**MPGE-4 codec based uplink resource allocation scheme for the video telephony service in IEEE 802.16e/m system**

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Abstract—This paper proposes the uplink resource allocation scheme based on MPEG-4 codec for the video telephony service in IEEE 802.16e systems. The main feature of the proposed scheme is that the base station (BS) exploits a pattern of variable-size frames which is the character of MPEG-4 codec to allocate uplink resources to the mobile station (MS). The simulation result shows the proposed scheme reduces that video telephony service delay and it also increases the efficiency of the radio resource utilization compare to conventional uplink scheduler schemes in IEEE 802.16e/m system.

I. INTRODUCTION

Recently, the demand of the video telephony service has increased with 3G wireless communication systems. And IEEE 802.16e/m system is taken notice of one of the next generation wireless communication system. Therefore IEEE 802.16e/m system should support the seamless video telephony service and it should have better video and audio qualities than WCDMA system. For the better quality of the video telephony service, IEEE 802.16m and 3GPP select MPEG-4 codec as a video telephony codec[1],[2]. MPEG-4 codec generates variable-size frames with a fixed pattern. Therefore the video telephony service has a delay sensitive feature as a VoIP service and it also has variable-size packet with a specific pattern like a video streaming service. However conventional uplink schedulers in IEEE 802.16e are not sufficient to support the video telephony service. As a result, the service delay can increase or the efficiency of the radio resource utilization can be degraded.

MPEG-4 codec is a main factor of the traffic generation of the video telephony service. MPEG-4 codec has two main features. First, it has three kinds of variable-size frames such as Intra coded frame (I frame), Predictive coded frame (P frame), Bidirectionally predictive coded frame(B frame) in order of size. Second, it has a fixed pattern of the frame sequence called Group of Pictures (GOP)[3]. Thus video telephony traffics are generated according to the GOP sequence with fixed frame interval.

IEEE 802.16e standard defines three uplink schedulers to support the delay sensitive service such as Unsolicited Grant Service (UGS), Extended real-time Polling Service (ertPS) and real-time Polling Service (rtPS) [4]. In UGS, the BS periodically provides the MS with a constant size uplink resource based on Maximum Sustained Traffic Rate. Thus it reduces the signaling overhead and transmission latency. However it can waste a lot of radio resource when it supports the video telephony service. The BS allocates fixed size resources based on I frame to the MS at every frame interval. Therefore remained resources are wasted when B frame or P frame is transmitted. ertPS complements UGS, it can reduce wastes of resource. But an amount of the granted resource changes based on the previous frame. So rtPS can lead the additional delay and the wasting of resource when it supports the video telephony service. In rtPS, MS periodically receives a chance to request uplink resources and the BS grants only the requested resource to the MS. Thus it prevents the waste of radio resources. However the signaling overhead increases and it takes additional delay to execute polling process.

II. PROPOSED UPLINK RESOURCE ALLOCATION SCHEME

The Proposed uplink resource allocation scheme consists of two progresses. First, A BS obtains the codec information from A MS. Second, the BS periodically allocates variable-size resources to the MS according to the traffic generation information of the codec.

This paper defines the GOP field and I, P and B frame size field in reserved fields of DSA-REQ message which delivers the session information in IEEE 802.16e system. When the video telephony service starts, the MS transmits DSA-REQ message to the BS for making the connection and it offers the BS the codec information simultaneously.

The BS makes the connection by transmitting DSA-RSP message to the MS in response to DSA-REQ message. And the BS periodically allocates variable-size uplink resources to the MS. The Period of resource allocation is referred from Unsolicited Grant Interval field in DSA-REQ like UGS. The amount of the allocated resource is determined by the GOP sequence and minimum I, P and B frame size. For example, if the GOP is “IBP”, the BS assigns the MS I frame size of the resource. After inter-frame time the BS assign the MS B frame size of the resource without any signaling messages. And after another inter-frame time the BS assigns the MS P frame size of the resource. Thus, the BS recognizes the order of the frame through GOP and it assigns the MS appropriate resource of the frame type. If the assigned resource is less than the frame size

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to transmit, the MS can request additional resources by adding extended piggyback request field in Grand Management subheader like conventional uplink schedulers. When the MS transmits Grand Management subheader, the present GOP sequence is also delivered within it to prevent the asynchronization of the order of the resource allocation at the BS and the order of the frame generation at the MS. The BS adjusts the next resource size by comparing with the recent amount of the allocated resource and the obtained GOP sequence from Grand Management subheader.

III. PERFORMANCE EVALUATION

TABLE I. describes simulation parameters referred from IEEE 802.16e/m system[1],[4]. This paper measures effective radio resource utilization ratio and an average packet delay to evaluating the proposed scheme. The effective radio resource utilization ratio is defined as the ratio of an amount of allocated resources and an amount of transmitted packet size. And an average packet delay is packet deliver time from the MS to the BS at IP layer.

Figure 1. shows the effective radio resource utilization ratio and the packet delay simultaneously. The left vertical axis means the radio resource utilization ratio. For UGS, the effective radio resource utilization ratio is 58%. Because the BS grants constant-size resource based on Maximum Sustained Traffic Rate to the MS, then a lot of resource is wasted, when B frames and P frames are transmitted. For erTPS, the BS changes an amount of the granted resource based on the previous resource changing request from the MS. However erTPS does not reflect the feature of MPEG-4 codec which is the frame size changes dramatically in every frame. Thus the effective radio resource utilization ratio is 89%. On the other hand, for rtPS, the effective radio resource utilization ratio is 99%. Because the MS requests an amount of the frame size and the BS assigns the appropriate resource in every frame. The proposed scheme also has 99% of the effective radio resource utilization ratio. The BS grants the MS the minimum frame size in order of GOP sequence and insufficient resources are assigned additionally by the request of the MS.

Light shaded bars according to the right vertical axis of Figure 1. show the packet delay. UGS grants sufficient resource in every frame, thus the scheduling delay can be minimized. It has only the fragmented transmission delay for the big size frame. In consequence, UGS shows the shortest packet delay as 10.78msec. erTPS has longer packet delay as 14.34msec, because it needs time to transmit resource request message alone when the resource is insufficient. For rtPS, Polling and resource request process is required in every frame transmitting. Thus, it need more than 2 frames compare to other schedulers. As a result, it shows the longest packet delay as 18.26msec. The proposed scheme grants resources periodically without polling process like UGS, but the number of the fragmented frame transmission is larger than UGS. Because the proposed scheme grants the minimum frame size according to GOP. Thus UGS has a fragmented frame transmission only in I frame transmission period. On the other hand, the proposed scheme can have fragmented frame transmissions in every transmission.

TABLE I. SIMULATION PARAMETERS

<table>
<thead>
<tr>
<th>Codec parameters</th>
<th>MPEG-4</th>
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<tbody>
<tr>
<td>I frame size</td>
<td>lognormal ($\mu=4742$ byte, $\sigma=178$ byte), Max=5184 byte, Min=4034 byte</td>
</tr>
<tr>
<td>P frame size</td>
<td>lognormal ($\mu=259$ byte, $\sigma=134$ byte), Max=1683 byte, Min=100 byte</td>
</tr>
<tr>
<td>B frame size</td>
<td>B frame size: lognormal ($\mu=147$ byte, $\sigma=74$ byte), Max=882 byte, Min=35 byte</td>
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<tr>
<th>System Parameters</th>
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<tr>
<td>GOP</td>
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<td>UGS</td>
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Figure 1. Radio resource utilization and packet delay

IV. CONCLUSION

This paper proposed the uplink resource allocation scheme based on MPEG-4 codec in IEEE 802.16e/m system. The proposed scheme utilizes the periodicity of variable-size frames of MPEG-4 codec to allocate uplink resources. The simulation results show that the proposed scheme outperforms conventional schedulers. It has higher effective radio resource utilization ratio up to 41% compared to conventional schedulers, and it also reduces packet delay by 6msec compared to the scheduler which has same effective radio resource utilization ratio. Therefore the proposed scheme can help to guarantee QoS of the video telephony service in IEEE 802.16e/m system.

REFERENCES