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Video Streaming Over Multihop Wireless Networks –Issues and Techniques

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***Abstract* -Video streaming over multihop wireless networks is considered to be a challenging issue and it is mainly affected by the factors like dynamic change in topology, multi path shadowing and fading, packet delay, video quality issues, interference and many more. Video streaming in real time requires special techniques that can overcome the losses of packets in the unreliable networks. There is an increasing demand for real-time communication services, so efforts to realize video streaming over multihop wireless networks have met many challenges which will be addressed in this paper. Various techniques and issues faced are addressed and the application-centric approach is found advantageous than the other earlier proposed method. We can rather improve possibly by incorporating more lower-layer information and refine its performance.**

***Keywords* -Streaming video, Bottleneck, Cross-layer optimization, dynamic programming, error concealment, multihop wireless networks, routing, video coding.**

I. INTRODUCTION

Recently, there has been an increasing demand for real-time video communication services, such as video telephony, video conferencing, video games, and mobile TV broadcasting. These video applications are promoted by two reasons: one is the extensive use of computing devices such as laptop computers, personal digital assistants, smart phones, automotive computing devices, and wearable computers, and the other is the fast-growing deployment of multihop wireless networks to connect these computing devices. However, transmitting video over multihop wireless networks remains challenging, some of the challenges such as unreliable link quality due to multi-path fading and shadowing, signal interference among nodes, and dynamic connectivity outages. The routing issue significantly affects the end-to-end quality-of-service (QoS) of video applications, raising a few questions, such as how to find the optimal path which can maximize the received video quality under strict delay constraints and how to dynamically and adaptively determine the optimal path which can meet a required QoS and achieve efficient network resource utilization with time-varying network conditions. Traditional network-centric routing approaches relying on simple metrics such as hop count (HC), average packet delay, or average packet loss rate fail to achieve the best perceived video quality.

So far, a number of cross-layer techniques have been proposed to address the routing problem for real-time video transmission over multihop wireless networks in order to maximize the received video quality. Most of the works on routing for video transmissions over multihop wireless networks focuses on how to satisfy the network oriented QoS such as throughput, delay, and packet loss rather than application-oriented QoS such as the user-perceived video quality.

The organisation of the paper goes this way, Section 2; Deals with the video streaming issues. Section 3; Explains about the general approaches for routing in video transmission. Section 4; Describes the comparative analysis of video transmission techniques followed by conclusion of the paper.

II. VIDEO STREAMING ISSUES

Video streaming over multihop wireless networks encounters many challenges. Some of the challenges faced are as follows:

A .Wireless medium

Wireless transmissions are susceptible to various transmission errors, caused by interference from other electrical equipment, multi-path fading, or colliding transmissions by other nodes. Recovering from such errors may require retransmission of data. This leads to an increase in delay and jitter, impacting the quality of the multimedia stream. Each node has a limited transmission range. This range is dependent upon many factors, such as the wireless transmission protocol, antennae size, energy use, obstacles and weather conditions. This limited range means that data must be routed through several other nodes to reach the destination. Each hop adds processing delay and increases the possibility of introducing bottleneck into the network path. For each hop, there is also the added possibility of a transmission error occurring, which adds delay and increases jitter.

B. Multihop-caused challenges

The end-to-end paths between nodes in the multihop wireless networks often consist of multiple hops, cause a lot of challenges. One such challenge is that end-to-end delay increases almost linearly with the number of hops. Thus there exists an upper bound for the number of hops while still providing a sufficiently low end-to-end delay, especially for live streaming. End-to-end packet loss rates are also significantly increased in multi hop wireless networks, where each error-prone wireless link adds to the overall packet loss probability. Another challenge introduced with multiple hops is the increased interference between nearby links.

In Multihop networks, optimal routing is a big challenge. The routing protocol should ensure that each session is provided with a route satisfying its QoS requirements (e.g., bandwidth, delay and jitter). Additionally, the routing protocol should avoid network congestion by load balancing between routes in order to utilize the resources optimally. Many existing routing protocols use single metrics for each end-to-end route and select the route that according to the metric calculation offers the best value. For video streaming through Multihop networks, a single common metric may not be sufficient to meet the QoS requirements of the session.

*C. **Lack of fixed infrastructure***

The lack of a fixed infrastructure requires that nodes function as routers in the network. This can introduce large bottlenecks, if a lot of responsibility is assigned to a node with very limited resources.

III. General Approaches -Routing In Video Transmission

So far, a number of cross-layer techniques have been proposed to address the routing problem for real-time video transmission over multihop wireless networks in order to maximize the received video quality. In [1], a set of pre-allocated paths is assumed over a network. A framework which considers the path selection, along with the retransmission strategy and the physical layer transmission scheme, is proposed to maximize the expected video distortion reduction at the application layer. In [2], a distributed Bellman-Ford-like routing algorithm for multi-user video streaming is developed to maximize the expected received video quality based on priority queuing analysis. The expected received video quality is modelled by a rate-distortion model which is a function of a set of parameters used by different video priority classes.

In [3] and [4], multi-path routing algorithms are developed for video multi-path delivery by utilizing path diversity. A set of paths are determined, one for each video stream/description, such that the received video distortion is minimized. In all the above work, although the application-centric utilities such as video distortion or video distortion reduction were adopted as routing metrics, they are either precalculated or pregenerated from video distortion-rate models, without considering the impacts of the dynamic nature of video coding and error concealment strategies on routing path selection. In fact, most existing works on video routing focus on video streaming applications, where precoded data is used.

IV. Comparitive Analysis Of Video Transmission Techniques

The approaches for video transmission over multihop wireless networks can be classified broadly into two quality-driven and network-centric.

*A. **Network -centric approaches***

1. Average packet delay

Unlike the application centric approach, the optimal path is calculated such that the average end to-end packet delay is minimized. Another difference is that this approach chooses QP from the available QP set for each video frame such that the expected distortion is minimized with the consideration of packet delay deadline. Delay performance analysis is the same as that used in approach 1.But this is a network centric approach and they may fail due to the fact that the path with the minimum average packet delay does not necessarily lead to the minimum video distortion if there are multiple paths all satisfying the required packet delay deadline.

2. Average packet loss rate (plr)

This approach calculates the optimal path to minimize the average PLR, taking into account the constraint of packet delay deadline. The same QP optimization and delay performance analysis as adopted in approach 1 are performed. This approach chooses the path with the minimum end-to-end packet loss rate, while ignoring the significant impact of the packetization scheme at the source on the perceived video quality, as well as ignoring the fact that not all the bits coded video bit stream are of equal importance in determining the perceived video quality.

3. Hop count based approach

This approach takes the path with the minimum number of hops as the optimal transmission path while satisfying the constraint of packet delay deadline. The same QP optimization and delay performance analysis as adopted in approaches 1 and 2 are also used here.

*B. **Quality-driven approaches***

1. Application-centric approach

This is the one of the existing approaches [1] which is one of the best recommended approaches for existing network centric routing approaches. Here the expected distortion is used as the routing metric and QP (Quantisation Parameter) is optimized for each slice to adapt video encoding to the underlying network conditions considering the constraint of packet delay deadline. The approach enables us to compute an optimal routing path to minimize the expected end-to-end video distortion within a given video packet delay deadline. Within the proposed quality-driven framework, video source coding has been integrated into the path routing to enhance the feasibility of Multihop routing and the utilization of network resources.

2. End-to end path selection

A state-of-the-art routing algorithm - the end-to end path selection [2] is determined statistically from a pre-determined path set. The expected video distortion is minimized through this approach. This approach is quality driven but it does not have a capability to jointly optimize video coding and routing as the proposed approach.

3. Multipath routing techniques

Routing is responsible to establish and maintain one or more end-to-end paths from source to destination. The main issue in video streaming is concerning route of video streams is to recognize the routes that guarantee the video to be delivered

with a satisfying perceptional quality. In general, Multipath routing can improve QoS by providing:

(i) Accumulation of bandwidth and delay: breaking the capacity of more than one route.

(ii) Route load balancing: balance the traffic load in higher number of nodes.

(iii) Fault tolerance: by adding redundancy, to reduce the effect of network failures onto affected video quality, it is important that the paths are disjoint.

In case the Multipath routing protocol offers multiple paths with sufficient path Diversity, it is less probable that a link failure affecting one of the paths simultaneously affects one of the other paths. In [3] and [4] this technique is used for

Table 1: Comparison table for the application-centric routing with the existing other approaches

	DELAY BASED APPROACH	PLR BASED APPROACH	HC BASED APPROACH	END-TO-END PATH SELECTION	MULTIPATH-ROUTING TECHNIQUES	APPLICATION-CENTRIC APPROACH
OPTIMAL PATH CALCULATION	Average end-to-end packet delay is minimized	Minimize the average packet loss rate	Takes path with minimum number of hops	Determine from predetermined path set	Not given much importance, increases quality using link utilization	Expected distortion
QUALITY CONCEPT	Network Centric	Network Centric	Network Centric	Quality Driven but does not support joint video coding and routing.	Quality driven but incurs complexity and communication overhead	Application Centric-Quality driven

video multi-path delivery by utilizing path diversity. A set of paths are determined, one for each video stream/description, such that the received video distortion is minimized. In this technique, although the application-centric utilities such as video distortion or video distortion reduction were adopted as routing metrics, they are either precalculated or pregenerated from video distortion-rate models, without considering the impacts of the dynamic nature of video coding and error concealment strategies on routing path selection.

4. Distributed system approach

Distributed Scheme [6] is comprised of Distributed Control (DC), Distributed Buffer (DB) and Distributed Error Control schemes. The DC scheme improves the efficiency of the network bandwidth usage and reduces the end-to-end delay of the streaming application. End-to-end delay jitter can be reduced by proper use of the DB nodes' buffer. Replacing the traditional FEC and ARQ with the distributed FEC and ARQ scheme reduces the error protection overhead and ARQ delay and improves the wireless channel throughput.

C. Comparison of network centric and quality-driven approaches

As mentioned in the table 1, though network centric approaches were adapted in video transmissions over multihop wireless networks, those were not quality driven. Those approaches focused on minimizing the parameters such as packet loss, packet delay etc. Looking at the quality driven approaches, they focussed on the user perceived video quality. Since the user perceived quality is important it's better to go for quality driven approaches. Among the quality driven approaches application-centric approach is found more advantageous.

V. CONCLUSION

Based on the survey for the video transmission over multihop wireless networks, application-centric routing approach was found as one of the better approach for real-time video communications in multihop wireless networks. The application-centric routing approach enables us to calculate an optimal routing path to minimize the expected end-to-end video distortion within a given video packet delay deadline. Within this quality-driven framework, video source coding has been integrated into the path routing to enhance the feasibility of multihop routing and the utilization of network resources. Experiments were conducted with the H.264 codec and different sizes of multihop wireless networks. The results demonstrate that the quality-driven application-centric routing approach provides superior end-to-end video quality over existing network-centric routing approaches. Improving possibly by incorporating more lower-layer information and refines the performance.

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