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MPEG-2 VIDEO TRANSMISSION USING THE HIPERLAN/2 WLAN STANDARD

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ABSTRACT

At present, Wireless Local Area Networks (WLANs) supporting broadband multimedia communication are being developed and standardised. These will provide data rates up to 54 Mbps in the 5GHz band. Highly compressed data such as video are extremely sensitive to the errors that are commonly encountered in wireless channels. This paper addresses the problems of transmitting MPEG-2 video over WLANs, and in particular HIPERLAN/2, and describes error resilient video transcoding as a means of handling channel errors.

INTRODUCTION

Recently, there has been an increasing interest in multimedia communications such as the transmission of video, images, and data over wireless networks. HIPERLAN/2 [1] is a wireless LAN standard that will provide data rates up to 54 Mbps. Highly compressed data are extremely sensitive to bit or burst errors that are commonly encountered in wireless channels. ARQ protocols, as recommended in HIPERLAN/2, may be unsuitable for real time video due to latency constraints. HIPERLAN/2 also supports an unacknowledged (unreliable, low latency transmission) and a repetition mode that will be employed in broadcast and multicast scenarios. Unicast data can be sent using either acknowledged or unacknowledged mode. In order to handle channel errors, one alternative to ARQ protocols is the use of error resilient video coding techniques [2].

This paper investigates the transmission of MPEG-2 video over HIPERLAN/2 and proposes video transcoding as a means of handling channel errors. The strategy employed in the video transcoder is to partition the MPEG-2 video stream into low and high priority packetized bit streams. Error resilience is achieved by employing EREC (Error Resilient Entropy Coding) [3] in the low priority data while the high priority bit stream is adequately protected by means of ARQ.

HIPERLAN/2 WLAN STANDARD

HIPERLAN/2 will support multiple transmission 'modes', providing data rates up to 54 Mbps. The physical layer (Figure1) of the standard is based on the use of Orthogonal Frequency Division Multiplexing (OFDM). The physical layer modes (Table1)with different coding and modulation schemes are selected by a link adaptation scheme. The physical layer of IEEE 802.11a is very similar [4].

Table 1: PHY Layer Modes

Mode	Modulation	Coding Rate R	Bit rate (Mbit/s)
1	BPSK	1/2	6
2	BPSK	3/4	9
3	QPSK	1/2	12
4	QPSK	3/4	18
5	16QAM	9/16	27
6	16QAM	3/4	36
7	64QAM	3/4	54

The channel model used to perform the simulations, is channel model A specified by ETSI [5]. The channel is wideband multipath, Rayleigh, with an rms delay spread of 50ns.

MPEG-2 BASICS

The MPEG-2 video coding standard [6] is being extensively used for the provision of video services worldwide. It is designed to provide distribution of quality television (normally using Main Level, Main Profile) at a bit rate between 4 and 9 Mbit/s depending on scene content. The MPEG standard relies on two basic techniques: an intraframe discrete cosine transform (DCT) for the reduction of the spatial redundancy, and interframe motion compensation for the reduction of temporal redundancy.

VIDEO TRANSCODING

In our scheme the data is partitioned into low and high priority bit streams so that most of the headers, motion vectors and low frequency image information is given a high priority while the remaining high frequency information is placed in the low priority partition. The high priority bit stream is adequately protected by means of ARQ protocols while the low priority bit stream does not employ ARQ in order to avoid network congestion and jitter. Error resilience is also achieved by applying EREC [3,7] to the low priority data. One of the most serious forms of error propagation within an image codec is caused by the loss of block synchronisation (horizontal strips in Figure 3a). The EREC process rearranges the variable length blocks of data, so that these can be packed into a set of fixed-length slots.

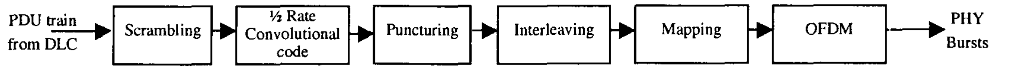

Figure 1: HIPERLAN/2 Transmitter

RESULTS

A fully compliant HIPERLAN/2 modem has been developed [4]. Figure 2 presents the BER performance of HIPERLAN/2 for channel model A.

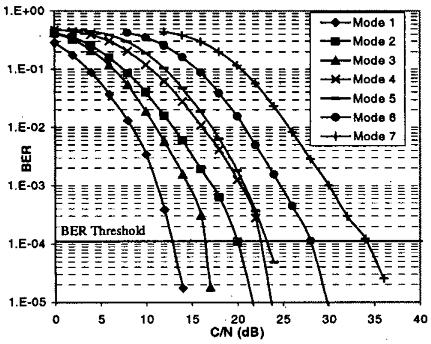

Figure 2: BER Performance of HIPERLAN/2

MPEG-2 data is read from a standard main level main profile (ML@MP) video file containing 4.0Mbit/sec data. The MPEG-2 video test sequence with and without transcoding is processed through the modem model.

Figure 3 shows example frames at a bit error rate of 10^{-4} (mode 5 in channel A). The standard MPEG-2 system is seen to suffer from a large amount of error propagation both spatially and temporally. It can be seen that the system with data partitioning and EREC gives much better subjective quality. Figure 4 shows the measured PSNR values against BER in channel A. Note that the PSNR in this case measures distortion due to channel errors and not due to compression (i.e. the received video frames are compared with the MPEG-2 frames before transmission).

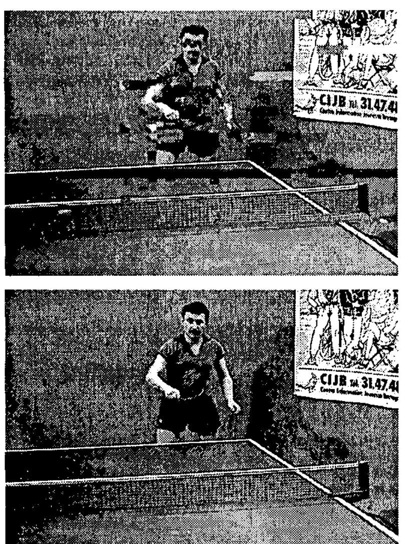

Figure 3: Example frames (BER=10^{-4}), frame number 115. a) MPEG-2, b) data partitioning with EREC.

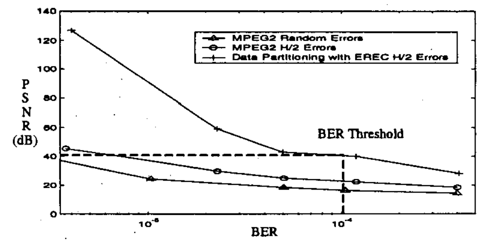

Figure 4: PSNR Performance over BER

In [8] it was shown that for perfect link adaptation with ARQ (the mode with the highest throughput is chosen for each instantaneous C/N value), packet delay can vary between 5-700 ms depending on the C/N value (in case of a poor radio link, transmission delay increases), and the number of MTs. If ARQ is not used for the low priority data, link adaptation can choose the mode with the highest rate for a required BER for each instantaneous C/N value. Hence by putting a threshold (for example BER=10^{-4}) for the low priority data the required video quality can be chosen (ex. PSNR>40dB, Fig. 3, 4). For the high priority data, a PER threshold can be set in order to make sure that the packets will be delivered within an appropriate delay.

CONCLUSIONS

Compressed video has multiple QoS requirements in terms of delay, delay variation and error rate. In this paper video transcoding was proposed as a means of handling channel errors, and reducing the delay caused by ARQ protocols. In our system only the high priority bit stream is protected by means of ARQ protocols while the low priority bit stream does not employ ARQ in order to avoid network congestion and jitter. Error resilience is also achieved by applying EREC to the low priority data in order to avoid the loss of block synchronisation (Figure 3). Figures 3,4 showed that the system with data partitioning and EREC gives much better quality than a standard MPEG-2 system. A HIPERLAN/2 system with link adaptation can choose the mode with the highest rate for a required BER for each instantaneous C/N value.

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