PATENT ASSIGNMENT COVER SHEET

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Invention Disclosure

Disclosure ID:	OSU-13-61		
Title:	**Flexible Dual TCP/UDP Streaming for H.264 HD Video Over WLANs**		
Submitted By:	**Ben Lee**	Submitted Date:	**9/12/2013**
Stage:	**Approved**	Status:	**Market Analysis**

Documents

File Name	Created By	Date Created
FDSP_patent_document.pdf	Ben Lee	9/10/2013

Funding

Funding Institution	Investigator	Grant / Contract No	Other Info

Interests

Electrical & Computer Engineering, Computer Software

Marketing Targets

Company	Contact	Email

Agreements

Agreement Id	Title	Party	Type	Status	Effective	Updated

Patents

App No	Patent No	Internal	Title	Country	Type	Status	Filed	Issued	Updated

Additional Contributors

Contributor(s) other than above-listed inventor(s):

Competition

Known inventions that will compete with invention:

Patent US20120173748 A1, 7 5, 2012: Hybrid transport-layer protocol media streaming. In this patent, both TCP and UDP protocols are used to stream media. The invention delivers the higher-priority media data to the client over TCP, and the lower-priority media data to the client over UDP. Although the patent does not speci cally de ne what higher-priority and lower-priority data are, it states the following: "In an instance in which the media data is encoded as a series of pictures, the fi rst portion of media data comprises higher-priority intra-coded pictures and the second portion of the media data comprises one or more lower-priority inter-coded pictures." The above statement clearly indicates that this invention also partitions the data at the frame level. Moreover, higher-priority data is sent as intra-coded frames, while lower-priority data is sent as inter-coded frames. In contrast, our invention utilizes NAL units as the basic unit for distinguishing between higher-priority and lower-priority data as mention above. Thus, our invention is very flexible as it allows prioritization of any H.264 syntax element. In addition, this invention does not consider initial bu ffering and re-buff ering, which are key metrics for Quality of Experience (QoE) of video streaming. Our invention divides a video into sub-streams and transmits them in an overlapped manner to minimize initial buff ering, and the occurrence and duration of rebuff ering. Moreover, for each sub-stream, high-priority data (i.e., SPS, PPSs, and slice headers) is fir rst sent via TCP to allow the decoder to apply EC and reconstruct frames when low-priority data (i.e., slice data) fails to arrive due to packet loss. Finally, our invention utilizes the slack times between sub-streams to send I-slices, which improves the visual quality of I-frames and reduce error propagation.

Description

Conception Date: 12/7/2012

First Reduction to Practice:

Video streaming over WLANs faces many challenges because video data requires not only data integrity but also frames have strict playout deadline. Traditional streaming methods that rely solely on either UDP or TCP have di culties meeting both

Abstract/Non-Confidential Summary:	requirements because UDP incurs packet loss while TCP incurs delay. To overcome this problem, this invention, called Flexible Dual-TCP/UDP Streaming Protocol (FDSP), utilizes the benefit of both UDP and TCP. The FDSP takes advantage of the hierarchical structure of the H.264/AVC syntax and uses TCP to transmit higher-priority syntax elements of H.264/AVC video and UDP to transmit lower-priority syntax elements. Moreover, if extra network bandwidth is available, FDSP can send additional lower-priority syntax elements via TCP to further improve visual quality.
Concise Description of Invention:	Video streaming over WLANs faces many challenges because video data requires not only data integrity but also frames have strict playout deadline. Traditional streaming methods that rely solely on either UDP or TCP have di culties meeting both requirements because UDP incurs packet loss while TCP incurs delay. To overcome this problem, this invention, called Flexible Dual-TCP/UDP Streaming Protocol (FDSP), utilizes the benefit of both UDP and TCP. The FDSP takes advantage of the hierarchical structure of the H.264/AVC syntax and uses TCP to transmit higher-priority syntax elements of H.264/AVC video and UDP to transmit lower-priority syntax elements. Moreover, if extra network bandwidth is available, FDSP can send additional lower-priority syntax elements via TCP to further improve visual quality.

Details Pg. 1

Problem(s) this invention solves:	Unlike traditional data, transmitting video data requires both data in- tegrity and strict delay. TCP and UDP are the two fundamental Transport Layer protocols used to transmit video data through the network. TCP is a reliable protocol but it incurs delay. In contrast, UDP results in minimal delay but su ers from packet loss. Current streaming methods solely rely on either UDP or TCP, and thus have di culties meeting both requirements. This invention solves this problem by utilizing both UDP and TCP, as well as prudently selecting important parts of H.264 syntax elements as high priority data. This combination e ectively achieves a balance between delay and visual quality.
Novel and unusual features:	The essence and novelty of this invention are two-fold: - First, a video stream is subdivided into sub-streams containing a sequence of frames. Then, H.264 bitstream for each sub-stream is parsed on-the-fly into high-priority data and low-priority data at the Network Abstraction Layer (NAL) unit level. For example, Sequence Parameter Sets (SPS) hold information common to the entire video, such as the H.264 pro le and level parameters. If a SPS is lost, the entire video cannot be coded. Picture Parameter Sets (PPS) contain common parameters that are applied to sequences of frames or group of pictures (GOPs), such as entropy coding mode employed. If a PPS for a certain GOP is lost, that GOP cannot be reconstructed. In addition, video frames are divided into units known as slices, which are comprised of slice headers, followed by slice data containing coded information for the macroblocks (MBs) contained in the slice. If a slice header is lost, the entire slice cannot be decoded even if the slice data is properly received. Furthermore, I-slice data is also given high-priority and sent via TCP based on the bandwidth availability to further improve visual quality. - Second, for each stream, TCP is utilized to deliver the high-priority data, while UDP is used to deliver the low-priority data. Then, trans- mission of these sub-streams are in an overlapped manner to minimize initial bu ering, and the occurrence and duration of rebu ering.
Disadvantages to invention:	This invention requires on-the-fly parsing of H.264 bitstream, but the overhead incurred is minimal.

Details Pg. 2

Possible uses for this invention:	This invention is realizable as an application software. The application functions as a steamer consisting of both the sender and receiver.
Future uses for this invention:	It is expected that the H.264 codec will remain as the codec of choice for some time but eventually it will be replaced by its succeessor H.265. Future uses for this invention include expansion to accommodate features of H.265, which will prolong the life and e ectiveness of the invention.
Limitations to be overcome:	It is expected that the H.264 codec will remain as the codec of choice for some time but eventually it will be replaced by its successor H.265. Future uses for this invention include expansion to accommodate features of H.265, which will prolong the life and eft ectiveness of the invention.

Future Disc.

Are there any future plans to disclose?:

If yes, future disclosure date:

If yes, describe future disclosure:

Prior Patents

The following discusses several existing patents related to FDSP. Patent US 008356109 B2, 1 15, 2013: Network streaming of a video stream over multiple communication channels. In this patent, the quality of received video is improved by sending intra- coded frames and high-priority inter-coded frames over multiple TCP channels, and low-priority inter-coded frames over multiple UDP chan- nels. This invention focuses on networks with multiple communication channels. In addition, the segregation of high-priority and low priority data is done at the frame level. However, multiple communication channels may not be always viable. For example, in a home environment, video streaming is done in a point-to-point fashion, which means only one communication channel is available. This invention is not applicable in this situation. Currently, the majority of video compression is done using H.264 due to its high compression e ciency. H.264 introduces loss resilience features, such as Network Abstraction Layer (NAL) and multi-slices encoding. With these features, the segregation of high-priority and low-priority data can be done at the NAL unit level instead of at the frame level. The NAL unit level segregation is more flexible because the data chunk is smaller than a compete frame. Furthermore, an intra-frame or a high-priority inter-frame can be received with errors because a decoder can use EC techniques to recover video frame with some reduction in quality. In such situations, transmitting only a part of the intra-frame via TCP is su cient. However, this invention can transmit only complete frames over TCP channels. Patent US20120173748 A1, 7 5, 2012: Hybrid transport-layer protocol media streaming. In this patent, both TCP and UDP protocols are used to stream media. The invention

Prior related Patent applications or Patents:

delivers the higher-priority media data to the client over TCP, and the lower-priority media data to the client over UDP. Although the patent does not speci cally defi ne what higher-priority and lower-priority data are, it states the following: "In an instance in which the media data is encoded as a series of pictures, the rst portion of media data comprises higher-priority intra-coded pic- tures and the second portion of the media data comprises one or more lower-priority inter-coded pictures." The above statement clearly indicates that this invention also partitions the data at the frame level. Moreover, higher-priority data is sent as intra-coded frames, while lower-priority data is sent as inter-coded frames. In contrast, our invention utilizes NAL units as the basic unit for distinguishing between higher-priority and lower-priority data as mention above. Thus, our invention is very flexible as it allows prioritization of any H.264 syntax element. In addition, this invention does not consider initial bu ffering and re-buff ering, which are key metrics for Quality of Experience (QoE) of video streaming. Our invention divides a video into sub-streams and transmits them in an overlapped manner to minimize initial bu ffering, and the occurrence and duration of rebuff ering. Moreover, for each sub-stream, high-priority data (i.e., SPS, PPSs, and slice headers) is fi rst sent via TCP to allow the decoder to apply EC and reconstruct frames when low-priority data (i.e., slice data) fails to arrive due to packet loss. Finally, our invention utilizes the slack times between sub-streams to send I-slices, which improves the visual quality of I-frames and reduce error propagation. Patent US US6771594 B1, 8 3, 2004: Reliable/non-reliable transmission of voice using TCP/UDP based on network quality of service. This invention monitors Quality of Service (QoS) of real-time data stream- ing. If the QoS falls below a threshold, the real-time data is routed through a reliable network service such as TCP. If QoS is adequate, data is routed to a non-reliable service network such as UDP. The quality of received real-time data may fluctuate by using this invention. When QoS falls below a threshold and thus the rest of data is routed to TCP, there is already a period of time during which the streaming video quality will be poor. Therefore, the quality of streaming may not be consistent because of the constant switching between TCP and UDP. Moreover, this invention applies only to Voice over IP (VoIP), which is signi cantly less data intensive than video streaming.

Products

Have the products been made, written or tested?:	Yes
Test Date:	
Comments:	The invention has been implemented and simulated. This invention shows improvements in terms of both visual quality and delay compared to video streamed using traditional methods such as pure-UDP and pure-TCP.

Public Disc

Has there been any full or partial disclosure?:	Yes
If yes, disclosure date:	1/1/2013
If yes, describe disclosure:	This invention is based on the paper titled "Flexible Dual TCP/UDP Streaming for H.264 HD Video Over WLANs," which was published in ACM International Conference on Ubiquitous Information Management and Communication (ICUIMC2013), Jan. 2013.

The undersigned declare that they are the true and only originator(s) of the invention disclosed to Oregon State University. By signing, OSU inventors recognize that as a requirement of employment at OSU, they hereby assign all right, title and interest in this invention to Oregon State University. OSU student inventors hereby assign all right, title and interest in this invention to Oregon State University.

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Witness Signature Date

Witness Signature Date