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A Survey on Telemedicine Approach Using Cross Layer Design in Video Streaming

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Abstract- Telemedicine is one of the effective applications of the technological advancements coupled with the developments in the field of medicine and plays a vital role in today's world. A survey has been conducted on various types of coding techniques, video compression standards for real time transmission of video over wireless network and also on the cross layer design framework which makes the telemedicine not only possible but efficient. In this paper we address and analyze the relevant challenges of cross layer design for real time rate adaptation of video streaming with reference to the various video coding techniques. A comparative performance analysis of such approach is validated and the advantages are analyzed. This survey is conducted in order to improve the performance of telemedicine considering the bandwidth constraints and quality of service. We review the existing Cross Layer Design (CLD) approaches and provide the solution to use the appropriate layers for CLD framework from the stack protocol.

Keywords – Cross layer design, Telemedicine, AVC, SVC, MDC.

I. TYPES OF TELEMEDICINE

A. Remote Monitoring

This type is also called 'self-monitoring/testing'. This type of telemedicine facilitates doctors to check a patient remotely using different technological equipment. This method is mainly used for handling chronic diseases or specific conditions like heart disease, diabetes mellitus, or asthma. These services can provide comparable health results to conventional in-person patient encounters, provide major level of satisfaction in patients, and can be economical also [14].

B. Interactive telemedicine services

This service offers concurrent interactions between patient and doctor. It includes phone conversations, online communication and home visits. Several activities such as history assessment, physical tests, psychiatric assessments and ophthalmology evaluation can be performed comparably to those done in traditional face-to-face treatments. Also, "clinician-interactive" telemedicine services may be cheaper than personal clinical visits [7].

C. Store-and-forward telemedicine

These involves obtaining medical information's, such as medical images, bio-signals etc. and then conveying this information to a doctor or medical specialist at a suitable time for evaluation offline. This type of telemedicine does not require the presence of both parties together. Dermatology, radiology, and pathology are general area of expertise's that are favorable to synchronous telemedicine. An appropriately prearranged medical record, if possible in electronic form should be a part of this transfer. A major difference between traditional in-person patient meetings and telemedicine is the exclusion of a regular physical assessment and history. In this store-and-forward process, the doctor depends on a history report and audio/video data for of a physical assessment.

D. Specialist and primary care consultations

This may involve a patient seeing a doctor over a live video connection or it may use diagnostic images and/or video along with patient data to a specialist for viewing later. It may be used for major care or for specialist referrals.

E. Imaging services

The radiology service prolongs to make the greatest use of telemedicine with thousands of images "read" by remote providers annually [5] [7]. Digital images, transferred to the expert over broadband networks, are analyzed with a report sent back. Radiology, pathology and cardiology all make use of telemedicine to offer such services.

TYPE	ADVANTAGE	DISADVANTAGE
Remote Monitoring	Provides comparatible results when compared with conventional in person patient encounters	Legal uncertainty and lack of features
Interactive telemedicine services	No need for a consulting physician in person.	Consulting physician cannot work with any further with the patient other than patient's disclosure.
Store-and-forward telemedicine	Does not require the presence of a medical faculty every time.	Involves exclusion of the general patient assessment and depends only on patient's history.
Specialist and primary care consultations	Provides a more wide approach for all the fields of specialists to combine and treat the patient	Expensive, implementation cost is high.
Imaging services	Cost effective and patient satisfaction	Awareness in rural area.

Table 1: Types of Telemedicine

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II. CROSS LAYER DESIGN

Cross-layer design (CLD) is given as any violation or modification of the layered OSI reference architecture. The intent of CLD simply stated, is to exploit information from multiple layers to jointly optimize performance of those layers. Dynamic cross-layer designs respond to changing network conditions [6].

The cross-layer framework (CLF) incorporates sets of communication layers in order to create a functional communication system. The cross-layer interactions are provided through a state repository, which stores all of the necessary cross-layer parameters. Additionally, the data management framework accesses the cross-layer framework through this state repository. Which blocks are available and how these blocks are chosen is not entirely clear.

Cross layer framework used to explore in depth about the cross layer design. The three different classes of CLF proposals are the first involves new interfaces for every layer of the OSI model, and removes the requirement that only adjacent layers communicate. The second class also utilizes an OSI-like stack, except new interfaces are only created between every standard layer and a single new shared layer, which would capture all of the cross-layer functionality. The third sets of proposals involve entirely new abstractions for communication systems design.

A. Dynamic-Multi-Attribute Cross-Layer Design (DMA-CLD)

DMA-CLD framework utilizes an OSI-like stack, with new interfaces created between adjacent and non-adjacent layers. The framework is narrow in scope, since it only provides a cross-layer extension for optimized routing. New interfaces are created from the Application, MAC and Physical layers in order to provide information to the DMA-CLD block, which resides in the Network layer. This proposal, while novel in its time is too limited to provide a broad, capable CLF. In general, direct inter-layer communication is not a good approach for CLD. The interactions between adjacent layers are well understood through the OSI model, and cross-layer interaction should take place outside of these. There are significant computational blocks associated with some cross-layer designs, and these should be implemented in their own sub-system [15].

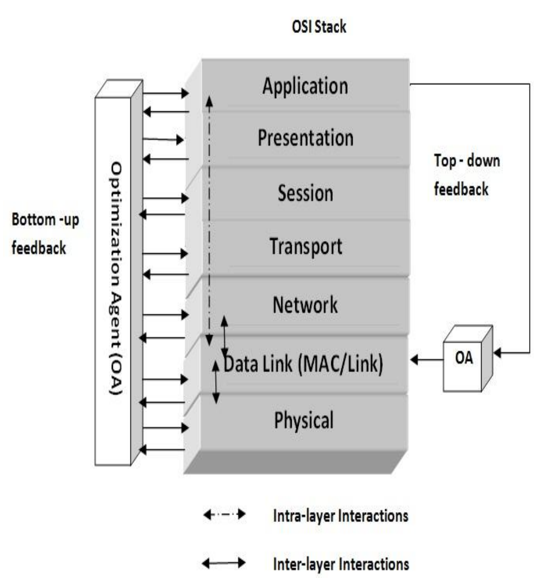

Fig. 2 The Optimization Agent Framework

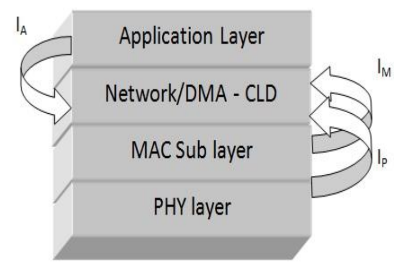

Fig. 1 DMA-CLD Framework

B. Shared Super Layer

Each layer in the stack would provide new interfaces, such that cross-layer optimization would be offloaded to the Optimization Agent (OA) super-layer. This methodology is flexible, and should provide the ability to capture most CLD methods. If each stack layer has the correct interfaces to the OA, a CLD proposal which utilizes those layers could function inside the OA.

III. TYPES OF CODING TECHNIQUES

A. Advanced Video Coding

The intent of the Advanced Video Coding (H.264/AVC) project was to create a standard capable of providing good video quality at substantially lower bit rates than previous standards (i.e., half or less the bit rate of MPEG-2, H.263, or MPEG-4 Part 2), without increasing the complexity of design so much that it would be impractical or excessively expensive to implement. The design of H.264/AVC (Fig.1.) covers a Video Coding Layer (VCL) and a Network Abstraction Layer (NAL). While the VCL creates a coded representation of the source content, the NAL formats these data and provides header information in a way that enables simple and effective customization of the use of VCL data for a broad variety of systems [1].

The coded video data are organized into NAL units, which are packets that each contains an integer number of bytes. A NAL unit starts with a one-byte header, which signals the type of the contained data [8]. The remaining bytes represent payload data. NAL units are classified into VCL NAL units, which contain coded slices or coded slice data partitions, and non-VCL NAL units, which contain associated additional information. The VCL of H.264/AVC follows the so-called block-based hybrid video coding approach. The way pictures are partitioned into smaller coding units in H.264/AVC, however, follows the rather traditional concept of subdivision into macro blocks and slices.

H.264/AVC supports two methods of entropy coding, which both use context-based adaptively to improve performance relative to prior standards. While context-based adaptive variable length coding (CAVLC) uses variable-length codes and its adaptively is restricted to the coding of transform coefficient levels, context-based adaptive binary arithmetic coding (CABAC) utilizes arithmetic coding.

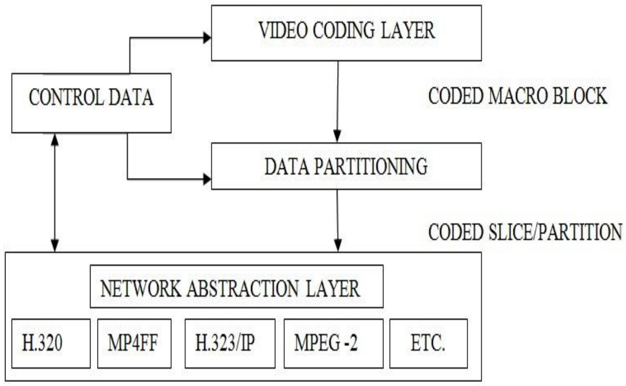

Fig.3 Advanced Video Coding (H.264/AVC)

The cross layer design enhances the QoS transmission of H.264/AVC [10], video stream in wireless environment. Cross layer adaptive video prioritization provides Application layer video frame prioritization, which prioritizes packet according to PSNR influence level, and MAC-layer Adaptive Prioritization which estimates the delay time of each access category and chooses the faster one. It provides higher video quality even when the channel is congested. It also avoids sending over time packets, thus make use of radio resource effectively.

B. Scalable Video Coding

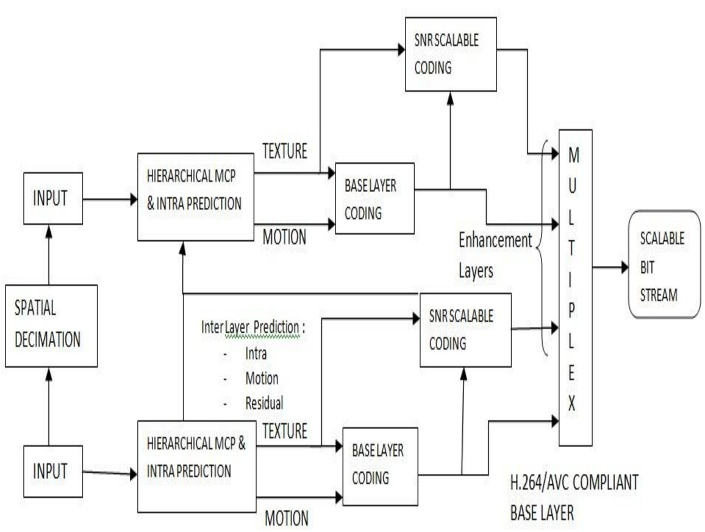

Fig. 4 Scalable Video Coding (SVC)

The Scalable Video Coding (SVC) standard as an extension of H.264/AVC has enabled a video bit stream to adapt to time-varying channel, transmission error, and fluctuating bit rate. SVC also provides a scalability of receiver side receptions since receivers have possibly heterogeneous capabilities in terms of display resolution and processing power. In addition, SVC can support lower throughput and improve better coding efficiency compared with prior video coding techniques such as H.262/MPEG-2, H.263, MPEG-4, and H.264/AVC [2].

The cross layer design between Medium Access Control (MAC) and Real Time Transport protocols used to achieve the channel dependent adaption in video server using scalable video coding. Dropping of packets in video server is more efficient solution than MAC layer dropping in base station to avoid congestion as shown in fig. 4. This method can deliver video with least possible bandwidth and with acceptable video quality [9] [11].

C. Multiple Description Coding

Multiple Description Coding (MDC) is better than H.264 because it can maintain a constant bit rate to feed the decoder and decreases the packet error rate to almost zero [3] [4]. It increases the video quality and it can maintain fairness among different users who are served. At the transmitter, a subset of frames, regularly spaced in the sequence, is compressed by a key frame video coder in intra mode.

The frames between the key frames are Wyner-Ziv coded. Each coder generates two descriptions using multiple description scalar quantizations (MDSQ). One description of key frames is combined with a description of Wyner-Ziv frames to create a new description for the entire input signal. Both descriptions D1 and D2 are sent on a loss-prone channel to the decoder [12].

At the decoder side, if only one description is received, the low quality of the side information generated from the key frames should be sufficient to decode the Wyner-Ziv frames, and the entire sequence could be recovered with an acceptable quality. When both descriptions are received, the descriptions for the key frames and the Wyner-Ziv frames are jointly decoded and should lead to a better quality than at the side decoders for every frame of the sequence. Scheduling model is used to avoid congestion or empty buffer when transmitting a frame. It is used to prioritize some data flows over others that currently pass through the same network node. MDC is used to obtain maximum throughput via high peak signal to noise ratio (PSNR).

MDC provides increased error resilience and scalability for free. It is very robust and it also conserves memory and power. It increase the quality of decoded multiple description. MDC is an alternative to the layered coding for streaming video over unreliable channels. It produces multiple sub streams that can be carried on separate paths. The loss of one packet does not influence the other and it does not require the retransmission [13]. The quality of the video can be increased by enabling the application layer to specify about the importance of packets and those packets can be preserved by the protocol in the transport layer along with MDC.

TYPE	ADVANTAGE WITH CLD
AVC	Provides Application layer video frame prioritization and MAC layer adaptive prioritization. Provides higher video quality even when the channel is congested. Effective use of radio resource.
SVC	Achieve the channel dependent adaption in video server. Dropping of packets in video server can deliver video with least possible bandwidth and with acceptable video quality
MDC	Produces multiple sub streams that can be carried on separate paths. Reduce retransmission of packets. Increased the quality of the video by packets priority and can be preserved by the protocol in the transport layer along with MDC.

Table 2: Advantages of CLD

IV. CONCLUSION

In this paper, we presented a comparative analysis study of optimized cross layer design over the various video encoding techniques. The approach when applied to the video streaming techniques will improve the practical performance in terms of quality of service requirements (m-QoS) and clinically acceptable diagnostic quality. However, in this work, we did not focus on the experimental results of real time applications that use this kind of approach for video transmission. The effect of coding efficiency and technologies on the optimized algorithm and network performance can be further studied in future work. Furthermore, we did not consider how the network and bandwidth constraints have an effect on this approach, which can also be assessed. The effect of the Cross Layer Design can also be extended to the H.265 video coding techniques.

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