of being closed at the end of every frame, transmits the next frame if one is available; otherwise it is left open for some idle period of time before being

closed down. The method reduces the overhead required for connection establishment and also has a reasonable utilization of the bandwidth.

The SVCCE method offers a compromise between bandwidth utilization and frame transfer delay. An important issue with SVCCE is how long to hold an idle VC open. Too short holding time will cause increased delay at the IWU and possible cell loss due to buffer overflow and will also result in increased opening costs. We have previously studied the holding time problem in [4] and the loss and delay issue in [5].

Traffic arriving from LANs to the ATM network is usually highly bursty in nature. As a result, there might be a lot of data arriving in a burst followed by a long silence period. In such a case, we have shown in [5] that if the period of inactivity in the ATM connection is greater than a certain period of time, it is more cost-effective to close the connection and re-establish the connection when the next burst of data arrives than to leave the connection open all the time. However, when the connection has to be reestablished, there is no guarantee that the network can provide a connection with the previous set of traffic descriptors or quality of service, or even provide a connection in the worst case.

In the SVCCE method, a connection is set up between a source-destination pair using a signalling protocol. In order to set up a switched circuit, a source requests, from the network, a connection with a desired bandwidth. Depending on the available capacity in the network, the connection admission control (CAC) mechanism may

- accept the connection offering the full bandwidth requested or
- may offer a connection with less bandwidth than requested.

In the second case, the source may either agree to the connection with reduced bandwidth in which case the connection is established, or may decide not to accept the connection and try again later after a waiting period. The decision on whether to accept the call with reduced bandwidth or to retry for a connection after a waiting period is the focus of this study.

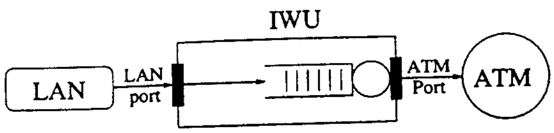

Figure 1: Model of the IWU used for simulation.

The performance parameter for our study is the average delay of the packets in the IWU. In the one hand, if a connection is accepted with reduced bandwidth, the transmission time of the packets will increase, which in turn will increase the average delay in the IWU. On the other hand, if the offer of a connection with a reduced bandwidth is turned down and a new connection is retried, the packets, waiting in the queue for a connection to be set-up, will experience increased queueing delay.

Using simulations, we study the performance of connection acceptance with reduced bandwidth for a range of bandwidths and connection set-up delays. The main objective of this study is to find a bandwidth threshold which can be effectively used by the source to decide whether to accept a connection with a given bandwidth or try later for a new connection with higher bandwidth.

The rest of the paper is organised as follows. Section 2 describes the simulation model of the LAN-to-ATM IWU. In Section 3, the performance results obtained from the simulation experiments are presented. Finally, a conclusion is made in Section 4.

2 Simulation Model

The model of the LAN-to-ATM IWU used in the simulations is shown in Figure 1. The aggregate LAN traffic, from the LAN to the ATM network, is simulated as an ON-OFF process. During the ON period, the packets arrive to the ATM port at a fixed rate. No packets arrive during the OFF period. The lengths of the ON and OFF periods are expo-

Parameter	*Value*
Packet size	1526 bytes
Requested VC bandwidth	10 Mbps
Waiting period π	10 ms
Mean ON period	50 ms
ON rate	819.14 pk/sec
Mean OFF period	100 ms
Inactivity timeout	100 ms

Table 1: Values of simulation parameters.

nentially distributed and can be adjusted to create a desired load on the ATM port.

An inactivity timer is simulated to release a VC after a period of inactivity. If a packet arrives and a VC is not established, a requested for a VC with the peak bandwidth of 10 Mbps is sent to the ATM network. It takes C time units to get a reply from the ATM network.

In reply to a VC request, the ATM network offers the full bandwidth (10 Mbps) 80% of the time. For the remaining 20%, the offered bandwidth is only a fraction of the full bandwidth requested. In this model, only a finite number of possible fractions are simulated. These are 0.0 to 0.9 with an increment of 0.1. A fraction is selected randomly from the above list.

When the ATM network offers a connection with a reduced bandwidth, the source accepts the connection if the offered bandwidth is above q times the requested bandwidth, where q is a fraction decided in advance. For an example, for $q = 0.5$, the source will not accept any connection with a bandwidth below or equal to half of the requested bandwidth.

If a connection with a reduced bandwidth is rejected (because the offered bandwidth is lower than or equal to q times the requested bandwidth) by the source, a new connection request is not generated until after a waiting period of π time units.

Values for various simulation parameters are shown in Table 1.

The statistics of the average packet delay W in the IWU, the queueing delay plus the transmission delay, is monitored on-line during the simulation and the simulation is stopped automatically when either a relative precision of 5% or less is achieved for a 95% confidence level or a maximum of two million samples are collected (i.e., two million packets are transmitted).

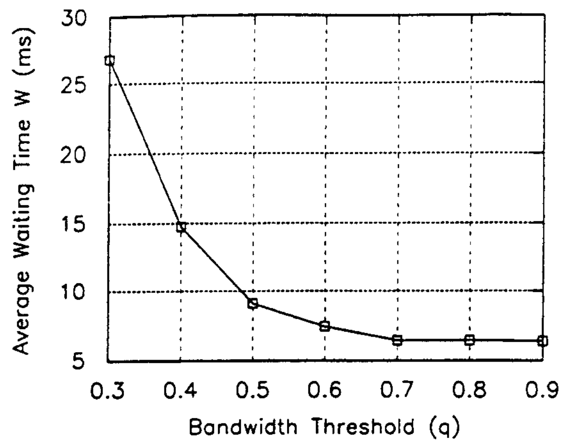

Figure 2: Average waiting time as a function of bandwidth threshold q for small connection set-up delay (C=10ms).

3 Simulation Results

Three sets of simulations were run, each with a different value for the connection set-up delay. In each set, many simulations were run for different values of q. The average waiting time W of a packet in the IWU is obtained as the output of each of these simulations.

Figure 2 shows the average waiting time for different values of q for a small connection set-up delay of only 10 ms. It can be seen that W decreases as q is increased. This suggests that for small connection set-up delays, accepting a connection with reduced bandwidth may degrade the performance (increase the delay).

For a large connection set-up time (C=500ms), the average waiting time as a function of q is shown in Figure 3. The graph in Figure 3 shows an opposite behaviour to the one in Figure 2; here the W increases as the q increases which sug-

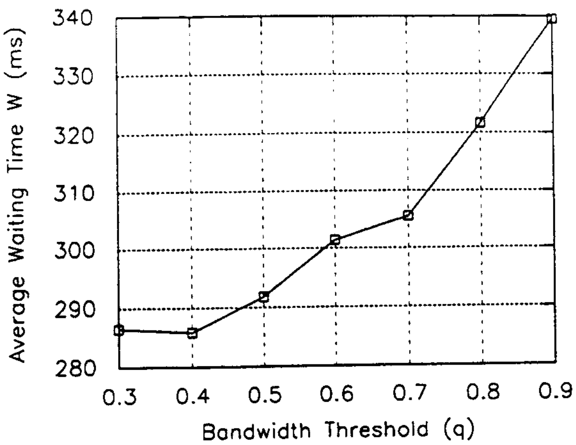

Figure 3: Average waiting time as a function of bandwidth threshold q for large connection set-up delay (C=500ms).

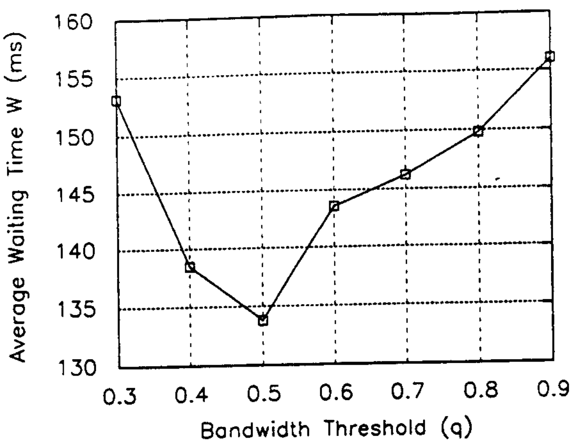

Figure 4: Average waiting time as a function of bandwidth threshold q for medium connection set-up delay (C=250ms).

gests that the performance might actually be improved by accepting connections with reduced bandwidth.

The third set of simulations were run with a medium connection set-up delay of 250 ms and the results are shown in Figure 4 It is interesting to observe that there exists an optimum q for which the delay is minimised.

4 Conclusion

Connections are dynamically established and torn down in a switched virtual circuit. When a connection has to be reestablished, the network may not have enough resources to reopen the connection with the requested amount of bandwidth. The network may however offer a connection with a reduced amount of bandwidth. In this paper, we have studied problem of whether the IWU should accept the reduced bandwidth connection or retry for a connection with the desired amount of bandwidth. Out performance measure is the average waiting time of user packets in the IWU. We have used a policy whereby the IWU accepts any connection which is over a certain fraction (threshold) of the requested bandwidth. We have observed that for a small connection set up time, the average waiting time diminishes as the threshold increases. On the contrary for a large connection setup time, the waiting time increases with an increase in the threshold. For a medium connection setup time, there is a certain value of the threshold where the waiting time is minimum and increases when the threshold either increases or decreases.

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