무선 ATM망에서 동적 변수를 이용한 비디오 데이터의 대역폭 할당방식에 대한 연구

장 동 혁† · 김 승 환†† · 이 선 숙††† · 권 오 석††††

요 약

무선 ATM망에서 동적 슬롯할당을 행하기 위해서는 이동국(MT)에서 요구되는 슬롯량은 이동국의 트래픽 특성을 반영하는 동적 변수들(DPs)에 의해 예측된다. VBR 트래픽에서 슬롯할당은 시의존성 특성 및 서비스품질(QoS) 요구를 고려하여 이동국에서 행해진다. 본 논문에서는 동적 변수들-버퍼상태 정보와 버퍼상태 변화-이 대역내 신호방식으로 전송된다. 또한, 기지국(BS)은 각 이동국의 트래픽 특성을 고려하여 동적 슬롯할당을 수행한다. 다시 말해서, 이동국 버퍼가 특정한 임계값을 넘으면 버퍼상태 정보는 기지국에게 '버퍼풀 상태'의 가능성을 알리며, 버퍼상태 변화는 이동국에게 입력 셀에 대한 버퍼상태의 변화를 알려준다. 만약 버퍼상태 정보가 '낮음(임계값보다 큰 경우)'과 '급상승' 상태이면 셀 전송지연과 셀 손실이 발생하는 '버퍼풀'을 가져온다. 이때 기지국은 이동국에게 부가적인 슬롯을 할당하며 이동국은 버퍼내의 셀들을 전송한다. 시뮬레이션을 통해 제안된 방식이 EPSA 대역내 신호방식보다 셀 지연과 셀 손실에 대한 성능이 우수함을 보여준다.

A Study on the Bandwidth Assignment Scheme for Video Data Using Dynamic Parameters in the Wireless ATM Networks

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ABSTRACT

In WATM networks, in order to perform dynamic slot allocation required slots of mobile terminals are estimated based on DP (Dynamic Parameter) reflecting characteristics of traffic. In VBR (Variable Bit Rate) traffic, slot allocation is done at MT considering both time-dependent characteristics and QoS (Quality of Service) requirements. In this paper, DPs-buffer state information and buffer state change-are transmitted through in-band signaling. BS (Base Station) performs dynamic slot allocation considering traffic characteristics of each MT (Mobile Terminal), in other words, buffer state information informs the potentiality of 'buffer full state' to BS if MT buffer is over the specific threshold value and buffer state change notifies change in buffer state of incoming cells to MT. If buffer state information is equal to 'low (more than threshold)' and 'abrupt increase' it generates 'buffer full' state cell transmission delay or cell loss might occur. At this time BS should assign additional slots to MT, and then MT consumes cells in its buffer. In simulation, the proposed scheme shows better performance in cell delay and loss than EPSA (Estimation-Prorated Slot Assignment) in-band scheme.

키워드 : 무선ATM(WATM), 동적 슬롯 할당(dynamic slot allocation), 동적 파라미터(dynamic parameters), 대역 내 신호방식(in-band signaling), VBR 트래픽(VBR traffic)

1. Introduction

WATM (Wireless Asynchronous Transfer Mode) is considered as a wireless access network to interconnect to mobile users to the ATM network. Therefore, the objective of WATM is to extend such broadband multimedia services to the wired line so that users on the move can be provided with diverse multimedia services with rapid transmission rates. That is, mobile users are also offered with different types of services provided for wired line through wireless channel even in mobile environment [1-3].

Dynamic reservation-based MAC (Medium Access Pro-

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tocol) is considered as one of the access which satisfy QoS (Quality of Service) previously defined for the ATM and accepts VBR (Variable Bit Rate) traffic service efficiently methods in WATM.

The scheduler at BS (Base Station) should perform dynamic slot allocation distributing available slots to the entire MTs (Mobile Terminals) satisfying QoS of each MT after understanding bandwidth requirements rapidly and precisely according to traffic characteristics of each MT. In order to realize dynamic slot allocation a signaling system, which sends/receives parameters representing traffic status of each MT and the related control information, is required.

Each MT must notify its bandwidth requirements through DPs (Dynamic Parameters). At this time, types of such parameters and establishing methods according to the algorithms of slot allocation should be decided. Also, in order to transmit such DPs an efficient signaling method, which is mainly divided into in-band signaling and out-of-band signaling, is required.

In this paper DPs, which are buffer state information and buffer state change, are transmitted using in-band signaling. BS performs dynamic slot allocation considering traffic characteristics of each MT, that is, buffer state information notifies the potentiality of buffer full state to BS if MT buffer is over the specific threshold value and buffer state change notifies change in buffer state of incoming cells of MT.

This paper is organized as follows. In section 2, the related studies are presented, and in section 3, a signaling system for dynamic slot allocation is described. In section 4, a novel bandwidth assignment scheme is proposed. And in section 5, the proposed scheme and existing schemes are compared and analyzed through simulation. Finally, we close with concluding remarks in section 6.

2. Related Studies

In order to realize dynamic slot allocation slot requirements should be estimated based on DPs reflecting traffic generation characteristics of MT. The slot allocation scheme applied at that time must be able to maximize transmission efficiency in radio access region by simplifying DPs necessary for scheduling and ; simultaneously a transmission scheme for DPs reflecting time-dependent slot requirements also must be considered.

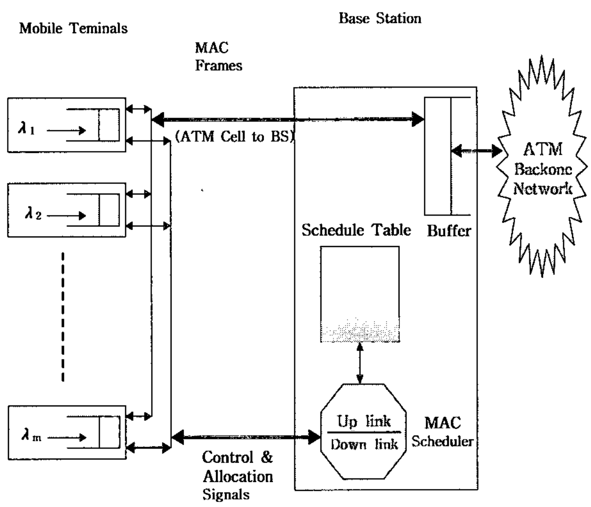
In previously studied EPSA (Estimation-Prorated Slot Assignment) algorithm [4], time-dependent slot requirements are reflected on schedule minimizing transmission delay for DPs notifying DPs through in-band signaling. However, in this scheme since BS estimates slot requirements based on transmitted DPs in two bits, estimating time-dependent traffic characteristics of VBR traffic is not easy. On the other hand, in EC-DRSA (Equivalent Capacity-based Dynamic Release Slot Assignment) scheme [5], efficiency for bandwidth usage is maximized by assigning basic slots to each MT and allocating idle slots of others to MTs, which have more slot requirements, at a specific time.

The objective of this paper is to reduce cell transmission delay and cell loss rate by scheduling slot allocation of BS with the buffer state information and buffer state change received from MT using in-band signaling for slot allocation of VBR video traffic to MAC frame.

3. A Signaling System For Dynamic Slot Allocation

In order to realize dynamic slot allocation a signaling system, which sends/receives parameters representing traffic status of each MT and the related control information, is required. (Figure 1) shows the signaling system.

Each MT must notify its bandwidth requirements through DPs. At this time, types of such parameters and establishing methods according to the algorithms of slot allocations should be decided. Also, in order to transmit such DPs efficient signaling method, which is mainly divided into in-band signaling and out-of-band signaling, is required.



(Figure 1) Signaling for Dynamic Slot Allocation

In CBR traffics, slots are assigned periodically with a full reservation according to their cell rate ; in VBR traffic reservation is dynamically controlled on a frame-by-frame basis ; and in ABR, traffic is handled as a dynamic allocation according to number of available and required slots[6].

In-band signaling can only transmit limited information even though the necessary information can be transmitted on time to up-link by piggybacking on a transmitting cell. For instance, DPs are transmitted via Generic Flow Control (GFC) field of an ATM cell header.

On the other hand, even though out-of-band signaling method can transmit a lot of information, since the designated signal slot such as Random Access Channel (RACH) accesses through competition, the information may not be transmitted on time.

4. Proposed Scheme

In this paper, DPs, which are buffer state information and buffer state change, are transmitted using in-band signaling. BS performs dynamic slot allocation considering traffic characteristics of each MT, in other words, buffer state information notifies the potentiality of 'buffer full' to BS if MT buffer is over the specific threshold value and buffer state change notifies change in buffer state of incoming cells to MT.

MT transmits DPs using three out of four bits in GFC field of an ATM cell to BS. One bit represents buffer state information of MT, and the other two bits buffer state changes. The buffer state information are classified into two different states : buffer low (BL) and buffer high (BH). BH means cells in a buffer are less than a specific threshold T, which may be one of mean rate, sustained rate, and MT's buffer size/2. BL means cells in buffer are more than T, therefore, MT's buffer may become 'full' causing cell delay or loss. The buffer state information is shown in <Table 1>.

〈Table 1〉 Buffer State information of MT

Buffer state information	Represented by	Description
BH	0	Less than T
BL	1	More than T

Buffer state information are transmitted using two bits of ATM cell. Since it is not possible to transmit absolute information with two limited information fields, relative information on increase/decrease of buffer length are encoded in those two bits. Let's call two bits, b0 and b1 respectively. If buffer length increases, b0 is set to 1 otherwise b0 is set to 0. If the difference between increase and decrease is over or under the threshold values $\triangle 1$ and $\triangle 2$, b1 is set to 1. That is, b0 indicates simple increase/decrease and b1 represents abrupt increase/decrease informing buffer changes of MT to BS and may allocate more idle slots or release slots. The buffer state changes are shown in <Table 2>.

〈Table 2〉 Buffer State Change of MT

Buffer state change	B0	B1
Simple decrease	0	0
Abrupt decrease	0	1
Simple increase	1	0
Abrupt increase	1	1

Let's consider one example. If buffer state information is equal to low and 'abrupt increase' it generates 'buffer full' cell transmission delay or cell loss might occur. At this time BS should assign additional slots to MT, and then MT should consume cells in its buffer. BS releases unused slots with highest priority which has high table value if the buffer state of MT is BL and 'buffer state changes' is abrupt decrease. The released slots are allocated to the MT requiring more bandwidth.

BS applies suggested scheme of EPSA in cases buffer state information changes of MT is equal to 'Simple increase' 'Simple decrease', and 'Abrupt increase'. BS reduces waste of bandwidth caused by over-estimation in assigning slots of MAC decreasing the ratio to the predefined ratio in case of Abrupt 'decrease between' MT and BS.

Besides the slots allocated with buffer state change if buffer station is equal to BL delay and loss are reduced by allocating additional slots, α, to MT by consuming cells in queue in BS' buffer. α is exponentially changing value

5. Simulation And Results

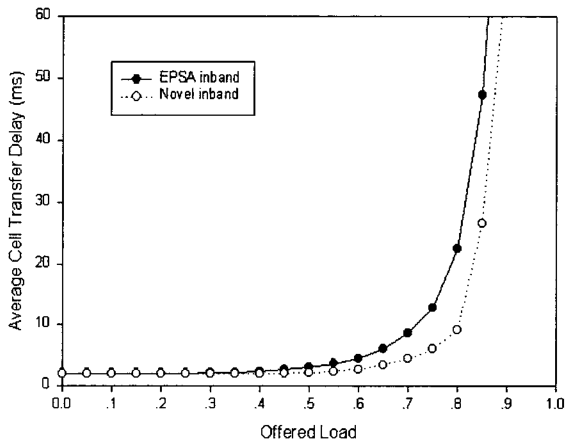
Cell transmission delay and loss of MT in the proposed scheme and EPSA in-band signaling scheme are compared. For experiment, encoded MPEG-1 VBR traffic, "Bonds", is used. Ten (10) MTs connected to BS are assumed. The MAC frames in this paper were adopted from TDMA/TDD MAC frame structure of EPSA. The parameters used are identical to the ones in EPSA in-band signaling are shown in <Table 3>. Also, the value of α is chosen as 8.

In (Figure 2), cell transmission delays per offered load of MT are compared. The proposed scheme shows better performance in cell delay than EPSA scheme.

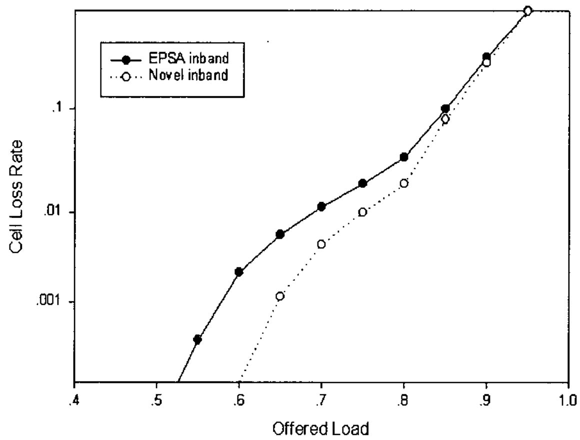
〈Table 3〉 MAC frame parameters and bandwidth partition

Channel bit rate	25Mbps
Frame duration	2ms
Slot size	8 bytes
Slots per frame	781
Data Cell Size	7 Slots
Cntrl packet size	1 Slots
Preamble size	2 Slots
Frame header	2 Slots
B-R control	8% of frame
R-B ALOHA control	15%
VBR + ABR data	77%

In (Figure 3), cell losses per offered load are compared The proposed scheme also demonstrates better performance in cell loss than EPSA scheme.



(Figure 2) Average Cell Transfer Delay against Offered Load



(Figure 3) Cell Loss Rate against Offered Load

EPSA assigns using two bits representing buffer state change by estimating incoming cells to MT from BS. However, in this paper loss and delay are reduced by considering buffer state information and buffer state change simultaneously by assigning additional remaining slots and expediting consumption of buffer if buffer state is equal to BL.

6. Conclusion

In WATM in order to perform dynamic slot allocation required slots of MTs are estimated based on DP reflecting characteristics of traffic. In VBR traffic, slot allocation is done at MT considering both time-dependent characteristics and QoS requirements.

In this paper, DPs for VBR video traffic are transmitted to BS through in-band signaling. The parameters are composed of three bits, in which the first bit represents buffer state information of MT and the other two represent buffer state change of MT. With buffer state information and buffer state change BS allocates slots through estimation if it is required. If buffer state information is equal to 'low (more then threshold)', 'abrupt increase' may 'bring buffer' full state causing cell transmission delay or cell loss. Therefore, BS should allocate additional slots to MT, and then MT expedites consumption of cells in its buffer.

In simulation, the proposed scheme demonstrates better performance in transmission delay and cell loss rate as compared to the previously suggested schemes of EPSA.

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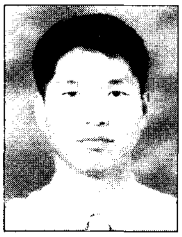

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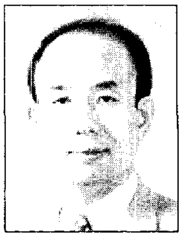

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