IMPROVE CHANNEL AVAILABILITY IN VEHICULAR IPTV SYSTEMS BY A HYBRID TRANSMISSION SCHEME

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Abstract: One important factor restricting the capacity of IPTV service over vehicular-to-infrastructure (V2I) networks is the limited radio resource reserved on the road-side-units (RSUs). This paper elaborates a hybrid video transmission scheme to improve the channel availability in vehicular IPTV systems. The advanced scalable video coding (SVC) technique is applied to encode TV channels. SVC layers are transmitted in different modulation and coding schemes (MCSs), so as to provide differentiated robustness and resource utility efficiency. The hybrid transmission scheme intelligently delivers SVC layers to vehicles via either pure V2I or inter-vehicle relay connections. Comprehensive simulation experiments are conducted and show that, compared to the legacy V2I transmission scheme, the proposed hybrid scheme can effectively enhance user quality of experience (QoE) by significantly increasing channel availability, with only slightly deteriorating the transmission delay for the enhancement layers.

Keywords: network modeling, multimedia applications, resource management, QoE, channel availability

1 Introduction

IPTV service in vehicular networks can provide passengers with live TV access on-the-road, and is regarded as one of the most promising multimedia applications in the future intelligent transportation systems. Communications in vehicular networks can typically be classified into V2I and vehicle-to-vehicle (V2V) modes. Firstly, the V2I mode relies on a series of RSUs which are built-up along the roads and can be accessed by vehicles via wireless communications. Secondly, the common manner to establish V2V communications is to build MANET, which in the context of vehicular network is called VANET.

Stemming from the fact that vehicular IPTV is a live video streaming service, which has to be delivered to users in real-time, i.e., with strictly limited transmission delay, service providers prefer to transmit the TV channels in pure V2I mode. However, the radio resources on RSUs are usually quite restricted, and when i.e., increasingly more TV channels are provided, radio resource shortage will pose a tough challenge. The users may consequently suffer from deteriorated channel availability and degraded QoE. Aiming at solving this problem, this paper adopts the advanced SVC technique to encode every IPTV channel in multiple SVC layers (including one base layer and at least one enhancement layer). Since different SVC layers typically possess non-identical weights, RSUs transmit SVC layers in different MCSs, so as to provide differentiated robustness and resource utilization efficiency. The major contribution of this work is attributed to the elaboration of a hybrid IPTV transmission scheme with the purpose of improving the channel availability in a resource restricted vehicular network. The hybrid scheme intelligently delivers SVC layers to different vehicles via either pure V2I or inter-vehicle relay connections (including both V2I and V2V communication modes). Comprehensive simulation experiments are carried out and the results show that, compared to the pure V2I transmission scheme, the proposed hybrid scheme can greatly enhance user QoE by effectively improving channel availability, with only slightly increasing the transmission delay for the enhancement layers.

The remaining part of this paper proceeds as follows. Sect. 2 introduces the related work. Then, the basic vehicular network architecture and the user behaviour model are discussed in Sect. 3. After that, as the paper's major contribution, a hybrid video transmission scheme for vehicular IPTV system is derived in Sect. 4. In Sect. 5, the performance of the hybrid scheme is evaluated by means of simulation. Finally, summary and outlook are given in Sect. 6.

2 Related work

Channel availability is an essential QoE performance metric in IPTV systems, which is closely related to call blocking probability (CBP). Earlier publications have already provided well-known exact or approximate analytical algorithms for the CBP calculation in the context of unicast and multicast scenarios. In addition, simulation based evaluation serves as another option. In Refs. [1-2], J. Lai et al. proposed a link state-vector-based model to simulate IPTV systems in detail. Besides, a TCAC scheme [2], Ref. [3] was also proposed to decrease the CBP and to improve the channel availability in both static and peak-hour scenarios. Those works, however, focused on IPTV in fixed wireline / wireless networks, where users rarely move while watching.

In vehicular networks, video steaming transmitted via

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