

# CO-OPERATIVE VIDEO STREAMING WITH HYBRID VEHICLE M-RELAY NETWORK USING H.264/SVC

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**Abstract**—Vehicular ad-hoc network (VANET) is a subclass of mobile ad-hoc networks which provides wireless communication among the vehicles. At the point when various persons, e.g., a family or a gathering of companions, drive their vehicles for a trip together, they can structure an armada of vehicles and impart their network resources during the trip. Let one member want to watch a video from the Internet. He might not have high resolution or video quality because of his restricted 3G/3.5G bandwidth capacity to the Internet. The cooperative video streaming scenario permits the requested member to ask other members of the same fleet to download video cooperatively. As such, different individuals can help to download parts of the video from the Internet and then forward video data to the requested member hop by hop through the ad-hoc network. This work proposes the k-hop cooperative video streaming protocol using H.264/SVC over the hybrid vehicular networks which consist of 3G/3.5G cellular network and Dedicated Short-Range Communications (DSRC) ad-hoc network. In order to smooth video playback over the DSRC-based ad-hoc network, this work proposes (1) one streaming task assignment scheme that schedules the streaming task to each member over the dynamic vehicular networks, and (2) packet forwarding strategies that decide the forwarding sequence of the buffered video data to the requested member hop by hop. Finally, we utilize the network simulator version 2 (NS2) to simulate the proposed protocol. Based on the simulation results, the proposed scheme can estimate the assignment interval adaptively and the playback priority first (PPF) strategy has the best performance for the k-hop video forwarding over the hybrid vehicular networks. Index Terms—Cooperative streaming, SVC (scalable video coding), Goodput, vehicular ad-hoc network (VANET), dedicated short-range communication (DSRC)

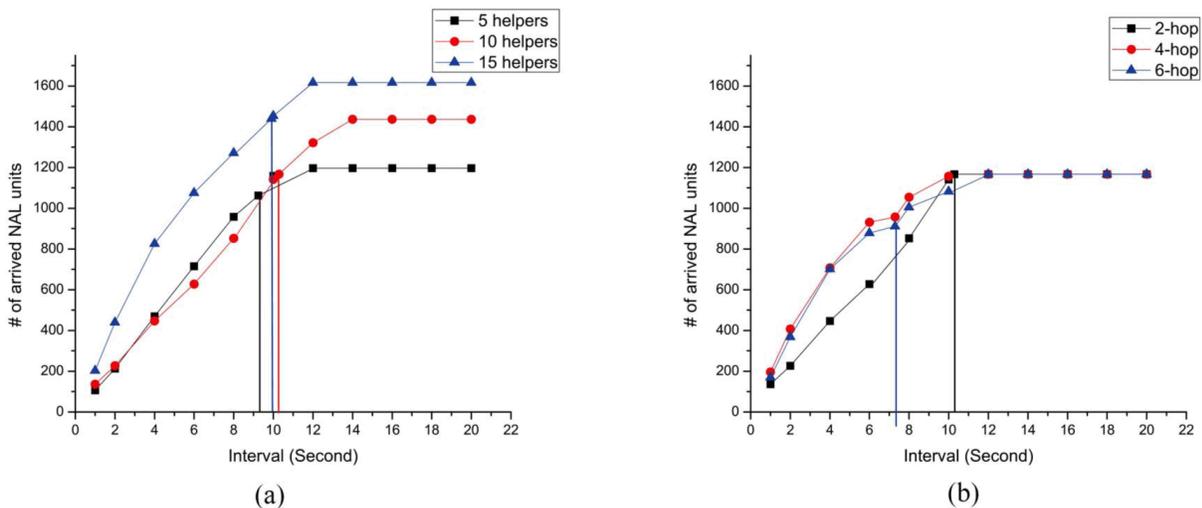
Keywords: VANET, wireless communication, H.264/SVC

## I. INTRODUCTION

Due to the development of interactive media transforming and network technologies, i.e., H.264/SVC codec and 3.5G/3G/4G wireless network, there is a significant increase in demand for universal multimedia services. A practical example is that a family or a gathering of companions drive their cars or RVs to take a road trip together, e.g., from Bangalore to Hyderabad in India or on the other hand from London to Paris in Europe. They drive their cars to meet in an entrance point of the highway and then structure an armada along the highway. In other words, a fleet which is composed of several vehicles starts at the same point with the same travelling route and the same

destination. If one of the vehicles in an armada needs to demand a video stream from the internet, it can download video data and the related information utilizing 3G/3.5G cellular network. Since the bandwidth of the 3.5G/3G network over the moving vehicular networks is unstable and deficient, the quality of video for the requested video stream may not be adequate. Even utilizing 4G cellular network, the bandwidth of the corresponding network still may not be adequate for the following issues. First, other applications may use 4G network simultaneously. Second, the moving conduct of one car, e.g., moving faster or around the coverage area of one base station, make the deteriorating of 4G network bandwidth. To improve the quality of the video during the travelling route, one car would ask other cars belonging to the same fleet to download video data using their redundant 3.5G/3G bandwidth. Once different cars download video data from the Internet, the downloaded video is forwarded by them to the requested car through the ad-hoc transmission among cars, in which Dedicated Short-Range Communications (DSRC) is intended for the car to have one-way or two-way short to medium-range wireless communication, particularly in the very dynamic versatile environment. In this work, the previously stated scenario is characterized as Cooperative Video Streaming (CVS) over the hybrid vehicular systems, which comprises of (1) 3G/3.5G system for vehicle-to-Infrastructure (V2I) communication and (2) DSRC ad-hoc network for vehicle-to-vehicle (V2V) communication.

Three discriminating roles of the proposed CVS are (1) requester, (2) forwarder, and (3) helper. Fig. 1 portrays the proposed CVS situation in this paper. A requester is a part of having the demand for streaming service. Forwarders are individuals that are in charge of sending bits of video information bounce by jump through DSRC-based ad-hoc network. Helpers are individuals that not just forward video information through DSRC-based ad-hoc network, additionally utilizes their 3G/3.5G interfaces to download video information from the Internet. In our supposition, these individuals know one another ahead of time, e.g., they may be companions or families. Then again, alluding to Fig. 1, the vehicular networks' condition is progressive and unusual. A few vehicles that don't fit in with the armada would stick the parkway and afterwards let the separation among individuals be more than one jump. In this manner, the downloaded video information ought to be sent hop by hop and is transmitted -



from numerous ways back to the requester. This work proposes the k-hop CVS protocol which is versatile to the hybrid vehicular systems environment. This work studies and determines the CVS situation in the application layer. Issues and problems of lower layers, i.e., transport layer, network layer and link layer, are past the extent of this work. In the proposed CVS protocol, four issues that need to be determined for having helpful streaming are (1) selection of helper, (2) packetizing video, (3) streaming task assignment and (4) packet forwarding method. The initial two issues, i.e., (1) selection of helper determines how to choose helpers from neighboring individuals and (2) packetizing video determines how to packetize layered video information for conveyance, have basically been examined in our preliminary examination [16],[17]. The other two issues, i.e., (3) streaming task assignment determines how to allot streaming tasks to helpers and forwarders and (4) packet forwarding method how to choose the sending succession of the buffered video information in a helper or forwarder to the requester, are determined in this work. First and foremost, this work embraces the scalable video coding strategy, i.e., H.264/SVC, to encode video feature into one base layer and different upgrade layers. The base layer is downloaded by the requester itself. On the other hand, enhancement layers are transmitted through DSRC-based ad-hoc network that is made out of helpers and forwarders. Because of conceivable activity conditions in all actuality, each partner's 3G/3.5G bandwidth capacity and the hop count distance between every helper and the requester may change with time. Consequently, the proposed k-hop CVS protocol incorporates a streaming undertaking task plan which adjusts the task interim as indicated by partners' 3G/3.5G bandwidth and chooses the task scheduling scheme taking into account the playback time of video information and the hop number distance in the middle of helpers and the requester. Second, since upgrade layers are downloaded by helpers, these layers need to be gone through the DSRC-based ad-hoc network. For a forwarder, it may get video information from diverse helpers or forwarders all the while. Since the DSRC system bandwidth is still constrained, which buffered video information in a forwarder ought to be transmitted first would influence the video quality of the requester. Thus, the proposed k-hop CVS protocol considers (1) time of arrival, (2) playback strategy and (3) accessible bandwidth independently. A few transmission procedures inside a forwarder for sending video information over the DSRC-ad-hoc network are analyzed and discussed in this work. The rest of this paper is presented as follows. Section II presents related works about CVS. Segment III surveys our preliminary study, including helper selection and packetizing video plans. Section IV portrays the proposed streaming task plan and Section V depicts the proposed packet forwarding procedures in subtle elements. Segment VI demonstrates the simulation results. At long last, we condense and finish up our work in Section VII.

## **II. RELATED WORKS**

In this section, we study existing exploration issues in the CVS, including neighbour discovery over vehicular networks, cooperative WWAN and WLAN integration, bandwidth aggregation and multipath routing, and scalable video coding. Step by step instructions to find neighboring vehicles rapidly and efficiently is one of the basic issues in vehicular ad-hoc networks (VANET). Concerning group formation in VANET, Luo and Guo used CDMA-like on-off signalling for group testing and afterwards they got hub can induce which hubs are neighbouring in light of the by and large on-off pattern [2]. Tsai et al. proposed an auto armada support plan in view of a swarming model and the little world phenomenon [3]. In [3], an element grouping convention arranges vehicles into pseudo-pioneers and devotees. Khalili et al. presented (i) a vitality

identification component that empowers hubs to gauge their gathering status and (ii) a feedback mechanism that gives crash information to the transmitters [4]. As indicated by the recreation and simulation results, gathering status input can decrease the time of the discovering neighbor. When neighbouring vehicles can structure a gathering, they can enhance system execution by imparting system assets. Taleb et-al. overviewed a routing protocol to guarantee the communication strength of VANET [5]. Okamura et al. proposed a wireless direct distribution protocol (WDDP) to give a gathering correspondence mechanism among vehicles [6]. The previously stated grouping mechanisms considered how to form a group to disperse information. In this paper, our proposed plan concentrates on the most proficient method which forms a group to aggregate bandwidth from individuals, which go on the same route to the same destination, not just for forwarding data in the paths of adhoc, but also for downloading information from 3G/3.5G systems to have video streaming.

There were a few explore focusing on the thought of cooperative downloading. In [7], the authors proposed a cooperative method for content delivery and partaking in vehicular systems, in which the proposed methodology did not concentrate on streaming and is intended to assemble a piece of the information from first-hop helpers only. In [8], the authors proposed a system for cell phones that get the same video stream and in this way can impart got video information over WLAN. Concerning helpful streaming situation, a collective downloading framework called COMBINE was composed by Ananth et al. [9]. COMBINE integrates neighbouring hubs' Wireless Wide Area Network (WWAN) interfaces to download assets for a dynamic hub. In [17], Guan et al. proposed a cross-layer plan utilizing rate control, transfer determination and force control for video streaming. In [18], Xing et al. proposed a helpful vehicle hand-off plan utilizing vehicles and street-side unit to improve feature quality in light of the variety of system condition. The principle contrasts between the work portrayed in [18] and our work are as per the following: (1) utilize 3G/3.5G networks instead of roadside units to augment wireless signal scope for downloading video; (2) the selected helpers are decided to aggregate different hubs' wireless bandwidth to increment downloaded throughput taking into account their 3G/3.5G and DSRC organizes in our work, in comparison, they are just for wireless network relay in the work of [18]. A related issue of the CVS framework is the multipath routing. Except for those single-hop cooperative helpers, a helper may utilize multiple routing ways to send the information to the requester. In [10], the authors introduced a structural engineering supporting transmission of different video streams in specially appointed systems by securing numerous steering ways to provide additional video coding and transport plans. In [11], the proposed multipath transmission control conspire not just totals the accessible data transfer capacity of different ways, additionally lessens the superfluous time of parcel reordering at the collector. In [12], the authors proposed a convention that chooses numerous maximally incoherent ways without bringing on stream blockage. Bandwidth aggregation is the essential and central issue of the CVS framework. A few papers have tended to this issue. In [13], authors focused on bandwidth aggregation of a host by all the while utilizing various interfaces and displayed a system layer building design that empowers assorted multi-access administrations. In [14], the authors proposed a k-path intermediary revelation calculation to aggregate unmoving cellular links' data bandwidth of others, which is like our work. In [15], authors focused on the bandwidth aggregation service for an Internet "conglomeration intermediary". In the proposed system design, the scalability issue may be the most obstacles on the grounds that all extra functionalities are developed proxies.

### III. PRELIMINARY STUDY REVIEW

As depicted in Section I, we have determined the initial two issues in our preliminary studies [16], [17]. The brief survey of our past studies in [16] and [17] is given in this area. Keeping in mind the end goal to give a higher quality of the video to the requester, how to choose suitable individuals as helpers to download video from the Internet is the principal challenge handled in [16]. The Greedy Approach (GAP) is intended to accomplish the maximal throughput in the CVS situation. In the proposed plan, individuals would answer their (1) hop - count distance, (2) accessible bandwidth of 3G/3.5G and DSRC, and (3) encompassing individuals to the requester. The requester executes the Greedy methodology (GAP) to choose suitable individuals as helpers. The fundamental thought of every system is first to rank individuals as per their abilities in both 3G/3.5G and DSRC interfaces and the hop-count distance from their answered messages. At that point, every technique will confirm applicant helpers from the most noteworthy positioning one and check whether including the new movement stream produced by selecting the part in the  $i$ -th hop as a helper would surpass left DSRC benefit available bandwidth capacity of any selected partner in the  $(i-1)$ -th jump or not.

Then again, how to packetize a layered video stream into numerous units utilizing H.264/SVC was determined in [17]. As per the H.264/SVC standard, the encoded video bit stream is made out of various network abstract layer (NAL) units. In the header of every NAL unit, three labels with respect to scalability facilities and decoding dependency are (1) Dependency ID (DID), which demonstrates spatial adaptability, (2) Quality ID (QID), which shows quality/SNR scalability, and (3) Temporal ID (TID), which shows fleeting scalability. We just consider QID and TID in [17]. General talking, NAL units with  $QID=N$  rely on upon those ones with  $QID=N-1$ . Along these lines, NAL units with  $QID=0$  is characterized as a base layer (BL). Then again, NAL units with  $QID > 0$  is characterized as enhancement layer (EL). Since BL is more critical than EL, all NAL units having a place with BL ( $QID=0$ ) are downloaded straightforwardly by the requester. Remaining NAL units fitting in with EL ( $QID>0$ ) are downloaded by helpers and then sent to the requester. We use a two-tuple  $NAL(x,y)$  to speak to the corresponding QID and TID of a NAL unit from this point forward, in which  $x$  indicates the TID and  $y$  means the QID. Just NAL units with the same TID have decoding dependency. It is not suitable to assign NAL units with the same TID to different helpers. For instance,  $NAL(1,1)$  is doled out to a fourth hop helper and  $NAL(1,2)$  is allocated to an alternate first-hop helper. If  $NAL(1,2)$  is received by the requester effectively, it gets to be pointless and is not able to be decoded. Along these lines, NAL units with the same TID ought to be packetized into one task unit (AU) that is characterized as the fundamental transmission unit in this paper. Taking into account the previously stated portrayal, AU0 is made out of  $NAL(0,1)$  and  $NAL(0,2)$ . AU1 is made out of  $NAL(1,1)$  and  $NAL(1,2)$ . Henceforth, NAL units having a place with EL can be packetized into one AU array sequence.

### IV. EXPERIMENTAL RESULTS

Keeping in mind the end goal to confirm our works, the NS2 simulation tool is used to evaluate the execution and performance of the proposed protocol. In the simulation, every mobile hub is outfitted with two wireless interfaces, in which one is 3.5G/3G cellular interface and the other one is DSRC interface. The 3.5G/3G interface is utilized to communicate with a base station that gives

availability to the Internet. The IEEE 802.11p interface of every portable hub is utilized for communication between hubs through the ad-hoc networks and the settings of comparing parameters are summarized in Table 1. We set related parameters of IEEE 802.11p into the 802.11Ext module and the Wireless Phy Ext module supported in the ns2 and the radio propagation model for the interface is situated to be the two-ray ground reflection model. To simulate the proposed CVS protocol, a YUV video file is encoded into three enhancement layers and one base layer using H.264/SVC.

Parameter	Value	Parameter	Value
Channel data rate	6Mbps	Slot time	13 $\mu$ s
SIFS	32 $\mu$ s	AIFS	71 $\mu$ s
Preamble length	32 $\mu$ s	Plcp duration	8 $\mu$ s
Propagation delay	2 $\mu$ s	CWmin	7
Beacon frequency	0.1 s	Beacon priority	2
Beacon size	200 bytes	Transmission range $R$	500m
CCH interval	46ms	Sync interval	4ms

TABLE 1. Simulation parameters of IEEE 802.11p interface

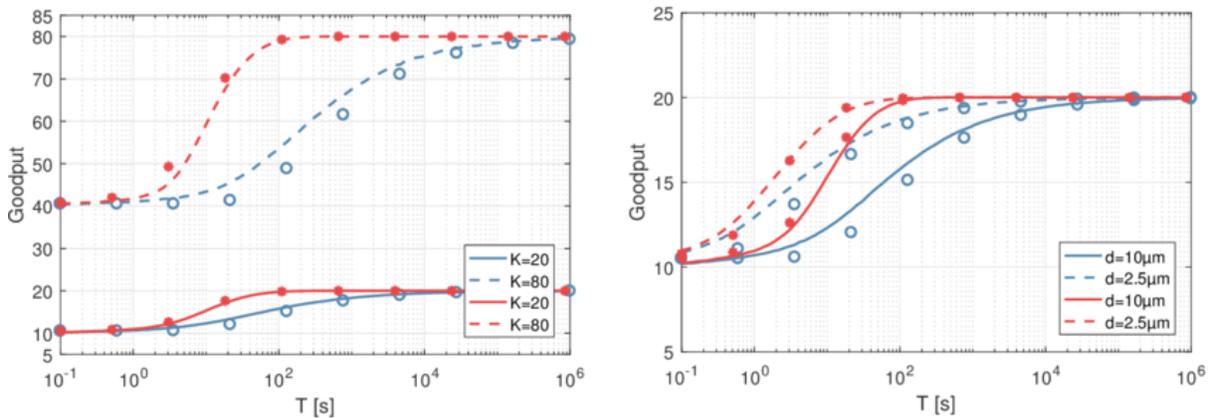


Fig. 3. Goodput of different intervals.

## V. CONCLUSION

This paper proposed a k-hop armada based co-operative video streaming (CVS) protocol over the hybrid vehicular networks, which is made out of 3G/3.5G cellular network and DSRC based ad-hoc system. The proposed k-hop CVS protocol has concentrated on the issues having a place with the application layer. Initially, keeping in mind the end goal to adjust to the time-differing characteristic of the hybrid vehicular systems, the steaming task plan considers (1) each helper's 3G/3.5G bandwidth capacity and (2) the hop count distance between every helper and the requester in this work. Second, with a specific end goal to transmit video information hop by hop easily through the DSRC based ad-hoc network system, three diverse transmission procedures, i.e., first in first out (FIFO), playback priority first (PPF) and time distance metric, have been proposed and examined in this work. At last, we have evaluated the proposed k-hop CVS protocol utilizing NS2

and used two parameters, i.e., (1) goodput that speaks to the effects received rate and (2) the quantity of NAL units that arrived before the due date, for execution and performance comparison.

## REFERENCES

- [1] Standard Specification for Telecommunications and Information Exchange Between Roadside and Vehicle Systems – 5 GHz Band Dedicated Short Range Communications (DSRC) Medium Access Control (MAC) and Physical Layer (PHY) Specifications, ASTM DSR STD E2313-02, 2002.
- [2] J. Luo and D. Guo, “Neighbor discovery in wireless ad-hoc networks based on group testing,” in Proc. 46th Annu. Allerton Conf. Communication, Control, Computing, Urbana-Champaign, IL, USA, Sep. 2008, pp. 791–797.
- [3] H.-W. Tsai, C. Chen, C.-C. Shen, R.-H. Jan and H.-H. Li, “Maintaining cohesive fleets via swarming with small-world communications,” in Proc. IEEE VNC, Tokyo, Japan, Oct. 2009, pp. 1–8.
- [4] R. Khalili, D. L. Goeckel, D. Towsley, and A. Swami, “Neighbor discovery with reception status feedback to transmitters,” in Proc. 29th IEEE Conf. INFOCOM, San Diego, CA, USA, Mar. 2010, pp. 2375–2383.
- [5] T. Taleb et al., “A stable routing protocol to support ITS services in VANET networks,” IEEE Trans. Veh. Technol., Vol. 56, no. 6, pp.3337-3347, Nov.2007.
- [6] T. Okamura, T. Ideguchi, X. Tian, and T. Okuda, “Traffic evaluation of group communication mechanism among vehicles,” in Proc. 4th ICCIT, Seoul, South Korea, Nov. 2009, pp. 223–226.
- [7] A.Nandan, S. Das, G. Pau, M. Gerla, and M. Y. Sanadidi, “Cooperative downloading in vehicular ad-hoc wireless networks,” in Proc. 2nd Annu. Conf. WONS, Washington, DC, USA, 2005, pp. 32-41.
- [8] Y. Liu and M. Hafeeda, “Video streaming over cooperative wireless networks,” in Proc. 1st Annu. ACM SIGMM Conf. Multimedia Systems, Phoenix, AZ, USA, 2010, pp. 99–110.
- [9] G. Ananthanarayanan, V. Padmanabhan, C. Thekkath, and L.Ravindranath, “Collaborative downloading for multi-homed wireless devices,” in Proc. 8th IEEE Workshop HotMobile, Mar. 2007.
- [10] M. Y. Hsieh, Y. M. Huang, and T. C. Chiang, “Transmission of layered video streaming via multipath on ad-hoc networks”, Multimedia Tools Appl., vol. 34, no. 2, pp. 155–177, 2007.
- [11] M. F. Tsai, N. Chilamkurti, J. H. Park, and C. K. Shieh, “Multi-path transmission control scheme combining bandwidth aggregation and packet scheduling for real-time streaming in multi-path environment,” Instit. Eng. Technol. Commun., vol. 4, no. 8, pp. 937–945, 2010.
- [12] K. Rojviboonchai, Y. Fan, Z. Qian, H. Aida, and W. Zhu, “AMTP: A multipath multimedia streaming protocol for mobile ad-hoc networks,” in Proc. IEEE ICC, 2005, pp. 1246–1250.
- [13] K. Chebrolu and Rao, “Bandwidth aggregation for real-time applications in heterogeneous wireless networks,” IEEE Trans. Mobile comput., vol. 5, no. 4, pp. 388-403, Apr.2006.

- [14] D. Y. Zhu, M. W. Mutka and Z. W. Cen, "QoS aware wireless bandwidth aggregation (QAWBA) by integrating cellular and adhoc networks," in Proc. 1 st Int. Conf. Quality Service Heterogeneous Wired/Wireless Networks, Oct. 2004, pp. 156-163.
- [15] P. Sharma, S. J. Lee, J. Brassil, and K. Shin, "Handheld routers: Intelligent bandwidth aggregation for mobile collaborative communities," in Proc. 1st Int. Conf. Broadband Networks, Oct. 2004, pp. 537–547.
- [16] C. M. Huang, C. C. Yang, and H.-Y. Lin, "A K-hop bandwidth aggregation scheme for member-based cooperative transmission over vehicular networks," in Proc. 17th IEEE ICPADS, Tainan, Taiwan, 2011, pp. 436–443.
- [17] C. H. Lee, C. M. Huang, C.-C. Yang, and H.-Y. Lin, "K-hop packet forwarding schemes for cooperative video streaming over vehicular networks," in Proc. 4th Int. Workshop Multimedia Computing Communications-21st ICCCN, Munich, Germany, 2012, pp. 1–5.
- [18] Z. Guan, T. Melodia, and D. Yuan, "Jointly optimal rate control and relay selection for cooperative video streaming in wireless networks," in IEEE/ACM Trans. Netw., vol. 21, no. 4, 1173–1186, Aug. 2013.
- [19] M. Xing and L. Cai, "Adaptive video streaming with inter-vehicle relay for highway VANET scenario," in Proc. IEEE ICC, Ottawa, ON, Canada, 2012, pp. 5168-5172.