Knowledge-Enhanced Mobile Video Broadcasting (KMV-Cast) Framework with Cloud Support

Xin-Lin Huang, *Senior Member, IEEE*, Jun Wu, *Senior Member, IEEE*, and Fei Hu, *Member, IEEE*

***Abstract*—The convergence of mobile communications and cloud computing facilitates the cross-layer network design and content-assisted communication. Mobile video broadcasting can benefit from this trend by utilizing joint source-channel coding and strong information correlation in clouds. In this paper, a knowledge-enhanced mobile video broadcasting (KMV-Cast) is proposed. The KMV-Cast is built on a linear video transmission instead of traditional digital video system, and exploits the hierarchical Bayesian model to integrate the correlated information into the video reconstruction at the receiver. The correlated information is distilled to obtain its intrinsic features, and the Bayesian estimation algorithm is used to maximize the video quality. The KMV-Cast system consists of both likelihood broadcasting and prior knowledge broadcasting. The simulation results show that the proposed KMV-Cast scheme outperforms the typical linear video transmission scheme called Softcast, and achieves 8dB more of the peak signal-to-noise ratio (PSNR) gain at low-SNR channels (i.e., -10dB), and 5dB more of PSNR gain at high-SNR channels (i.e., 25dB). Compared to traditional digital video system, the proposed scheme has 7dB more of PSNR gain than JPEG2000+802.11a scheme at 10dB channel SNR.**

***Index Terms*—Cloud Computing, Wireless Video Transmission, Quality of Service (QoS), Correlated information, Hierarchical Bayesian Model.**

I. Introduction

According to the prediction of Cisco VNI Mobile Forecast 2015, the amount of mobile video services will increase 13-fold between Year 2014 and 2019, accounting for 72 percent of total network traffic by the end of 2019 [1]. Meanwhile, the 4G/5G communications are expected to bring linear increase of network capacity [2]. Despite the desperate efforts of the network operators in terms of enhancing the wireless link bandwidth, the soaring video traffic demands from mobile users are rapidly overwhelming the wireless link capacity. One interesting thing is, if we take a close look at the traffic flows generated by the cloud video services, we can see that they often show certain content correlation due to the image similarities.

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Xin-Lin Huang (email: xlhuang@tongji.edu.cn) is with the Department of Information and Communication Engineering, Tongji University, Shanghai 201804, China.

Jun Wu (email: wujun@tongji.edu.cn) is with the Department of Computer Science and Technology, Tongji University, Shanghai 201804, China.

Fei Hu (email: fei@eng.ua.edu) is with the Department of Electrical and Computer Engineering, the University of Alabama, Tuscaloosa, AL 35487, USA.

With the surge of cloud computing, a large amount of data is stored in data centers. According to the study of Pyramid Research, the total number of personal cloud accounts worldwide is anticipated to go beyond 3 billion by 2018 [3]. Cloud computing has many advantages by offering servers, networks, and storage services at low cost [4]. As the cloud servers store more and more multimedia data, there is a high chance of finding similar images/videos in the cloud due to the duplicated contents.

Mobile network is being merged with cloud computing [5–7]. Its advanced network architecture enables mobile users to make full use of information in clouds [8–12]. Theoretically, assume that we want to deliver a information source with the entropy $\mathcal{H}_1$, and the receiver already knows partial information $\mathcal{H}_2$, then only information $\mathcal{H}_1 - \mathcal{H}_2$ is needed to be transmitted. Instead of using some complex physical layer techniques, such as massive multiple-input multiple-output (MIMO) or non-orthogonal multiple access, we attempt to extract the correlated information from the big data in clouds, and make full use of such information to improve the quality of service (QoS) of mobile video transmissions.

Particularly we propose a brand-new video transmission framework, which consists of two functions: (1) correlated information extraction, and (2) utilization of such information for fast video recovery at the receiver. We first search the correlated information from the cloud based on certain criteria [13]. Then we make full use of the correlated information for video data reconstruction at the receiver.

A conventional scheme, called Softcast [14], is a joint source-channel coding scheme. It avoids quantization, entropy encoding and channel encoding. The initial motivation of Softcast is to overcome the cliff effect of wireless video transmission. But it does not take the correlation information into consideration. In our previous work [13], the correlated information assisted video transmission called DaC-RAN, was proposed in pseudo analog wireless video transmission. It can make full use of correlated information to improve the reconstructed image/video quality. However, the peak signal-to-noise ratio (PSNR) of the reconstructed images can not be improved linearly with the increase of channel signal-to-noise ratio (SNR), due to the mutual interference in the reconstructed images.

Inspired by the mutual interference cancellation in [13], we propose a QoS-enhanced KMV-cast framework. With the help of the correlated information in the cloud, the received video/image can be reconstructed with high quality.

In a nut shell, the contributions of this paper include the following three aspects: