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Quality Driven Modulation Rate Optimization for Energy Efficient Wireless Video Relays

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***Abstract*—Modern mobile computing devices such as smart phones have become the major user-centric video data sources in future 5G wireless networks. However, battery energy efficiency becomes the critical bottleneck for such uplink multimedia contributors. In this paper we propose a new approach to reduce energy consumption while improving Quality of Experience (QoE), by innovatively investigating video encoding frame prioritization, mode, dependency, and rate control overheads, based on communication model of a transmitter device to an access-point via a relay device. In the proposed approach, we investigate various frame level encoding dependencies and different communication data rates to study their impacts on energy efficiency and QoE. We also incorporate some simple game theory concepts to determine the best compromise of energy-quality tradeoff between the transmitter and the relay. Simulation results demonstrate that cross layer exploration of encoding dependency and game theoretical rate control have significant energy saving and quality gain potentials.**

***Index Terms*—Wireless Video Streaming, Rate and Dependency Control, Energy Efficiency, Game theory**

I. Introduction

With the popularity of online video streaming and social media video sharing, the wireless video delivery will be the driving factor for mobile device energy consumption in the near future [1]. To accommodate such new wireless video communication paradigms, achieving energy efficiency of mobile communication devices becomes a critical issue [2]. This poses that uplink users (i.e. contributors[1]) push video contents to the social media servers by a relay node for other users to download.

The wireless video streaming with energy efficiency consideration scenario is shown in Figure 1. In this figure we can see, the multimedia video services are regarded as uplink[2] video contributors. Those users frequently take video shots and upload them to a base station (BS), eager to share the contents with other users in the community. The data transmission can be helped by mobile relays to enhance the multimedia quality. The major energy consumption for uplink users and relays lies in the video transmission energy, plus computational energy spent on content compression. For both users and relays, the video contents are generically separated into important part (for example, the positions, which does not rely on other information in the decoding process) and unimportant part (e.g. the values, which does rely on other information in decoding process). To facilitate transmission QoE, the important and unimportant video contents are treated differently to save energy.

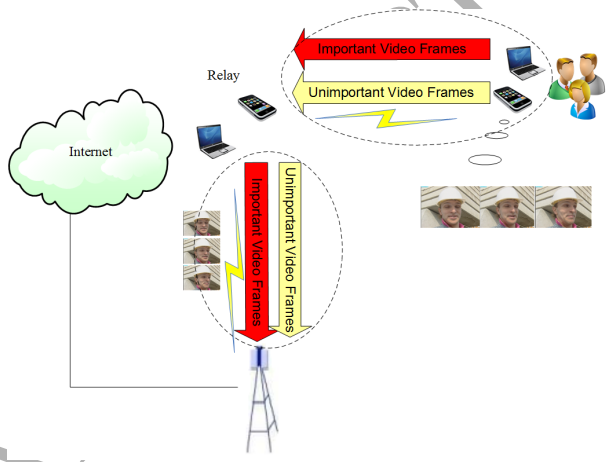

Fig. 1. Video traffic generation of uplink users, with unequal treatment of video contents.

We propose a new game theoretical approach to save energy in wireless video content sharing and study the energy-quality impacts of various encoding dependencies. The contributions are summarized as follows. Firstly, we explore the energy-quality tradeoff to define the utility of game participates, i.e., the video contributor and the relay. Secondly, the proposed approach is a cross-layer fashion scheduling strategy integrating source coding in MPEG-4 or H.264 video compression and communication data modulation rate control in network protocol design. Thirdly, we investigate various levels of video compression dependency and identify frame level dependency control as the practical level of resource allocation granularity in a game theoretic way. The packets that are more inclined to be depended by others are regarded as important packets, and more resources like the modulation rate are allocated to them. Finally, the energy efficiency impacts of various

[1]We use contributor and transmitter alternately in this paper. They both represent user devices in uplink communications. From the point of communication, it is a transmitter; From the point of content, it is the video contributor.

[2]The proposed game model between the user device and the relay device in an uplink channel can be applied to the interactions between the downlink multimedia transmission participates, i.e., the BS and the relay device in an downlink channel.