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August 2013, 20(Suppl. 1): 91–95
www.sciencedirect.com/science/journal/10058885

The Journal of China Universities of Posts and Telecommunications

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# Virtual community-based video resource sharing solution in MANETs

JIA Shi-jie[1,2], ZHI Xi-hu[2], XU Chang-qiao[1,3,5] (✉), GUAN Jian-feng[1,5], LU Jun-qiang[4], ZHANG Hong-ke[1,5]

1. State Key Laboratory of Networking and Switching Technology, Beijing University of Posts and Telecommunications, Beijing 100876, China
2. Academy of Information Technology, Luoyang Normal University, Luoyang 471000, China
3. Institute of Sensing Technology and Business, Beijing University of Posts and Telecommunications, Wuxi 214135, China
4. Office of academic committee, Beijing University of Posts and Telecommunications, Beijing 100876, China
5. National Engineering Laboratory for Next Generation Internet Interconnection Devices, Beijing Jiaotong University, Beijing 100044, China

**Abstract**

The virtual community has emerged as a state-of-the-art technology, grouping the user with the common interest and providing a feasible solution for large-scale deployment of resource sharing services. Efficient sharing for video resources and low maintenance cost of overlay topology are key factors in MP2P video on demand systems. In this paper, a novel virtual community-based video resource sharing (VCVRS) solution in MANETs is proposed. VCVRS design a virtual community construction strategy to group the nodes with the common playback behavior and a flexible community maintenance mechanism so as to obtain the fast supplier discovery and low maintenance overhead. Simulation results show how VCVRS achieves higher lookup success rate, lower server stress, lower node load and less overlay maintenance overhead, in comparison with another state of the art solution.

**Keywords** virtual community, video, P2P, MANETs

## 1 Introduction

A mobile Ad-hoc network (MANET) typically consists of a collection of geographically distributed mobile nodes that communicate with each other over a wireless medium without any fixed infrastructure [1]. MANETs support numerous applications such as entertainment, disaster relief and military and have attracted great interest of academia and industry. Provision of rich media content to users is increasingly popular in mobile Internet. Mobile peer-to-peer solutions have emerged as state-of-the-art approaches for large-scale deployment of video-on-demand (VoD) system over MANETs [2–3].

In order to reduce the energy consumption and enhance the utilization of resources, 'green' communications have received considerable attention recently [4]. However, the existing P2P-based video resource sharing solutions focus on constructing overlay topology and supporting stream interactivity, so that their capability and efficiency of sharing video content in the resource-constraint wireless environments cannot meet the requirement of 'green' communications. For instance, BBTU and SDNet proposed in previous work [5–6], make use of a balanced binary tree and a multi-way tree structure to support VCR operations and enhance the efficiency of resource sharing. Each peer pre-fetches and stores video segments to achieve the uniform distribution of video resources and peers load. However, the increasing number of peers in the tree structure results in high maintenance cost of overlay topology, so as to limit the scalability of BBTU and SDNet. VMesh in Ref. [7] utilizes a distributed hash tables (DHT)-based chord network to group the peers and improve the distribution of video resources and support user interactive behavior. However, the increasing number of peers in the chord introduces the high-cost overhead of chord maintenance, which becomes the bottleneck of VMesh scalability. In QUVoD in previous work [2], vehicles form an upper layer chord structure on top of a cellular network via 4G interfaces and construct a low

Received date: 20-07-2013
Corresponding author: XU Chang-qiao, E-mail: cqxu@bupt.edu.cn
DOI: 10.1016/S1005-8885(13)60241-1

layer VANET. QUVoD proposed a novel grouping-based storage algorithm in order to distribute uniformly the video resource and peer load along the chord overlay. By making use of this architecture and multipath transmission strategy, QUVoD can obtain high efficiency of video resource sharing. However, the maintenance cost for Chord also becomes the bottleneck of system scalability. Therefore, high-efficiency video resource sharing over MANETs is a challenging issue.

The virtual community is a promising avenue for the resource sharing, which can discover and group the users with the similar interest. The members in the community can collaboratively obtain and share the resource so as to improve performance of resource sharing and reduce the energy consumption. In this paper, a novel VCVRS solution in MANETs is proposed. By investigating the correlation between video content requested, VCVRS estimates the popularity of viewing history traces. VCVRS designs a playback pattern selection scheme and makes use of the popular patterns refined to recognize and cluster the mobile nodes. As Fig. 1 shows, the nodes with the common patterns form a community. In order to overcome the frangibility of community structure, VCVRS constructs a community maintenance mechanism to handle the management of community members and distribution and sharing of video resources. Simulation results show how VCVRS achieves higher lookup success rate, lower server stress, lower node load and less overlay maintenance overhead, in comparison with another state of the art solution.

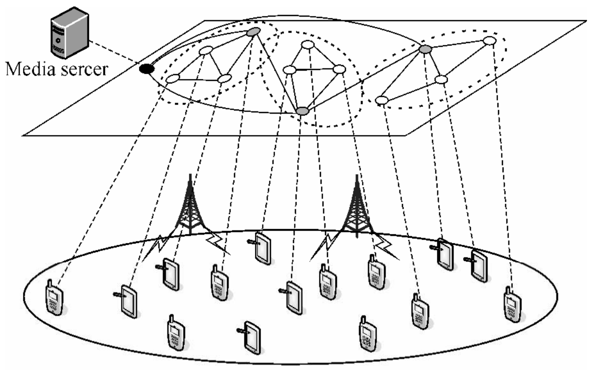

**Fig. 1** Two-level structure of VCVRS

## 2 VCVRS detail design

### 2.1 Nodes join

The media server stores the original video resources and provides the streaming services for all mobile nodes. Any video resource is uniformly divided into $n$ segments: $V=(s_1,s_2,\ldots,s_n)$. Let $L_{\text{node}}=(n_1,n_2,\ldots,n_n)$ be a node set which is maintained at the server side. Each item $n_{\text{c}}$ in $L_{\text{node}}$ can be defined as a 2-tuple $n_{\text{c}}=(I_{\text{c}},b_{\text{c}})$ where $I_{\text{c}}$ is the node ID and $b_{\text{c}}$ is the information of resource stored in $n_{\text{c}}$'s static buffer. Each member of community needs to store one or multiple segment(s) required by broker node of community to static buffer in terms of its storage capacity, which will be detailed in section 2.3. When the member quits system or changes current community, it stores new segment(s) to static buffer. When the server receives a request message of joining system from a mobile node $N_i$, it adds $N_i$ to $L_{\text{node}}$ and sends a message containing $L_{\text{node}}$ and a sample set $L_{\text{sample}}$ of user playback behavior. By mining the playback trace set $S_{\text{trace}}=(t_1,t_2,\ldots,t_m)$, the extracted traces with high popularity are considered as the playback patterns and added into $S_{\text{trace}}$. $N_i$ can find the available supplier by making use of sending the multicast message to all candidates which have the requested resource of $N_i$. If $N_i$ cannot obtain the available supplier, the server provides the original streaming and re-seeks the supplier for $N_i$; otherwise, if $N_i$ receives the response message of multiple available candidates, it selects a candidate which has the closest geographical distance as initial supplier. When $N_i$ connects with the selected supplier $n_j$, $n_j$ returns a new $L_{\text{node}}$ for $N_i$. Each item in the new $L_{\text{node}}$ is redefined as a 4-tuple $n_{\text{c}}=(I_{\text{c}},b_{\text{c}},p_{\text{c}},u_{\text{c}})$ where $p_{\text{c}}$ denotes the playback pattern of $n_{\text{c}}$ and $u_{\text{c}}$ is the broker node of all members in current pattern. The nodes which belong to the same playback pattern form a virtual community. In order to avoid the frequent replacement of broker node, the member which has the maximum similarity between its trace and pattern becomes the broker node to maintain the community, which will be detailed in Sect. 2.3. Because the playback trace of $N_i$ only includes one video segment, $N_i$ cannot make use of calculating the similarity between trace and samples to join a community. $N_i$ normally joins the community of current supplier. This is due to the fact that $N_i$ can obtain more resources from community which has the more members so as to reduce the cost of search resources such as start delay and number of request message. The members in a community can collaboratively share the resource to enhance the efficiency of sharing resources. For instance, the members pre-fetch several segments to static buffer in terms of playback patterns. Each member can provide the streaming service for other members so that the number of request message