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ADAPTIVE GROUP BASED INTRABLOCK REFRESH TECHNIQUE FOR MBMS SYSTEMS

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Abstract

Mobile phone besides being communication device is being transformed to another role as an entertainment device. Mobile devices enable the user to access entertainment such as TV anywhere and not limit it to just homes. It is expected that the traditional broadcast multimedia content is multicast instead of unicast to the mobile users to conserve bandwidth. 3GPP is currently working on a standard for Multimedia Broadcast and Multicast Services (MBMS). This paper presents an intra-refresh based error resilience technique for video delivery over MBMS. We propose an adaptive Intra block refresh rate technique based on the loss statistics from the multicast group and dynamically partitioning multicast groups. The proposed technique improves average PSNR of the received video for all the multicast groups.

INTRODUCTION

Multimedia broadcast services on mobile devices are getting popular starting from broadcasting small clips of video to receiving television channels. The advent of 3G or 4G networks that provide very high bandwidths would revolutionize the cellular devices into entertainment providers. However, due to mobility, the mobile handsets experience wide variety of network conditions such as fading, diversity of signal strength condition, interference etc. The transmission of video over such time varying wireless channels is very challenging especially with real-time requirements in a session shared by multiple users. With members of the multicast/ broadcast sessions experiencing diversity of network conditions, maintaining video quality is a challenging problem and requires significant research in this area.

MBMS OVERVIEW

3GPP is currently working on a standard for MBMS [3]. Streaming of live or stored video content to group of mobile devices comes under the scope of MBMS. Some of the typical applications are subscription to Football games, music videos, news clips, weather information and live TV content. Figure 1 shows an example of a multicast broadcast network. This shows the required components and functionalities for broadcasting such as QoS handling and where they are implemented within the core network. This architecture enables services offered on the internet or offered by the operator to be broadcast to the terminals. MBMS specifies transmission of data packets from single entity to multiple recipients using a common broadcast channel. This is much more efficient than IP multicast where packets are duplicated for each recipient in a broadcast/multicast group.

There has been significant amount of research on error resilient video [2]. The existing work on error resilient video multicasting focuses on traditional IP multicasting [3]-[4]. MBMS differs from the traditional IP multicast due to the wireless access and the existing work on error resilience in wire-line IP multicasting is not fully applicable Error resilient video multicasting reported in the literature has primarily focused on network level techniques such as FEC, ARQ and combinations of both. However, for multicasting, ARQ is not recommended due to Ack explosion. The FEC adds coding overhead that requires extra bandwidth on precious spectrum. The source (video) level error resilience techniques are not applied in multicasting.

PROPOSED SCHEME AND RESULTS

Hybrid video coding techniques for efficiency purposes incorporate heavy dependencies. Due to this, any error is propagated until an error-free I frame is decoded. I frame frequency determines the synchronization time. However, using too frequent I frames result in lower compression efficiency.

One tool that is effective against error propagation is Intra block refresh (IBR) technique [5]. The IBR technique works well for multicasting as the gain of worse link users is dramatic whereas the incurred penalty to good link users is small. Such property is essential in multicasting where users of diverse conditions are part the same group. Periodically, depending on the algorithm, certain percentage of P or B frames blocks are intra coded.

In MBMS and multicasting scenarios, using RTCP feedback reports, the average signal strength conditions of the group members can be determined. Based on that, the percentage of intra blocks can be determined. If the receivers are experiencing high error rates, the intra block percentage is increased and vice versa. This technique is effective for a smaller group of members such as the case of a wireless cell served by a base station. A proxy could be integrated with the base station that handles the multicasting and has the capability to vary the intra block percentage through decoding and re-encoding video stream coming from the sender. The RTCP feedback based

0-7803-9459-3/06/$20.00

error resilient coding techniques have been studied in the past. Our work considers the partitioning of multicast users into groups that maximize video quality of the entire group.

An MBMS delivery environment was simulated with a given packet loss rate. The burst errors caused by fading are treated as packet losses. Since Packet data network is used for transport of video over wireless networks, any errors after error correction result in packet loss. Since broadcasting involves several independent links that are uncorrelated, the losses in receivers from the Base station perspective can be assumed to be random. The Foreman sequence was encoded using MPEG-4 SP, QCIF, with a bitrate of 128 kbps and 15fps. The I frame is repeated every 5 seconds and this value determines the synchronization time for joining members. The sample size is 100 mobiles with baseline fixed IBR. The range of loss percentage was chosen from 1 to 24 % since losses over 25% are very rare wherein the session is usually dropped.

The results are evaluated by dropping packets and decoding the remaining packets, and recording the PSNR values at each mobile. The average PSNR for the group is used as the metric. We found that if the loss rates are heterogeneous, varying the IBR has little impact on the overall PSNR.

In the second baseline, the users were sorting into groups where each group has a packet drop rate in the ranges of 0-8%, 9-16% and 17-24%. This would mean having three multicast groups instead of one multicast group within a cell and requires more bandwidth. The alternative is to use the same bandwidth for one multicast group to send more repair packets resulting in improved quality. However, this is unfair to mobiles that experience good signal strength conditions in two aspects: 1) extra power required in decoding repair packets that are not necessary and 2) extra cost in packet based billing systems. Partitioning the users according to their loss characteristics also allows better user management and improves the QoS by using an IBR rate appropriate for the group.

Table 1 shows the results of the experiments with varying group size and loss rate. IBR percentage is increased by 5 and the three sets of experiments are conducted. From the table, based on group average loss rate, the IBR rate based on the knowledge of packet loss conditions can make significant impact on the average PSNR. The PSNR reaches a peak for a particular IBR rate and this varies depending on the loss rate. The average PSNR can be improved by determining the "peak" IBR rate for group of homogenous loss rates. The theoretical or heuristic framework to determine the IBR percentage for peak PSNR is focus of our future work.

IBR Percentage	**0-7%Loss**	**8-15% Loss**	**16-24% Loss**
0%	25.71	20.77	18.82
3%	***26.72***	23.13	20.85
10%	26.00	***23.54***	21.3
15%	25.63	23.25	***21.46***
25%	25.34	23.14	21.42

Table 1 Performance of IBR rate for various loss rates

CONCLUSIONS

We presented the problem of video delivery using MBMS. The existing approaches to error resilient multicasting are in adequate. We proposed a method based on users' loss characterization and multicast group partitioning. We showed that IBR technique performs better when partitioning the users into different multicast groups. While this technique has higher bandwidth requirements, the fairness of the approach outweighs the bandwidth costs.

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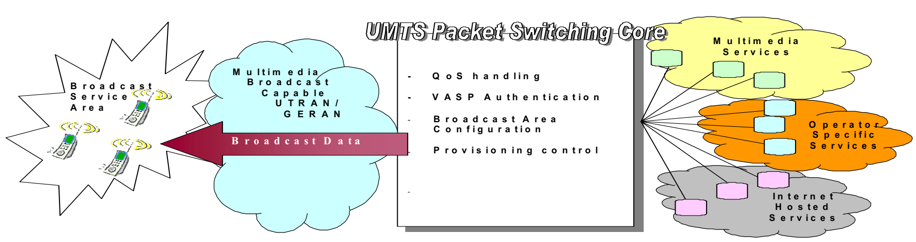

Figure 1 Example of Multicast Broadcast Node Network