무선 ATM에서 핸드오프 동안 실시간 VBR 서비스를 위한 전송 지연의 최소화 방안

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요 약

일반적으로, 유선 및 무선 ATM망에서 서비스 품질(QoS)에 대한 요구 사항은 서비스 유형에 따라 다르며, 실시간 비디오 서비스는 셀 손실보다 셀 전송 지연에 더 민감하다. 셀 손실 방지를 강조하고 있는 기존 핸드오프 방안들은 QoS를 만족시키기 위해 셀 전송 지연이 큰 단점을 가지고 있었다. 본 논문에서는 실시간 VBR 서비스에서 핸드오프 동안 새로운 기지국으로 전달될 셀 들 중에서 ATM 셀 헤더의 셀손실 우선순위(CLP)가 낮은 셀은 전달하고 CLP가 높은 셀은 폐기함으로써 셀 전송 지연을 최소화하는 방안을 제안한다. 제안된 방안은 MPEG 비디오 프레임을 대상으로 시뮬레이션을 통해 실시간 VBR 서비스의 QoS를 만족시키고 신속한 핸드오프에 적절하다는 것을 보여 주었다.

A scheme to minimize transmission delay during handoff for rt-VBR service in the wireless ATM Networks

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ABSTRACT

In general, requirements for QoS are different according to the type of services in wire-line and wireless ATM networks, and real-time video service is more sensitive to cell transmission delay than to cell loss. Existing handoff schemes emphasizing prevention of cell loss had limitations in cell transmission delay to satisfy QoS. In this paper, a novel scheme to transmit ATM cells with low CLP(when CLP=0) prior to others and discarding cells with high CLP(when CLP=1) in ATM cell header among cells to be forwarded to new base station during handoffs in real-time VBR service is proposed. The proposed scheme is proven to be suitable for the satisfaction of QoS of real-time VBR service and appropriate for fast handoffs by giving high CLP value to less meaningful MPEG frames through simulations.

키워드 : 무선 ATM(Wireless ATM), 핸드오프(handoff), 셀 손실 우선순위(Cell Loss Priority), 실시간 VBR 서비스(real-time VBR Service), 셀 전송 지연(cell transmission delay)

1. Introduction

With increasing growth in ATM-based multimedia services and growing interest in telecommunications services, Wireless ATM(WATM) has emerged to support the seamless delivery of integrated voice, video and data with high quality[1, 2]. In this context WATM is intended to be a direct extension of the wireline ATM network with uniformity of end-to-end Quality of Service(QoS) guarantees [3]. WATM, therefore, has been proposed as a technology to support this because of its free access capability, mobility, and multimedia handling capability[4, 5]. As compared to wire-line channels, wireless channels are typically low-bandwidth, unreliable, and non-stationary, that is, characteristics of wireless channels change with time. Accordingly, the ultimate objective of the WATM is to realize a telecommunication system with 155Mbps bit rates in the wireless region using high frequency bandwidths such as 5GHz, 17GHz, or 60GHz[6].

The requirements for WATM are to provide users with similar quality of services as wire-line and transparency of insensible difference between wire-line and wireless

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networks.

The wireless ATM specifications can be clearly identified and divided into two distinct parts, namely the Radio Access Layer, dealing with radio link protocols for WATM access, and the Mobile ATM, dealing with higher-layer control/signaling functions needed for generic mobility support[7, 8]. Wireless ATM, on the other hand, aims to support : (a) fast handoffs, (b) higher bandwidth, and (c) mobile QoS.

The Radio Access Protocol Layers consist of a high-speed radio physical(PHY) layer, capable of high speed physical level transmission and reception ; a Medium Access Control(MAC) layer to efficiently share available wireless bandwidth among multiple mobiles along with QoS management ; a Data Link Control(DLC) layer to overcome radio channel impairments ; and a wireless control layer for radio resource management. Mobile ATM is used to denote the set of enhancements needed to support terminal mobility within a fixed ATM network. Mobile ATM, therefore, is responsible for the necessary functions to support mobility of terminals in the WATM. In order to support terminal mobility new techniques such as location management, handoff control and consequent routing of connections, traffic and QoS control, and wireless network management, should be considered.

handoff is a basic mobile network capability for dynamic support of terminal migration in both end-to-end WATM and PCS/cellular interconnection applications[9]. Since wireless ATM mainly serves data applications unlike existing cellular networks, cell transmission delay and cell loss must be minimized during the handoff process. However, transmission delay should be minimized within a tolerable QoS in real-time(rt) Variable Bit Rate(VBR) service.

Real-time video service is expected to be major area of the multimedia services in the near future. Real-time video service is more sensitive to cell delay than it is to cell loss. Thus, previous handoff schemes, which are concentrated on cell loss, have limitations to satisfy QOS in cell transmission aspect. In this paper, a handoff scheme suitable for real-time video service is proposed and its results are proved through simulation.

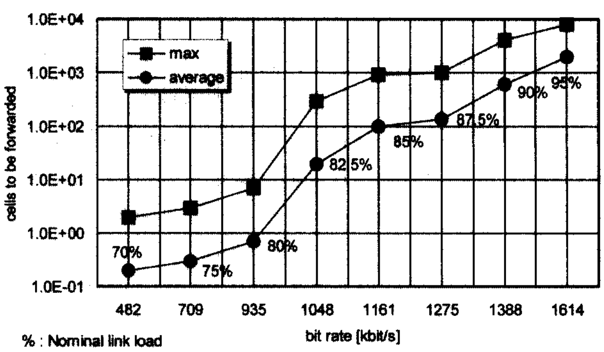
This paper is organized as follows. In section 2, the related studies are presented, and in section 3, the proposed scheme is described. And in section 4, existing schemes and the proposed one are compared and analyzed through simulation. Finally, we close with concluding remarks in section 5.

2. Related Studies

2.1 Microcellular handoff scheme supporting ETSI radio interface

Microcellular handoff scheme suggested by Nokia is forward/backward handoff algorithm without loss using inband signaling cells during hanoff at wireless cellular environment. The micro-cellular handoff scheme supporting wireless interfaces prevents cell loss and cell overlap and maintains the sequence of cells. The scheme guarantees cell loss and maintains the sequence of cells by buffering all the cells in down-link and up-link at base station and terminal during the handoff until the handoff process is terminated. If handoff occurs without receiving all the cells in the OldBS buffer at terminal, in order to prevent cell loss the remaining cells in the OldBS should be forwarded to NewBS. In order to prevent cell loss buffering is required at MT during handoff process and cell sequence is maintained using inband signaling cells. On the other hand, cell loss is prevented by buffering cells at COS, NewBS and OldBS, or OldBS to NewBS in inband signaling cells[10-12].

As shown in (Figure 1), as the transmission rate and link load increase cells to be forwarded abruptly increase[13]. That is, if the link is overloaded and cell transmission rate is heavy delay problem occurs. Thus, the scheme is suitable for Unspecified Bit Rate(UBR), which does not require real-time service and Available Bit Rate(ABR), but is not appropriate for the real-time service such as CBR or rt-VBR.



(Figure 1) Cells to be forwarded against Bit Rate

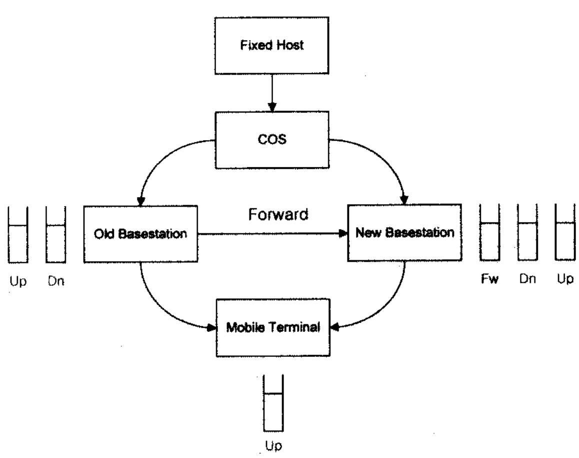
2.2 Traffic Characteristics of MPEG Video Data

Since the amount of video data is tremendous as compared to audio data, transmitting raw data over the network is inadequate[14]. Therefore, video data should be compressed for the efficiency of storage, transmission, and maintenance of the constant quality during the playback. The compressed VBR MPEG video data shows differences in bit rates between Intra-coded (I) frames with the spatial coding, and Predictive (P) frames and Bi-directional (B) frames with the predictive coding.

While I frames use intra frame, P and B frames use inter frame generating relatively less frames. Especially, B frames have less data because they are compressed using I or P frames. Thus, loss of one or two frames during transmission of video data with 25 frames per second does not make any differences in satisfying QoS. In this paper, a scheme to minimize transmission delay by reducing cells to be transmitted using Cell Loss Priority(CLP) bit in the cell header of ATM cells carrying information on B frames, is presented.

3. Proposed Scheme

In this paper, a scheme using CLP bit of an ATM cell header applied to the micro-cellular handoff scheme supporting European Telecommunications Standard Institute (ETSI) radio interface is proposed. Since cells with high CLP (when CLP = 1) are less meaningful than cells with low CLP(when CLP = 0) the cells with low CLP should be forwarded from OldBS to NewBS making it suitable for rt VBR service as in (Figure 2).



(Figure 2) Proposed handoff scheme

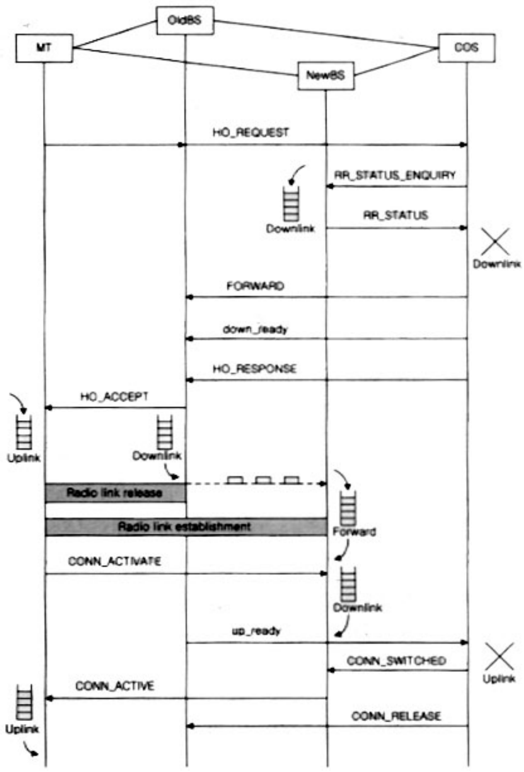
The signaling messages used in the proposed handoff scheme are presented in <Table 1>.

〈Table 1〉 Signaling message for handoff

Source/ Destination	Message	Parameters	Note
MT to OldBS	HO_REQUEST	MT_{ID}, OldBS List_of_APs	
MT to NewBS	CONN_ACTIVATE	MT_{ID}, Conn_id, MAC_{INFO}, DR_flag	per-VC message
COS to MT	HO_RESPONSE	NewBS, Ack/Nack, Cause, VCack /Nack	
NewBS to COS	RR_STATUS	MT_{ID}, NewBS, Conn_id, VCack/ Nack	
OldBS to MT	HO_ACCEPT	NewBS, Ack/Nack, Cause, VCack /Nack	
NewBS to MT	CONN_ACTIVE	Conn_id	per-VC message
COS to OldBS	FORWARD	MT_{ID}, NewBS, Conn_id	
	RR_DEALLOC	MT_{ID}	
COS to NewBS	RR_STATUS_ENQUIRY	MT_{ID}, OldBS, Conn_id, VC_{INFO}, Traf_desc, QoS	
	CONN_SWITCHED	MT_{ID}, Conn_id	per-VC messgae

HO_REQUEST messages generated in mobile terminal (MT) are transmitted to Cross Over Switch (COS) through OldBS and then COS assigns channels to NewBS by sending RR_STATUS_ENQUIRY message. If the connection setup to an access point is completed the switch announces the result of handoff request to MT with HO_RESPONSE message. At the same time, the COS switches down-link of MT from OldBS to NewBS and transmits End Of down (EO_down) cell to notify OldBS that there are no more down-link cells and then the cells transmitted thereafter are buffered. Also, if handoff occurs when MT did not receive all the cells of the OldBS buffer by transmitting FORWARD message to OldBS at the switch, all the remaining cells in the OldBS buffer should be transmitted to NewBS. At this time, only cells with CLP = 0 are forwarded. In order to maintain the sequence of cells the cells sent from OldBSto NewBS by FORWARD message are transmitted to MT prior to the cells in NewBS buffer.

Meanwhile sensing the completion of transmission of all the cells in the buffer by an EO_down cell OldBS transmits the last cell with no_more_traffic flag and disconnects wireless link between MT and OldBS. And the OldBS notifies up-link that it is the last cell in OldBS by sending out an End Of up (EO_up) cell right after the last cell. If an EO_up cell transmitted from OldBS arrives at the switch the COS switches up-link of MT from OldBS to NewBS and NewBS transmits CONN_SWITCHED message. After receiving CONN_SWITCHED message NewBS notifies MT that it is ready for transmission of data cells to up-link by sending CONN_ACTIVE message to MT and the switch completes the whole process by disconnecting link with OldBS.



(Figure 3) Signaling message flow of handoff process

4. Simulation and Results

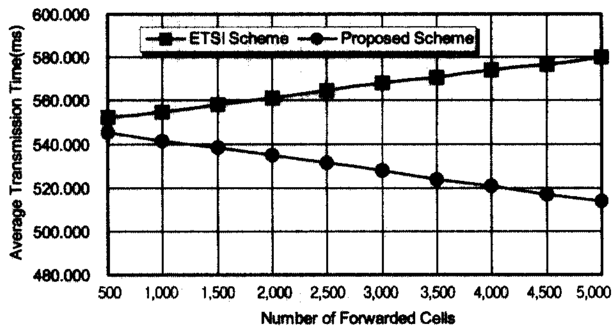
The proposed scheme is compared to well-known *micro-cellular handoff scheme supporting ETSI radio interface*. First, average transmission time and forwarded cells are compared. Next, buffered cells and forwarded cells at terminal are compared. Last, cell loss rate against the sizes of buffer when forwarding cells are 2,000 are provided.

For simulation, one of the MPEG-1 VBR trace bit data, *Bonds*[15] with the playback rate of 25 frames per second, are used and the exponential distribution with an average transmission rate of 250ms for both from COS to OldBS and from COS to NewBS, is assumed. And CLP of I and P frames is set to low and CLP of B frames is set to high.

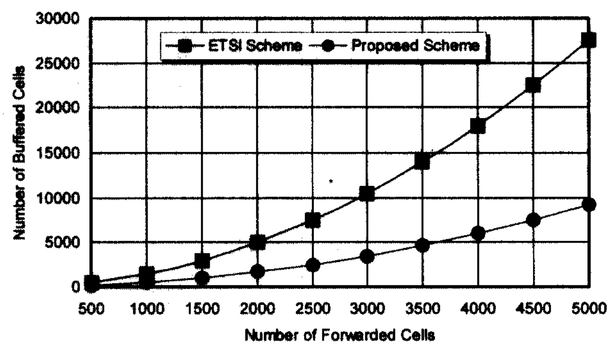
Transmission delay for NewBS to OldBS at COS is assumed to be 50ms~100ms, transmission delay in forwarding from NewBS to OldBS 100ms~150ms, and from NewBS to OldBS 50ms~100ms.

In (Figure 4), average transmission time and forwarded cells are compared. In ETSI scheme, all the cells to be forwarded, which are generated during handoff, are transmitted since all the cells are transmitted. In the proposed scheme, excellence in average transmission delay is demonstrated because transmitting cells with low CLP among forwarding cells results in short handoff time.

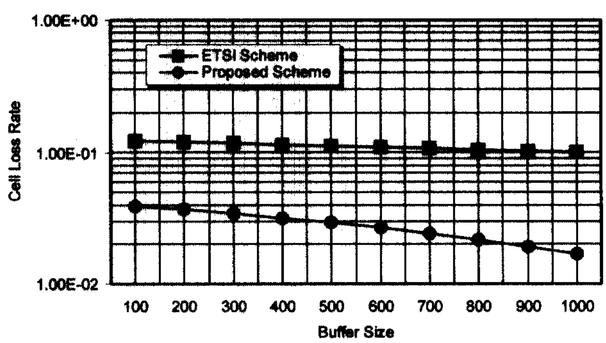
In (Figure 5), buffered cells of up-link channel at mobile terminal until the completion of assignments to NewBS vs. forwarding cells are compared. The proposed scheme shows less buffered cells because of shortness of handoff time as compared to that of ETSI.



(Figure 4) Average transmission time (ms) against Forwarded cells



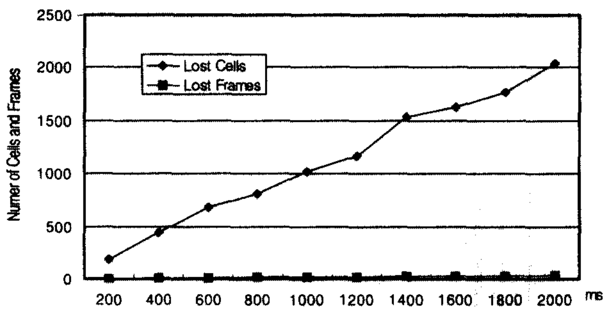
(Figure 5) Buffered cells against Forwarded cells



(Figure 6) Cell Loss Rate against Buffer sizes

In (Figure 6), cell loss rate vs. buffer size at MT are compared. With small buffers the proposed scheme shows excellence in cell loss since there are less cells to be buffered.

(Figure 7) shows WATM cell loss and MPEG video data frame loss during handoff process. Even though cell loss occurs, cell loss of MPEG video frames is negligible since it is transmitted at 25 frames/sec.



(Figure 7) WATM Cell Loss and MPEG Video Frame Loss

5. Conclusion

Real-time video service is expected to play an important role among multimedia services in the near future. Real-time video data service is more sensitive to cell delay than to cell loss. Since existing handoff schemes are concentrated on prevention of cell loss only it is limited to satisfy users with high quality of service in transmission delay aspect. In this paper, a scheme transmitting ATM cells with low CLP(when CLP = 0) in the cell header by discarding cells with high CLP(when CLP = 1), is proposed. As a result with reduction of cell transmission delay the proposed scheme is suitable for real-time VBR service, which is proven through simulation with MPEG-1 bit trace data with 25 frames per second. Also, the proposed scheme is appropriate for fast handoff, which is the requirement of handoff, and also QoS is satisfied by giving high CLP to less meaningful cells through simulation. As shown in the result of simulation, the proposed scheme minimizes cell transmission delay by reducing average transmission delay as a result of short handoff time as compared to micro-cellular handoff scheme supporting ETSI radio interface. Moreover, cell loss is reduced even with small size buffers at terminal by decreasing buffered cells due to the reduction of handoff time. More real-time multimedia services are expected to appear in the near future. Thus, the proposed scheme is expected to be a suitable one for the real-time multimedia service because it can reduce cell transmission delay and requires small buffer size.

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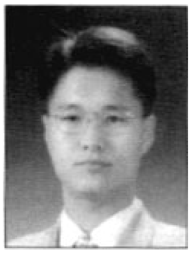

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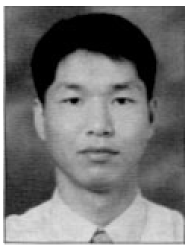

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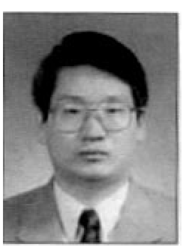

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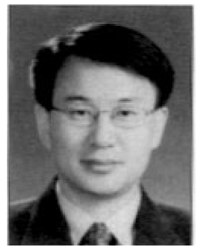

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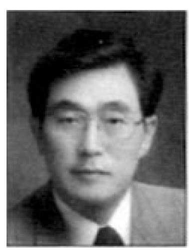

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