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Video Streaming on Multiple Routing Networks

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Abstract **- In this paper, we present a simulation study of network coding schemes for multi-layer video streaming on multiple hop wireless networks. We consider in this study mainly two points: the packet loss due to the wireless environment and the unequal importance of scalable video packets. First we study generation based network coding schemes with static and adaptive redundancy adaptation on packet loss rate. Second we evaluate an extension of the Expanding Window concept with a hop-by-hop coding to highlight the effect of layer discrimination for scalable video streaming. Extensive simulations have been carried out using ns-3 for two different video test sequences with quality scalability. The simulations results show that adaptive redundancy can decrease the packet loss rate and introduce less overhead while Expanding Window can improve the PSNR of the video by reducing the base layer packet loss.**

Keywords: Wireless Networks, Generation based network coding, Expanding Window coding, Scalable Video Coding (SVC).

I. INTRODUCTION

The proliferation of multimedia applications and services in wireless networks such as mobile TV, video surveillance, peer to peer video streaming and network gaming has introduced new research challenges. Due to the changes of channel conditions and heterogeneity of device capabilities, the transmission of video content over wireless networks impacts significantly the video quality. Several techniques at both video and network levels have been investigated to address the adaptation of multimedia contents over wireless networks for a better end-user experience.

Scalable Video Coding (SVC), the scalable extension of H.264/MPEG4-AVC [1], is proposed to address the heterogeneity of networks and user capabilities. SVC produces a video stream with various levels of quality: a base layer and one or multiple enhancement layers. SVC supports three types of scalability: quality, temporal, and spatial scalability. The base layer provides the video quality while the enhancement layers offers a gradually increasing quality. Similarly temporal and spatial scalability improve respectively the frame rate and the SNR in the enhancement layers. An enhancement layer is considered successfully decoded if the base layer and all the other lower enhancement layers are received correctly. Thus the base layer packets are mandatory to decode the SVC bit streams.

Several studies have shown that network coding is an effective technique to improve performance and provide reliable transmissions over wireless networks. In standard intra-flow network coding each node (i.e., source node and intermediate nodes) generates linear combinations from the incoming packets. The redundancy factor r is the ratio between outgoing and incoming packets.

Some networks coding schemes use fixed redundancy, while others adapt the redundancy according to specific parameters such as network conditions, application requirements, etc. Considering the way packets are protected, we can distinguish two classes of coding schemes: Coding schemes where all the packets have an equal priority and coding schemes based on discrimination of packets.

One of the most used coding methods, protecting packets equally is Batch Coding. In this method, batches of packets, having a defined size, called generation are defined. Linear combinations are generated from the packets belonging to the same generation.

Expanding Window Fountain (EWF) coding [2], [3], [4] is a class fountain codes proposed to offer unequal protection of SVC content. It is based on the idea of creating a set of windows of the source data to be transmitted. The set of Expanding Windows is defined in such a way each window is included in the next one. Hence the packets are included or excluded from the encoding window based on their importance. Basically, Expanding Window coding operations are implemented on end system nodes. Only the source node generates coded packets from defined set of windows. Intermediate nodes do not code the packets and only forward them.

In this paper, we aim through a simulation study to evaluate network coding methods for multi-layer video streaming in lossy networks. We focus in this study mainly on two points: loss of packets due to the environment and the unequal importance of scalable video packets. We propose to

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study first, standard generation based network coding with fixed and adaptive redundancy to evaluate the effect of redundancy adaptation on the packet loss rate in a wireless environment. Second, we consider an extension of EW concept with a hop-by-hop coding to highlight the effect of layer discrimination for multi-layer video streaming in a lossy network.

The rest of this paper is organized as follows. Section provides an overview of related works on network coding schemes. Section III describes motivations behind this study and presents the schemes that we evaluated. The results of our study are presented in Section IV. Conclusion of this work is given in Section V.

II. RELATED WORK AND BACKGROUND

In this work, we focus on intra-flow coding schemes where a node generates a linear combinations from the incoming packets. We address, first, the impact of redundancy adjustment on packet loss rate of video streaming over a wireless network. Second, we focus on EW based schemes and the effect of prioritizing video layers on end user experience.

As described in section I we can distinguish two classes of coding techniques based on the way of packets are protected. In generation based schemes, all the packets are protected equally. The coded packets are generated only from the current generation, with size N. In Batch Coding, the node waits until it has N innovative packets to code or decode the packets. This may lead to increasing the coding and decoding delays. Pipeline coding proposed a progressive encoding and decoding scheme to reduce the end to end delay. As soon as an innovative packet is received, pipeline generates encoded packets. This scheme uses a fixed redundancy which may lead to the non-decodability of packets because of the lack of packets or to network overload due to over-redundancy. Note that in generation based schemes, all nodes are allowed to generate linear combinations of incoming data. The authors in [6] propose a network coding based solution for video multicast applications over wireless networks. It assumes also a static redundancy.

In [7], the authors propose to combine intra and inter-flow network coding using generation encoding window. The redundancy is adapted depending on the link quality. The proposed scheme is based on adding a new header field tracking the number of received packets to estimate link quality. The scheme proposed in [8] adapts the rate of coded packets based on vegas loss predictor. The results shows that improve significantly TCP good put. The authors in [9] propose to enhance TCP performance by using adaptive redundancy to compensate link losses. They proposed to integrate the degree of freedom in ACK of TCP, to help the source node moving its encoding sliding window and adapting redundancy. Note that the solutions presented in [9] and [8] are related to TCP traffic.

Expanding Window Fountain (EWF) coding [2],[3],[4] has been developed for SVC traffic to offer unequal protection of SVC video content, while generation based scheme offers an equal protection of packets. EWF coding considers creating a set of windows of the original data with L different classes of importance. The first window contains the base layer packets. The l^{th} window contains the packets belonging to the first l^{th} layers. Generally, a probability selection distribution is associated with the set of windows. In [2], [3], [4] as in [9], only source node encode packets, while intermediate nodes are only allowed to forward encoded packets.

III. ENCODING APPROACHES

In this work, we are interested in studying how network coding can help in improving the performance of scalable video streaming over wireless networks. We evaluate, first the performance of generation based scheme for multi-layer video traffic over a wireless network. The transmission over a lossy network may introduce a notable packet loss rate. Network coding scheme has shown its efficiency in such environment. Thus, we propose in this work to use generation based network coding. As mentioned previously, standard generation based network coding scheme protects equally all video packets. We propose to apply static and adaptive redundancy for generation based scheme to evaluate the effect of adaptive redundancy over a lossy network.

The number of redundant packets has to be adjusted to avoid undecodable generations caused by an insufficient number of received combinations. In this work an adaptive redundancy scheme based on the link quality is used.

Since scalable video coding produces various class of layers with different importance, we propose to study the impact of layer discrimination on the quality perceived by end users. Hence, we propose, in the second part of this work, to integrate a nested window scheme inspired from EW scheme on intermediate nodes. Similarly, we evaluate static and adaptive redundancy with EW scheme. The ETX metric is used to decide the amount of redundancy required r for adaptive schemes. For each studied scheme, we evaluate mainly three metrics, while varying link loss rate. We first evaluate the packet loss rate of base layer and enhancement layer apart. We next evaluate the overhead introduced by each scheme. The overhead is defined by the ratio between all the coded packets transmitted by the nodes of the evaluated

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scheme by the total number of packets of a reference scheme, which is the network coding scheme without redundancy. The overhead shows the extra packets added due to network coding redundancy relatively to the reference scheme. Finally, we choose to evaluate the end user experience. To this end, we adopt the peak signal to noise ratio (PSNR) value to measure the amount of distortion. The overall distortion can be calculated using the maximum possible pixel value of the image.

IV. SIMULATION STUDY

In the following subsections, we present the simulation results of our study. We use ns-3 simulator to evaluate the performances of studied schemes. We evaluate a unicast video transmission on a grid topology composed of nodes. The distance between nodes is set to 100m. Table I summarizes the simulation setup.

We consider during this study two scalable bit streams generated using JSVM (Joint Scalable Video Model) reference software [11]. The used scalable streams are encoded with two layers, which correspond to a quantization factor difference of 6 from the base to the enhancement quality layer. Both streams are of various bitrates with important peak bit rates for intra-predicted frames. The intra-period is set to 30 frames. The two video contents present very different profiles. For sequence 1, the standard deviation is significantly lower than for sequence 2.

TABLE I
Simulation Parameters

Parameter	Value
Number of Nodes	16 nodes
Transmission Range	150m
Node Distance	100m
Simulation Time	30 Seconds
Channel Bit-rate	24 Mbps
Channel Access Control	IEEE 802.11g
Per Link loss rate	Between 0% and 30%
Maximum Packet Size	1500 bytes
Generation Size	N = 16 packets

4.1 Redundancy

In this section, we use a standard generation based network coding scheme. We conducted simulations for both video sequences, defined in II, and evaluated network performance and video quality metrics for various link loss rates.

TABLE II
Scalable Video Stream Bitrates

	Base layer	Base + Enhancement Layer
Sequence 1	477 Kbps	1767 Kbps
Sequence 2	749 Kbps	2251 Kbps

We compare the adaptive scenario to a scenario using network coding scheme with a static redundancy. Since pipeline coding encodes packets progressively as they arrive to the buffer, the encoding and decoding delay are reduced. For a static redundancy schemes we choose pipeline coding [5] with two values of redundancy factor r=1.5 and r=1.7, while varying link loss rate.

Figs. 1(a) and 1(b) show respectively the packet loss rate of base and enhancement layer of Seq 1 while varying the link loss rate between 0% and 30%. Similarly, 1(d) and 1 (e) illustrate the packet loss of base and enhancement layers of Seq2. For both video test sequences, we see clearly that, for the three schemes, packet loss rate for base and enhancement layer is the same. For low link loss rates, we see that the adaptive schemes ensures nearly the same protection of packets as the static scheme with the highest redundancy while it introduces less overhead as depicted in Figs. 1(c) and 1 (f).

Adaptive redundancy scheme outperforms the static redundancy scheme with the highest value of redundancy scheme with the highest value of redundancy in a very lossy network as it adapts redundancy based on the ETX metric. To recover more losses, more coded packets are required. Hence, its overhead in a very lossy network exceeds slightly the static redundancy scheme.

We can notice that the overhead of network coding schemes with static redundancy remains nearly constant whatever the link state, while the adaptive one is increasing eventually. PSNR values, illustrated in Fig. 2, show that the adaptive scheme for the lowest link loss, while it offers better quality when the network experiences very poor quality.

4.2 Layer Discrimination

The results, in Fig. 3 and 4, reveal the effect of protecting the most important packets. We compare EW scheme with different values of redundancy r=1.5 and r=1.7 to a generation

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based scheme for both test sequences, seq 1 and seq 2. We compare the adaptive redundancy scheme based on EW to the generation based scheme. Fig. 3(a) and 3(b) show the packet loss rates of the base and enhancement layers of the first sequences seq 1 respectively. We can see that the loss affecting base layer packets is less important than the enhancement layers for the EW Scheme, while it remains nearly the same for generation based scheme. Figs. 3(d) and 3 (e) illustrate the packet loss of seq 2. Similarly to seq 1 the results show the impact of EW on protecting the base layer packets.

The results in Fig. 4 show that, for both video sequences, the EW scheme decreases the packet loss for both base and enhancement packets. We can notice the unequal protection of packets provided by the EW scheme. The figures show that the packet loss of base packets compared to the enhancement ones is less important by nearly 10%. The figures show also that the packet loss rate for both layers is around 20% less than a generation based scheme.

The overhead introduced by each scheme is shown in Figs. 3(c) and 3(f). We see that the EW scheme introduces more overhead than the generation based scheme, while it ensures a better quality. Similarly to the results described previously in section of EW scheme with adaptive redundancy introduces less overhead than the static scheme for lower loss rate, while it exceeds slightly static scheme for higher values of loss rate.

The PSNR for both static and adaptive schemes is evaluated and plotted in Figs. 5 and 6. For both values of static redundancy. We see clearly that almost all schemes can recover most of lost packets when the link experiences low losses. For higher loss rate even if the static redundancy scheme recovers more packets, the impact of distortion is still high. This is mainly due to the loss of the base layer ones means clearly that the enhancement layers packets are useless.

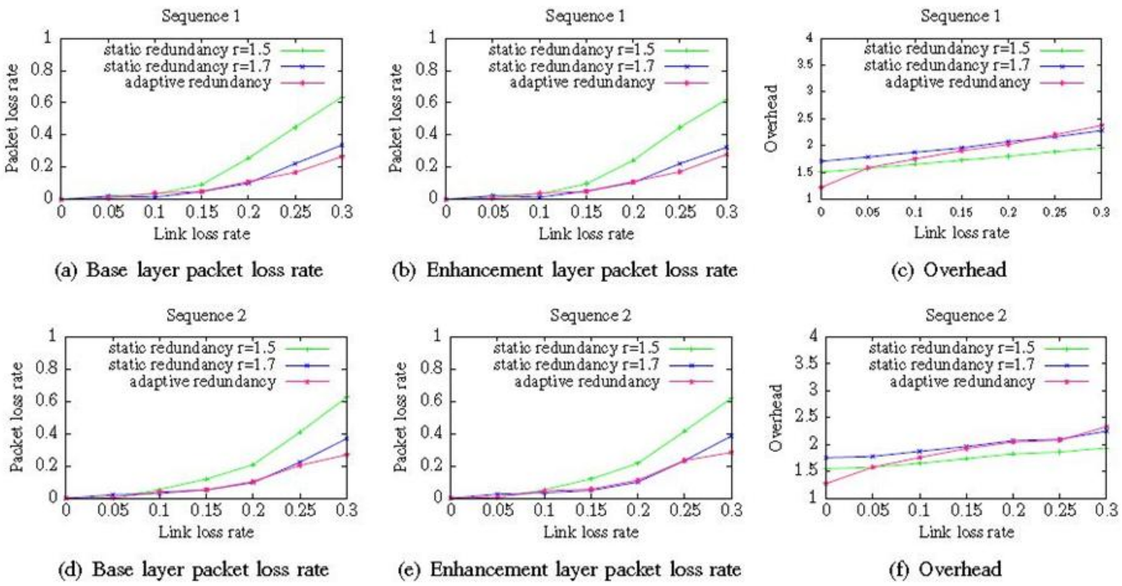

Figure 1: Evaluation of network metrics for different values of link loss rate of generation based schemes

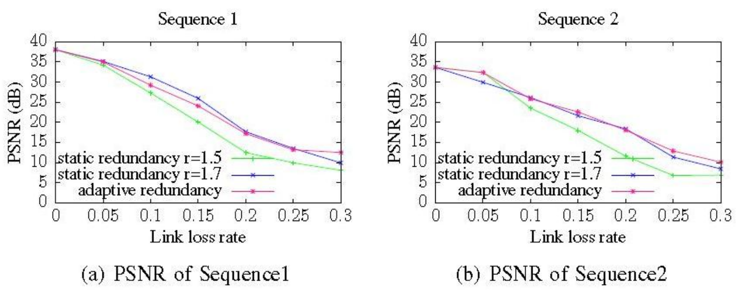

Figure 2: PSNR for different values of link loss rate of generation based schemes

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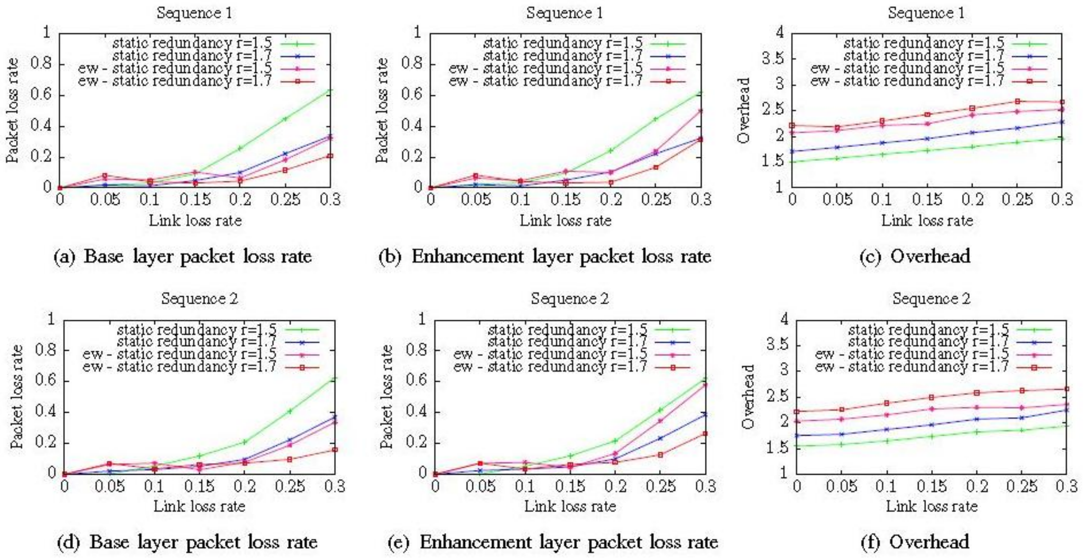

Figure 3: Evaluation of network metrics for different values of link loss rate static redundancy schemes

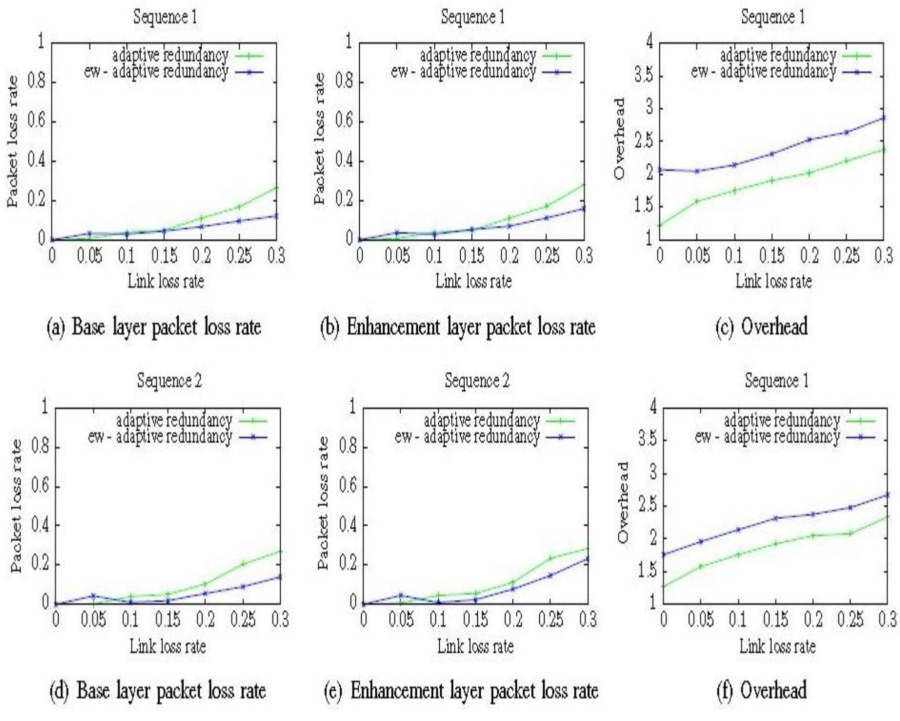

Figure 4: Evaluation of network metrics for different values of link loss rate adaptive redundancy schemes

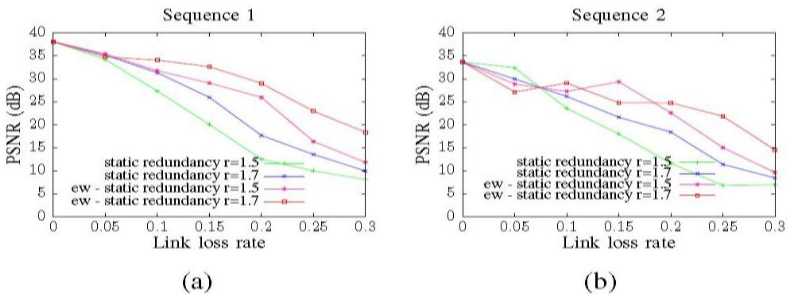

Figure 5: Evaluation of PSNR for static redundancy schemes

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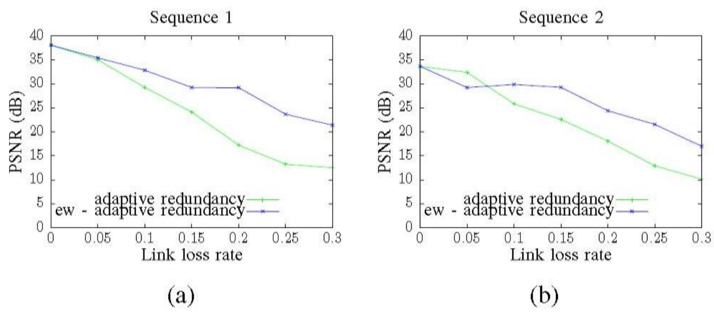

Figure 6: Evaluation of PSNR for adaptive redundancy schemes

Finally, we can conclude that the EW scheme with adaptive redundancy offers the best quality while introducing more overhead, which is still reasonable.

V. CONCLUSION

In this work, we evaluate through a simulation study two network coding schemes for multi-layer video streaming on multi-hop wireless networks. Firstly we focused on packet loss due to the lossy environment. We evaluate generation based scheme with static and adaptive redundancy for two video rest sequences. The results show that adaptive redundancy decreases the packet loss rate compared to the static ones for high lossy links. It ensures nearly the same packets loss rate and PSNR as a static scheme with an important redundancy, while introducing less overhead.

Secondly, we evaluate an extension of the EW concept with a hop-by-hop coding to highlight the effect of layer discrimination for multi-layer video streaming. We notice that EW scheme offers unequal protection of packets. Since the packets loss rate of base layer packet is less important than the enhancement layer packets. We see also that packet loss rate for both layers decreased compared to generation based schemes. Hence, PSNR value is increased, which improves consequently the end user quality.

REFERENCES

[1] C. C. Chen, C. Chen, S. Y. Oh, J. S. Park, M. Gerla, and M. Y. Sanadidi, “Combo Coding: combined intra-/inter-flow network coding for TCP over disruptive MANETs”. *Journal of Advanced Research*, 2(3), 241-252, 2011.

[2] C.C Chen, S.Y Oh, P. Tao, M. Gerla, and M.Y. Sanadidi, “Pipeline network coding for multicast streams.” *Proceedings of the 5th International Conference on Mobile Computing and Ubiquitous Networking (ICMU)*, Seattle, USA. 2010.

[3] D. Vukobratovic, and V. Stankovic, “Unequal error protection random linear coding for multimedia communications”. *In Multimedia Signal Processing (MMSP), IEEE International Workshop on* (pp. 280-285), 2010.

[4] H. M. Ruiz, M. Kieffer, and B. Pesquet-Popescu, “An adaptive redundancy scheme for TCP with network coding”. *In IEEE International Symposium on Network Coding (NETCOD)*, United States, 2012.

[5] H. Schwarz, J. Vieron, T. Wiegand, M. Wien, A. Eleftheriadis, and V. Bottreau., “JSVM text, software, and conformance status.” *ITU-T SG16/Q6 VCEG*, VCEG-AM13, 2010.

[6] H. Schwarz and D. Marpe and T. Wiegand, “Overview of the scalable video coding extension of the H. 264/AVC standard.” *IEEE Transactions on circuits and systems for video technology*, 17.9: 1103-1120, 2007.

[7] J. K. Sundararajan , D. Shah, M. Medard, M. Mitzenmacher ´ and J. A. Barros. “Network coding meets TCP”. *In INFOCOM, IEEE* (pp. 280-288), 2009.

[8] J.-S. Park, M. Gerla, D. S. Lun, Yu.Yi, and M. Medard, “Code- ´Cast: A Network Coding based Ad hoc Multicast Protocol.” *IEEE Wireless Communications*, October 2006.

[9] M. Esmaeilzadeh, P. Sadeghi, N. Aboutorab, “Random Linear Network Coding for Wireless Layered Video Broadcast: General Design Methods for Adaptive Feedback-free Transmission.” *arXiv preprint arXiv*.

[10] N. Javaid, A. Javaid, I. A. Khan, and K. Djouani, “Performance study of ETX based wireless routing metrics.” *In Computer, Control and Communication, 2009.IC4 2009.2nd International Conference* on (pp. 1-7), 2009.

[11] S. Nazir, V. Stankovic, and D. Vukobratovic, “Expanding Window Random Linear Codes for data partitioned H.264 video transmission over DVB-H network,” Image Processing (ICIP), *2011 18th IEEE International Conference on*, vol., no., pp.2205, 2208, 11-14 Sept. 2011.

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