Simple Cell Scheduling for Application Level Jitter Reduction over ATM-ABR service

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1 Introduction

The characteristic of ABR service class is that it guarantees only the cell loss ratio (CLR) and does not provide any other QoS guarantees such as the cell transmission delay (CTD) and cell delay variation (CDV). The mechanism for supporting CLR in ABR service category is based on the feedback control where the allowed cell rate (ACR) of source node is dynamically adjusted according to the congestion state of ATM network. With this mechanism, ABR achieves higher bandwidth utilization of link capacity than CBR and VBR service classes.

On the other hand, [1, 2] proposed the design method of the queue control function which guarantees not only CLR but also the CTD. By using this queue control function, ABR service category can support multimedia communication with small delay. However, the CDV, or equivalently, the jitter is not taken into consideration in their algorithm. The jitter is also important factor for the real-time video transmission where the jitter affects the quality of decoded video at destination node.

In this paper, we propose a scheduling scheme at source node to reduce the jitter at application level under the ATM-ABR service class. In our proposed scheme, we focus on the departure points of the end part of data packet. Throughout the paper, we call this end part of packet the critical cell. In our scheme, the critical cell is intentionally delayed until next data packet generation and transmitted at the beginning of the next cycle of packet generation. The departure points of critical cells at source node are like CBR traffic and therefore the reduction of jitter at application level is expected by our scheme. Since the points of sending critical cells are intentionally delayed, we call our proposed scheme intentionally delayed transmission (IDT). We verify the effectiveness of our proposed method by simulation.

2 IDT Scheme

First we suppose that the application layer generates data packets and that the interarrival time of consecutive packets is constant equal to T (Figure 1). The period T is regarded as a cycle of packet generation. In addition, we assume that the application program generates at least one cell during each period T.

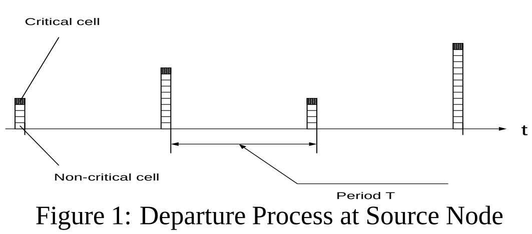

Figure 1: Departure Process at Source Node

In the case without IDT, the source node sends cells as fast as possible according to the ACR. Since the packet size at application level is variable, the interdeparture time of critical cells varies depending on the packet size. In our proposed method, the critical cell is delayed at source node until the next data packet generation and transmitted at the beginning of the next cycle of packet generation. Therefore the interdeparture time of critical cells is constant with period T and it is expected that the resulting interarrival time of critical cells at destination node varies less than that of ordinary ABR service (Figure 2). Here the jitter at application level is defined as the variance of interarrival time of critical cells at destination.

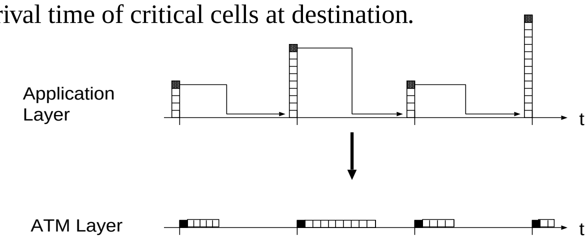

Figure 2: IDT Scheme

3 Performance Evaluation of IDT

3.1 Simulation Model

In our simulation model, the capacity of all links is equal to 155 Mbps and all connections belong to ABR service category. We assume that the time between the consecutive points of packet generation is $1/30$ sec. We also assume that the bitrate of application data is 7.2Mbps and the number of cells for background traffic generated within a slot is distributed according to the geometric distribution.

In order to investigate the characteristics of IDT scheme, we consider the following two cases in simulation.

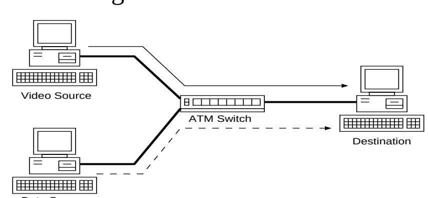

Figure 3: Simulation Model for Single Node Case

1. Case of Single Node
   The critical and non-critical cells are generated at the Video Source as shown in Figure 1 and are transmitted to the Destination. The background traffic cells are generated at Data Source and transmitted to the same destination. The IDT scheme is implemented at Video Source.

2. Case of Multiple Nodes
   In this case, Data Source 1-3 generate the background traffic and Data Destination 1-3 are the corresponding destinations, respectively. The Destination 3 is the destination for Video Source and Data Source 3.

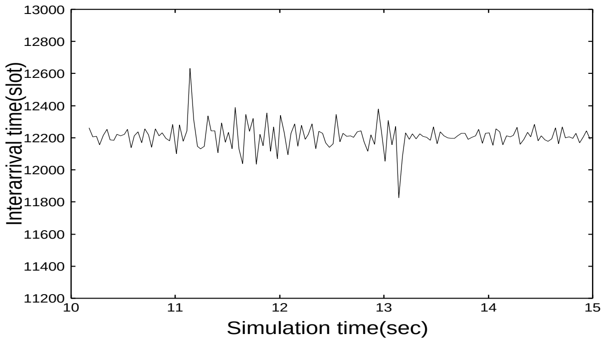

Figure 4(a): Single Node Case without IDT

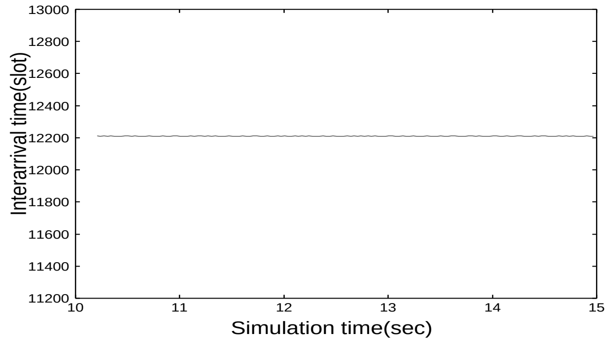

Figure 4(b): Single Node Case with IDT

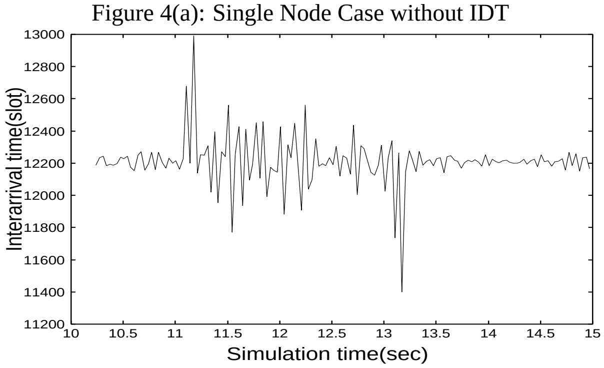

Figure 4(c): Multiple Nodes Case without IDT

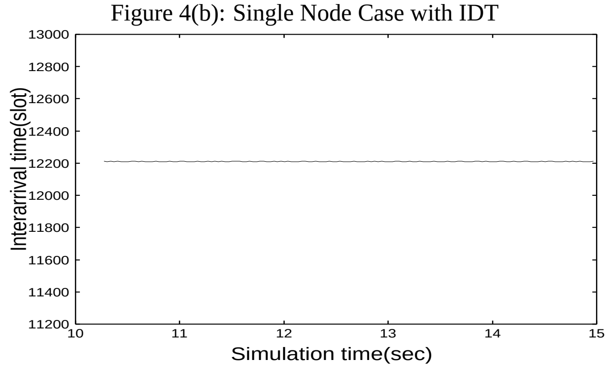

Figure 4(d): Multiple Nodes Case with IDT

Figure 4: Interarrival Time of Critical Cells

In order to investigate the robustness of IDT scheme against the background traffic, we focus on the dynamics of the interarrival time of critical cells at destination. We consider the following situation: The video traffic is transmitted to the destination during the simulation time from 10 to 15, and the data source nodes start to transmission of 100 Mbps background traffic at 11 and end at 13.

3.2 Simulation Results

Figures 4(a) to 4(d) show the simulation results with and without IDT scheme in single and multiple nodes cases. In these figures, the horizontal axis represents the simulation time and the vertical axis means the interarrival time of critical cells at destination. Figures 4(a) and 4(b) are the single node case while Figures 4(c) and 4(d) are the multiple nodes case where the number of ATM switches is three.

From Figure 4(a), we observe that the interarrival times vary largely when the background traffic is multiplexed and the interarrival times still vary even when there is no background traffic. On the other hand, from 4(b), we find that the interarrival time with IDT is almost constant even when the background traffic interrupts and the IDT is effective for reducing the application level jitter.

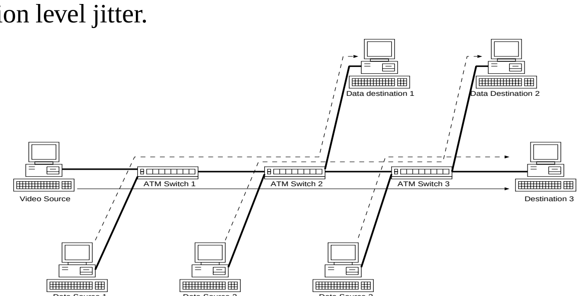

Figure 5: Simulation Model for Multiple Nodes Case

Figure 4(c) shows the simulation result of the multiple nodes case without IDT scheme, and we find the same tendency as Figure 4(a). Figure 4(d) is the case with IDT. We observe that the interarrival time is almost constant insensitive to the background traffic and IDT is also effective for reducing the in multiple nodes cases. From these results, we observe that the IDT scheme also shows good performance for the robustness against the impact of background traffic.

4 Conclusion

In this paper, we focused our attention on the departure point of the last cell for the packet and proposed IDT scheme to reduce the application level jitter. We investigated the jitter process with IDT scheme and the robustness of IDT scheme against the interruption of the background traffic by simulation. We also compared the IDT scheme with the original ABR system.

As we see in the simulation results, the variation of the interdeparture time of the tagged node causes the further variation of the interdeparture time of the next node. Therefore it is important for the source node to make the departure process of critical cells less variable. From this point, the IDT scheme is quite efficient.

References

[1] B. Vandalore, et al., “QoS and Multipoint Support for Multimedia Applications over the ATM ABR Service,” *IEEE Communications Magazine*, pp. 53-57, Jan. 1999.

[2] B. Vandalore, et al., “Design and Analysis of Queue Control Functions for Explicit Rate Switch Schemes,” *Proc. IEEE ICNP*, pp. 780-786, Oct. 1998.