QoS for Video Transmission in MANETs: ASurvey

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***Abstract*—A Mobile Ad hoc network (MANET) is a randomly setup network. It has no particular infrastructure. The nodes which come in the transmission range of each other can communicate directly. So, to communicate with a distant node, nodes work in multi-hop fashion. In MANETs, nodes cancontinuously move and so routes often get disconnected. Thus transmission of data and specially video data becomes a very challenging task due to the such known features of MANET nodes viz., mobility, limited bandwidth, constrained energy etc. But still MANETs are required to support video transmission with some provisioning of guarantee and quality.This paper presents a survey of the current researchrelated to the QoS provisioning for video streaming in MANET. We also discuss the preliminary concepts involving QOS, coding methods and challengesin providing QoS in a MANET.Weanalyze what are the optimum parameters for video transmission and suggest areas for future work.**

Keywords—MANET; QoS; video transmission; QoE; MOS

I. INTRODUCTION

Communication is the key to all networks. The advancements in the last decade have made all types of communication possible- from textual to voice to video and multimedia data. We have also seen a great change in the way devices can be connected. Due to the ease of deployment and the need to avail data anytime and anywhere, Mobile Adhoc Networks (MANETs) require supporting multimedia data. MANET is an adhoc network in which the nodes can move freely.

No infra-structure is required to set up a MANET. It works in a hop by hop fashion. Nodes can share data if they come in the wireless range of each other. Amobile node is not only responsible to transmits its own packets butit alsohas to perform routing by forwarding packets for other mobile nodes.

They are beneficial in emergency situations, military field operation, business and law enforcement operations. MANET provides datacommunication serviceswhereinfrastructure might not exist or has been destroyed (e.g., natural calamities). In suchsituationsvideofeeds like video on Demand or live video streaming are quite helpfulfor the rescue personnel.Application like live video conferencing helps business growth rapidly.

Nowadays, users demand better viewing experience. But supporting the videotransmission systems in MANET is a real challenge.In particular, variations in topology causes loss of routes resulting in large packet loss.

QoS is the overall performance of a system as perceived by the user. It means that the network should guarantee the user about theservice it offers. It varies according to application[1]. In case of video streaming, QoS must support video with reliability, synchronization and no disruption. Some surveys related to the QoS, QoE, routing methodsare done by few researchers. Asurvey done by Ash and Oivind (2008) provides issues and challenges involved in providing QoS. A survey illustrating comparison of video streaming tools, evaluation parameters and metrics used for QoSis presented in Spyros et al. (2008). Anothersurvey aboutvideo transmission over multiple paths considering network parameters and routing options is presented in Cikovski et al. (2012).

However, still a survey is required for QoS provisioning in MANETs. In this paper, we describe a summary of the research carried out in this area. We first describe the basic concepts about provision of QoS andthen discuss the state-of-the-art practices carried out in research that address these issues.

The rest of this paper is organized as follows.In Section 2, we describe the basic concepts related toQoS provisioningin ad hoc networks. In Section 3, wepresent the input parameters which should be considered for quality video transmission.Section 4 provides a classification of QoS provisioning methods. In Section 5, wedescribe the strategies used for the performance evaluation of the surveyed approaches.Last section concludes the surveywith scope of further research in the field.

II. PRELIMINARIES

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This section describessome conceptsrelated toQoS in MANETs.There after we discuss different coding practices and parameters that influence video transmission over MANETs.

A.QoS

Quality is a term which cannot be directly put into words. In case of video transmission, when the user receives the uninterrupted data with a high speed and a satisfying view level, it is QoS. But QoS cannot be directly guaranted in every application. It requires to focus and optimize the underlying constraints. Some constraints like jitter, end-to-end delay, packet loss, bandwidth available limit QoS provisioning in video transmission.

B. Challenges

As mentioned earlier, nodes in a MANET are freeto move, so routes often get disconnected. A MANET works in a multi-hop fashion because of the limited propagation range of wireless stations. In particular, topology changes, causes loss of routes, and hence cause large packet loss [9]. Thus, it becomes difficult to send video data over MANETs is difficult. The following challenges further increase the difficulty level:

- Multipath fading and shadowing
- Interferences
- The heterogeneous mobile nodes
- Collisions
- Node mobility
- Limited throughput
- Limited Battery Lifetime.

Therefore, to provide QoS in MANETssuch protocolsshould be designed which can meet the above mentioned challenges and efficiently utilizethe resources.

C. Coding methods

QoS can be enhanced by choosing an appropriate coding method. This work is done by the application layer. Its primary focus is to control the rate and to decide the appropriate number of streams in which the video should be splitted for transmission over multiple paths. It also adds redundancy data to meet the effects of failures during transmission.The coding methods which can be employed are :

- Layered coding- LC mechanisms code video stream into a single base layer and multiple enhancement layers. The media stream cannot be decoded if the base layer is missing. The enhancement layers are applied to the previous layer to improve video quality. The first enhancement layer depends on the base layer. Each $(n+1)^{th}$ enhancement layer depends on its subordinate n^{th}layer . It can only be applied if layer n was already applied. Hence, if the base layer is missing, the media streams are interrupted.

- SVC (Scalable Video Coding)- SVC is an improvement over layered coding. In SVC, a video bit stream is coded in such a way that if parts of the stream are removed than also the resulting video sub-stream can be decoded. Because the new resultant sub-stream also forms another valid bit stream.

- MDC (Multiple Description Coding)-MDC is a coding technique that divides a single media stream into nsub-streams ($n \geq 2$). These sub-streams are referred to as descriptions. These descriptions are routed over different multiple paths. In order to decode the video, any description can be used, however, the quality improves with the number of descriptions received in parallel.

D. Video data rate

Video data rate is the number of bits that are conveyed or processed per unit of time. Using an optimal bitrate is another coding parameter which providesoptimisation. Bit rate There are two types of video data rate:

- CBR (Constant Bit Rate)
- VBR (Variable Bit Rate)

E. Multi-path routing

The study from various papers indicate although QoS can be applied on all the layers yet researchers usually focus on the upper layers of the network model i.e. the network, transport and application layers. The primary function of the network layer is routing. Routing is the process of moving data from one host to another. The survey reveals that multipath routing is better than single path routing because it reduces the probability of data loss. So it benefits in video distortion, security, bandwidth utilization and congestion of links.

III.MAJOR INPUT

The input parameters which should be considered for quality video transmission are[5]:

A. Network parameters

Transmission of video data over MANETs should be done by considering the following metrics:

- Jitter
- Delay
- Data Loss
- Bandwidth

B. Influencing factors

The basic network characteristics identified are:

- Network structure (e.g. the number and density of nodes),
- mobility of nodes,

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- State of radio channel (e.g. weather, fading, interference),
- Protocols deployed (at various layers) and
- Path selection

C. Coding methods

To transfer a video over MANET using multiple paths, the first task is to decide the most suitable coding method. The most used multi-stream coding methods are:

- Layered Coding (LC)
- Scalable Video Coding (SVC)
- Multiple Description Coding (MDC)

D. Optimal number of streams

Before transmitting a video, it is required to decide the number of video streams and the number of routing paths on which these streams will be transmitted.

E. Video data rate

After deciding the number of streams, optimal video bit rate for each stream should be considered foroptimization.

F. Multi-path routing

Multi-path routing protocol selects the path sets for forwarding video streams. The factors considered by multiple path routing protocols for the selection of the appropriate path are bandwidth, mobility, reliability, delay etc. Path selection is also characterized by the type of protocol: proactive, reactive or hybrid. Multipath routing protocol must be integrated with the video coding method.

IV. SURVEY OF QoSROUTING PROTOCOLS

Several protocols are suggested by various researchers to provide QoS provisioning at routing level. They differ by their purpose, approach and application considered. In this section, we present some QoS routing protocols proposed for MANETs.

A. Multipath QoS Routing Protocol [1] [2] [3] [11]

Transmission of video data on a single path can face many limitations and the resultant video can be distorted. Therefore, it is suggested that the data should be transmitted through multiple paths. Researchers have found that it is better if the video data is divided into multiple streams and forwarded on multiple paths. This improves the quality of the received video. But one should have a proper knowledge of the network conditions to choose the best routes. Paper [11] surveys the state-of-the-art practices to analyze the network conditions and combines the diverse aspects. One should firstly choose the optimum number of video streams, bitrates, appropriate multi-stream video coding method, and other parameters. A routing protocol should analyze and select the best paths from the set of all possible paths. Finally, the paths with minimum distortion should be chosen.

In [1], a video distortion model is presented to analyze the performance of low latency video streaming for MANET in multipath environment with limited congestion. In such environments, nodes may require to check the video rate and optimize it to achieve sustainable video quality.To achieve this, optimal routing can be used as it minimizes congestion and distributes traffic over multiple paths. In paper [3], authors have proposed a framework for multipath routing over ad hoc networks. This framework enlists and compares important features, likemultipath routing, multi-stream video coding, and transport mechanisms.

B. QoS Routing Protocol for WEAC protocol [6]

In this paper the authors focus on two main constraints of wireless networks: power minimization and delay jitter. The end-to-end delay is maximized by the routing delay. Paper [6]suggests WEAC/VBS-O protocol i.e., Warning Energy Aware Clusterhead/Virtual Base Station- On demand. It compares the performance in terms of power minimization and average delay.

C. QoS Routing Protocol for 3D video [7]

3D video is a multi-view video, withdifferent views of a given scene, giving viewers the perception of depth. 3D video transmission has higher bandwidth requirements associated with it. Since the frequency band is limited, so the complete 3D video stream cannot be transmitted in one wireless channel. In this paper, the authors have tried to successfully meet the bandwidth demands and minimize the total transmission power in the same time. They named it as PABAVQA problem, which considers issues like video quality selection, SNR-aware power control, Frequency-spectrum-aware routing algorithm, Traffic bifurcation and Converged Routing scheme.

One method is to bifurcate the 3D video stream into multiple 2D video streams using any coding methods and transmit them through multiple paths and then combine these streams at the receiver node. The important observations made are Cooperative scheme performs better than the non-cooperative schemeand IBAIP outperforms the other algorithms.

D. QoS Routing Protocol using Cross Layer [8]

In almost all the surveyed papers, it is found that cross layer methods are the most suitable for QoS provisioning. Since all the layers work in co-ordination so cross layer means to work on multiple layers to get the combined effect on improvement of video streaming.Both the upper and lower layers need to adapt to each others' requirements to achieve a better performing system. Usually the cross layer approach applies to the upper layers, i.e. the network, transport and application layers. Initially at the application layer the video bitrate is adjusted to the available bandwidth by adjusting different coding parameters.Then to avoid transmission failures redundant data is added to the stream, and finally the video stream is divided into more than one descriptions for transmission across several paths. The transport layer provides an adequate interface to the

application layer. Then at the network layer, the data is forwarded on multiple paths according to the needs of the video streams. Thus, the cross-layer techniques proposals can be classified into four classes depending on the way the different layers aregrouped: (a) merging adjacent layers, (b)creation of new interfaces, (c) design coupling without new interfaces and (d) vertical calibration across layers.

E. Distortion Aware QoS Routing Protocol [10] [18]

In MANETs the distortion level is directly proportional to packet error probability. Error may occur in video transmission due to noise and congestion present in the network. If this distortion can be predetermined than protocols can be designed so as to minimize the end-to-end video distortion.

So, calculation of distortion is necessary and the authors in [10] have derived formulas for prediction of distortion. In [18], a probabilistic model to estimate video distortion has been developed and based on this model a feedback based routing strategy is proposed using smart mobile nodes capable of making decisions considering network-specific constraints like congestion and signal-to noise ratio(SNR). The results show that distortion prediction improvesvideo quality for many environments.

F. QoS using multiple interfaces and multiple channels [12][17]

One way to support video transmission over MANET is to use more (wireless) interfaces per mobile node and consequently more communication channels. Through MIMC a node cansend or receive packets through multiple channels. One wireless interface corresponds to one communication channel. So, the more the number of channels, the more the number of packets that can be transferred.

It is a mechanism for assigning channels to interfaces that enhances Video Transmission in MANETs with nodes supporting MIMC. The proposed solution of [12] makes use of MIMC using rate adaptation. Simulation results show that the different routing protocols respond differently when MIMC is introduced.

The AOMDV (Ad hoc On-Demand Multipath Distance Vector) and the AODV (Ad hoc On-Demand Distance Vector) routing protocols benefit significantly, while the Destination Sequenced Distance Vector shows fewer improvements. The proposed mechanism of [17] also uses MIMC and enhances the network's ability to accommodate more streams and reduce packet delay.

G. Delay Sensitive Packet Scheduling QoS Routing Protocol [14] [19][20]

In emergency situations, delay sensitive data should be delivered in real time. So papers [14], [19], [20] focus on the delay sensitive packet data and suggest routing algorithm to schedule real time data over multi-hop networks thereby improving QoS. For this, packet urgency, node urgency, route urgency are calculated. Depending on these, a priority is assigned to each packet and routing algorithm finds the best route to minimize the delay.

H. QoS considering User Preference for Video Content [15]

The video quality is always subjected to parameters related to its receipt. And no focus is paid on the parameters related to its viewing experience. But nowadays, the user's Quality of Experience (QoE) i.e., the user's subjectivity is also taken into account. Thus, paradigm is being shifted from QoS to QoE.For this, video quality assessment methods are done. These methods consider the user's preference for video content. To accomplish it, user's were shown different videos and their perception about each video were recorded. Then, subjective tests were performed on the gathered data. Results indicated that the users' QoE is directly related with the QoS.

Some metrics is proposed for calculation of QoE. These are Preference Factor (PF) and quality index score. In [15], the enhanced Video streaming Quality Metric (e-VsQM) is proposed based on PF and the results demonstrate an improvement in QoE. Furthermore, e-VsQM has low complexity and can be utilized in different video services.

I.Content-Centric-Network-based QOS [16]

QoS of video streaming transmission for CCN-based MANET which is a very challenging environment due to its dynamics. The essence of CCN is that the network layer of each CCN node provides consumers with contents, instead of providing communication channels between hosts. The basic idea of CCN is to use content names as addresses instead of IP-based host addresses.This paper considers CCN as an important ingredient for designing MANET protocol and uses it to evaluate QoSprovisioning of video streaming in CCN-based MANET. In addition, the aim of this paper is to evaluate the performance of AODV protocol and CCN network for different speed values for Waypoint mobility. Through simulationsresults indicate that CCN network can make mobile networks more effective and efficient.

J. QoS considering video traffic model [13]

To evaluate the performance of video transmission in a network, an appropriate traffic model is necessary. A traffic model is used for creating synthetic loads in the network so that its performance can be measured. A video traffic model considers the coding method, bitrate, video standard and other parameters required for the transmission of video. HD and 3D video have different requirements compared to 2D video. So for assuring QoS in video transmission, appropriate video traffic model is must to be considered. In [13], the authors surveyed that CBR is not as suitable as VBR for video transmission.

K. Bandwidth estimation based QoS Routing Protocol [4]

Usually, routing protocols search for optimal paths without considering the network conditions, traffic, bandwidth and the application's requirement.So, the

network may get congested, overloaded or may be unable to meet the requirements of delay sensitive data.that requires a support for QoS may not be met. Therefore, paper [4] suggests that if traffic is pre-estimated and the requirements of the application well considered than video can be sent according to the bandwidth needs and QoS can be met.

V. STRATEGIES FOR PERFORMANCE EVALUATION

This section summarizes and discusses the different strategies used for the performance evaluation of the surveyed approaches. Firstly, the simulation parameters, used by different researchers are presented. Then, the evaluation parameter values and metrics chosen are described.

A. Simulation Parameters

The analysis of the surveyed papers show that since it is difficult to set up a real world network scenario yet some papers code in MATLAB. But still most of the evaluation experiments are performed through simulation. TABLE I summarizes the simulation parameters. From the table we can see, Network Simulator 2 (NS-2) and its different versions are the most popular among all the well-known simulation tools. H.264 is the most suitable coding standard for video transmission in MANET.

B. Evaluation Parameters and Metrics

This section gives an overview of the simulation parametersand performance evaluation parameters. The values utilized by the surveyed techniques are summarized in TABLEII. Since the network scenarios assumed by various researchers vary, so there is a variation in the parameter values. This point should be given certain consideration because a proper comparison can only be made on similar ground. Thethree basic experiment parameters are: (i) number of nodes, (ii) speed of node and (iii) area size of the scenario size.

Finally, regarding the performance evaluation parameters, the most common is peak signal-to-noise ratio (PSNR). Other measured metrics involve packet loss, delay and jitter.

TABLE I. SIMULATION PARAMETERS.

Protocol	Layer	Bitrate	Codec	Video Sequence	Simulator
Multipath	Network	CBR	H.264	QCIF Foreman Mother and Daughter	NS-2
WEAC	Network	CBR	H.263 and H.264	QCIF	MATLAB
PABAVQA	Application, Network, Physical	--	H.264	3D	--
Cross Layer	All	VBR	H.264 and MPEG	CIF or QCIF	NS-2
MIMC	Network	VBR	--	QCIF	NS-2.35
QoE	MAC, Network	--	H.264	VQEG	--
CCN	Network, MAC	--	H.264	CIF	NS-3

TABLE II.COMPARISON OF PERFORMANCE EVALUATION PARAMETERS.

Protocol	Performance Issues	Performance Metrics	Performance Evaluation Parameters
Multipath	Distortion	PSNR	Different number of paths, Loss rates
WEAC	Power minimization, Delay Jitter	Average delay, Power consumed, Delay Jitter	Number of nodes, Number of hops, Delivered packets
PABAVQA	Power, Bandwidth, Video quality	Tansmission cost	No. of destination nodes
Cross Layer	--	PSNR, packet loss, delay and jitter.	number of nodes, node transmission radius and area size of the scenario size.
MIMC	Packet delay	PSNR, Throughput, Delay	Video Packet, Time
QoE	QoE	PSNR, MSE	MOS
CCN	Traffic	PSNR, PDR, End-to-End Delay	No. of nodes, Speed

VI. CONCLUSION

QoS provisioning to realize video streaming in MANETs is a challenging task due to the dynamic changing nodes, limited resources frequently occurring transmission

and path errors. In this paper, wepresented an overview of the research related to theprovision of QoS in mobile ad hoc networks. Thecontributions of the paper are as follows.

- We pointed out the challenges in providingtheQoS in a mobile ad hoc network which are due to the typical characteristics and limitations associated with anad hoc network.
- We discussed important standards for video including coding methods and rate control.
- In this paper, coding methods and optimal parametersfor video transmission in MANETs have been suggested.
- We discussed various methodologies reported in theliterature that provide QoS in one form or theother.
- We found that multipath transport is more suitable over a system using a single path.
- 3D video transmission requires higher bandwidth. So, designing routing protocols for the 3D video stream is challenging because it needs to meet the limited frequency in wireless networks.
- Cross layer methods are the most suitable for QoS provisioning. Usually the cross layer approach applies to the upper layers, i.e. the network, transport and application layers.At the application layer the video bitrate is adjusted to the available bandwidth by adjusting different coding parameters, then to avoid transmission failures redundant data is added to the stream, and finally the video stream is divided into more than one streams or descriptions for transmission over several paths. Then at the network layer, the data is forwarded on multiple paths according to the needs of the video streams. Some works also focus on datalink and physical layers while considering the lower layers.
- Experimental results show that consideration of user's satisfaction is necessary for video quality assessment.
- The surveyed results show that H.264 outperforms H.263 and is best suitable for video coding.
- Experimental results are difficult to compare because of the fact that there is no common ground to select the network scenario. Our comparison shows the most common metrics, workloads.
- Real life scenarios are quite fluctuating and error prone. Very few proposed solutions have been implemented and testedon real world networks. So, the employment of hardware testbeds inaddition to network emulators would be desired.
- Finally, we conclude thatinspite of the various challenges, it is possible to launch video streaming with acceptable qualityand throughput over MANETs. Yet, there aremany unresolved issues that can be addressed by future researchers.

VII. FUTURE WORK

- Since the nodes in a MANET have different capabilities, therefore issues with regard to heterogeneous MANETs (H-MANETs) should be studied.
- In the future, we plan to investigate the effect of different traffic models on the existing routing protocols.
- We also plan to investigate 3D video transmission under multipath scenario with path selection.
- Forfuture work, 3D video models need to be further studied and investigated.
- Further study of video transmission under multipath scenarios with path selection can be done.
- Finally, we plan to investigate how the proposed mechanism affects the energy consumptionin the end nodes and what the performance is on real network testbeds.

REFERENCES

[1] E.Setton, X. Zhu and B. Girod, Minimizing "Distortion for Multi-path Video StreamingOver Ad hoc Networks", In Proceedings of International Conference on ImageProcessing (ICIP), 2004.

[2] Johannes Karlsson, Haibo Li and Jerry Eriksson, "Real-time video over wireless ad-hocnetworks", IEEE, 2005.

[3] Shiwen Mao, Shunan Lin, Yao Wang, Shivendra S. Panwar and Yihan Li, "MultipathVideo Transport Over Ad Hoc Networks", IEEE Wireless Communications, August2005.

[4] Ash Mohammad Abbas, Øivind Kure, "Quality of service in mobile ad hoc networks: asurvey", International Journal of Ad Hoc and Ubiquitous Computing, Jun 2010.

[5] Morten Lindeberg, Stein Kristiansen, Thomas Plagemann and Vera Goebel, "Challengesand techniques for video streaming over mobile ad hoc Networks", Elsevier, 2010.

[6] Tarek R. Sheltami, Elhadi M. Shakshuki, Hussein T. Mouftah, "Video streamingapplication over WEAC protocol in MANET", Elsevier, Journal of computer and SystemSciences, 77, pp 705-719, 2011.

[7] Hong Hsu Yen, "Power-aware, Bandwidth-aware and Video-quality-aware CooperativeRouting algorithm for 3D video transmission in Wireless Networks", Proceedings ofIEEE Pacific Rim Conference on Communications Computers and Signal Processing(PacRim), pp. 470-475, 23–26 Aug. 2011.

[8] Spyros Mantzouratos, GeorgiosGardikis, HarilaosKoumaras, AnastasiosKourtis, "Surveyof Cross-layer Proposals for Video Streaming over Mobile Ad hoc Networks(MANETs)", Proceedings of IEEE International Conference on Telecommunications andMultimedia (TEMU 2012), July 2012, Heraklion, Grece (2012), pp. 101–106

[9] Muhammad Shaffatul Islam Md. Adnan Riaz Mohammed Tarique , "PerformanceAnalysis Of The Routing Protocols For Video Streaming Over Mobile AdhocNetworks", International Journal of Computer Networks & Communications (IJCNC)Vol.4, No.3, May 2012

[10] Zhifeng Chen and Dapeng Wu, "Prediction of Transmission Distortion for WirelessVideo Communication: Analysis", IEEE Transactions On Image Processing, Vol. 21,No. 3, March 2012.

[11] Cikovskis, ilmarsSlaidins, SergejsVdovins, "On Optimal video Transmission overMultiple Paths in wireless Ad-hoc Networks", 20th Telecommunications forumTELFOR, Nov 20-22, 2012.

978-1-5090-6785-5/18/$31.00 © 2018 by IEEE

[12] C.Bouras, A. Gkamas, V. Kapoulas, D. Politaki, E. Tsanai, “Evaluation of RoutingProtocols for Video Transmission over MANETs that use Multiple Interfaces andMultiple Channels per node”, IEEE International Conference on Networks (ICON), pp.1-6, Dec. 2013.

[13] SaveraTanwir and Harry Perros, “A Survey of VBR Video Traffic Models”, IEEEcommunications surveys & tutorials, vol. 15, No. 4, fourth quarter 2013.

[14] E.Vaidhegi, C.Padmavathy, T.Priyanga, A.Priyadharshini, “Delay Sensitive PacketScheduling Algorithm for manetsbyCross Layer”, International Journal of InnovativeResearch in Advanced Engineering (IJIRAE), March 2014

[15] Demóstenes Z. Rodríguez, Renata L. Rosa, Eduardo A. Costa, Julia AbrahãoandGraçaBressan, “Video Quality Assessment in Video Streaming Services ConsideringUser Preference for Video Content”, IEEE Transactions on Consumer Electronics, Vol.60, No. 3, August 2014.

[16] Olfa Ben Rhaiem, Lamia ChaariFourati and AnisMasmoudi, “Content-Centric-Network-based MANET for streaming video transmission”, IEEE InternationalConference on Computer and Information Technology, Ubiquitous Computing andCommunications; Dependable Autonomic and Secure Computing; PervasiveIntelligence and Computing (CIT/IUCC/DASC/PICOM), pp. 1022-1027, 2015.

[17] C. Bouras, A. Gkamas, V. Kapoulas, D. Politaki and E. Tsanai, “Video transmission inmobile ad hoc networks using multiple interfaces and multiple channels”, InternationalJournal of Communication Systems (2016), Published online in Wiley Online Library(wileyonlinelibrary.com).

[18] Diwakar Bhardwaj Krishna Kant Durg Singh Chauhan, “Distortion Aware NovelRouting Protocol for Video Transmission over MANETs”, IEEE WiSPNET conference,2016.

[19] Fang Zhou, Jianguo Jiang and Peizhen Wang, “A Joint Scheme for Delay-Limited Video Transmission over Energy- Constrained MANET”, IEEE, 2008.

[20] HyunchulJoo, Ki JinAnandHwangjun Song, “Urgency- Based Packet Scheduling And RoutingAlgorithms For Video Transmission Over MANETS”, CCWMC, 2011.