High Quality Wireless Medical Video Communication: From WIMAX to LTE Network

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***Abstract*— In this paper an effective video communication framework is discussed for the wireless transmission of H.264/AVC medical ultrasound video over mobile 4G networks. Here demonstrate how our proposed system allows for the transmission of high-resolution clinical video that is encoded at the clinical acquisition resolution and can then be decoded with low delay. Recently investigate the high resolution (4CIF-704x576) medical video communications over mobile WIMAX networks for emergency telemedicine. But LTE provides increased data rates, improved spectral efficiency and bandwidth flexibility and reduced latency. Medical ultrasound video is encoded using diagnostically driven, error resilient encoding, where quantization levels are not varied as a function of the diagnostic significance of image region and can then be decoded with low delay. Encode the medical ultrasound videos at the 4CIF (704×576) resolution and compare the QoS performance parameters of LTE with WIMAX network. Video quality assessment is based on both clinical (subjective) and objective evaluations. In this case NS3 simulator used for modeling the mobile LTE Network.**
Keywords— flexible macroblock ordering (FMO), 4G, H.264/AVC, m-health, mobile WiMAX, telemedicine, ultrasound video, video quality assessment (VQA).

I. INTRODUCTION

Continuous advances in medical video coding, together with wider availability of current and emerging wireless network infrastructure, provide the key technologies that are needed to support m-health video communication technologies in standard clinical practice. Over the past decade, demand for mobile health systems has been growing [1]–[3]. Demand is driven by the need for responsive emergency telematics, remote diagnosis and care, medical education, as well as for mass population screening and emergency crisis management. Advancements in mobile health systems are expected to bring greater socioeconomic benefits, improving the quality of life of patients with mobility problems, the elderly, and people residing in remote areas, by enhancing their access to specialized care. Moreover, they will provide a critical time advantage that can prove life saving in life-threatening emergency incidents.

In terms of wireless infrastructure, thus far, m-health video systems have been primarily based on 3G wireless networks. Given the limited upload data rates supported by these channels (up to 384 kb/s), the associated source encoding parameters were bounded to CIF resolution video size. As documented in [2], medical video resolution directly impacts the clinical capacity of the transmitted video. For atherosclerotic plaque ultrasound video, shifting from QCIF (176×144) to CIF (352×288) resolution enables the assessment of plaque type, providing critical clinical information to the medical expert for assessing the possibility of a plaque rupture, leading to stroke. Some recent studies that have briefly highlighted the benefits associated with streaming higher resolutions can be found. However, these studies are based on a limited number of cases, while the clinical aspect has not been extensively addressed. Moreover, these previous studies did not address individual network parameters' issues associated with clinical capacity of high-resolution video transmission.

As a result, there is a strong demand to investigate new 3.5G and 4G wireless technologies facilitating medical video communication at the clinically acquired video resolution.

II. CHALLENGES OF WIRELESS MEDICAL VIDEO TRANSMISSION SYSTEM

For medical wireless video transmission systems, the two most significant components include the medical video-compression technology and the wireless infrastructure that will be used for the transmission. Efficient video-compression systems can be built using the current state-of-the-art video-coding standard H.264/AVC, which provides for both an efficient (size-wise) and timely (real-time) encoding. Several challenges over standard video communications methods, Strong demand for high bandwidth, a requirement for high quality, mobility & short time delays, frequent communications errors associated with wireless channels. In the case of H264/AVC encoding one of the great challenges is to ensure the clinical data in the transmitted video is sufficient to identify the presence of the plaque and its boundary.

III. WIRELESS ULTRASOUND VIDEO TRANSMISSION FOR EMERGENCY TELEMEDICINE

Basic architecture of an emergency telemedicine system designed for the transmission of wireless medical video as shown in fig.1.

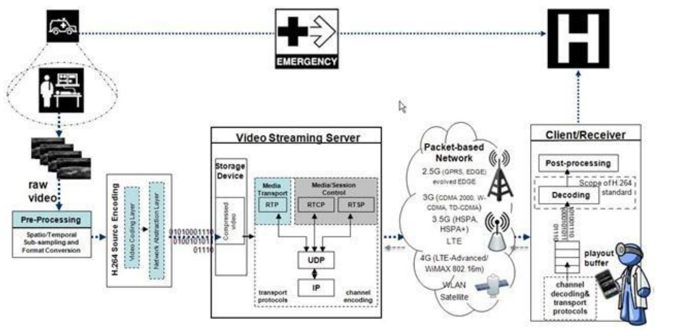

Fig.1. Wireless ultrasound video transmission for emergency telemedicine system

At the incident scene (ambulance, helicopter, ship, airplane), appropriately trained paramedical staff following the established protocol provide the designated patient emergency care. Wireless transmission of medical video is essentially composed of four steps. Following the acquisition, raw medical video is pre-processed so that it is suitable for encoding [8]. This step typically involves resolution and frame-rate adjustments, as well as format conversion. H.264/AVC source encoding is then used to compress the video. In this case, RTP/UDP/IP services are normally adopted to transport H.264/AVC over candidate wireless networks. Given the best-available wireless transmission medium, the medical video is transmitted to the client's side (medical expert), where the reverse procedure is followed for decoding, post-processing, and error recovery.

IV. LTE NETWORK FOR VIDEO COMMUNICATION

LTE stands for Long Term Evolution and it was started as a project in 2004 by telecommunication body known as the Third Generation Partnership Project (3GPP). SAE (System Architecture Evolution) is the corresponding evolution of the GPRS/3G packet core network evolution. The term LTE is typically used to represent both LTE and SAE A rapid increase of mobile data usage and emergence of new applications such as MMOG (Multimedia Online Gaming), mobile T V, Web 2.0, streaming contents have motivated the 3rd Generation Partnership Project (3GPP) to work on the Long -Term Evolution (LTE) on the way towards fourth-generation mobile. The main goal of LTE is to provide a high data rate, low latency and packet optimized radio access technology supporting flexible bandwidth deployments. Same time its network architecture has been designed with the goal to support packet-switched traffic with seamless mobility and great quality of service.

V. ADVANTAGES OF LTE

1) High throughput: High data rates can be achieved in both downlink as well as uplink. This causes high throughput. 2) Low latency: Time required to connect to the network is in range of a few hundred milliseconds and power saving states can now be entered and exited very quickly. 3) Superior end-user experience: Optimized signalling for connection establishment and other air interface and mobility management procedures have further improved the user experience. Reduced latency (to 10ms) for better user experience. 4) Plug and play: The user does not have to manually install drivers for the device. Instead system automatically recognizes the device, loads new drivers for the hardware if needed, and begins to work with the newly connected device. 5) Simple architecture: Because of Simple architecture low operating expenditure (OPEX).

VI. METHODOLOGY

A block diagram of the system's architecture is depicted in Figure.2. Firstly, the ultrasound video of the CCA is captured using a portable ultrasound device. Create videos at the desired resolutions (4CIF) and frame rate (5, 10, and 15), as well as format conversion (yuv 420). FFMPEG software [5] is used for this purpose. This is followed by source encoding by the JM reference software [6], employing encoding which is suitable for clinical evaluation. Video trace file is used to simulate the transmission errors likely to occur when transmitting over error prone wireless mediums. Up to 30 percentages of the transmitted packets are dropped following a uniform distribution. At the receiver end, the JM reference software is used to decode the received trace file and render the transmitted ultrasound video. Quality assessment is based on the EvalVid software.

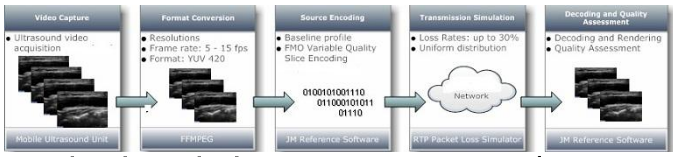

Fig.2. Wireless Ultrasound Video Transmission System Diagram for LTE & WIMAX

VII. PERFORMANCE COMPARISON

In this section, we discuss the experimental evaluation of the proposed medical ultrasound video transmission framework. We present results in terms of video encoding, medical video transmission over mobile LTE and compare it with results of WiMAX channels, and finally clinical evaluation. A schematic representation of the clinically relevant regions is depicted in Figure 3

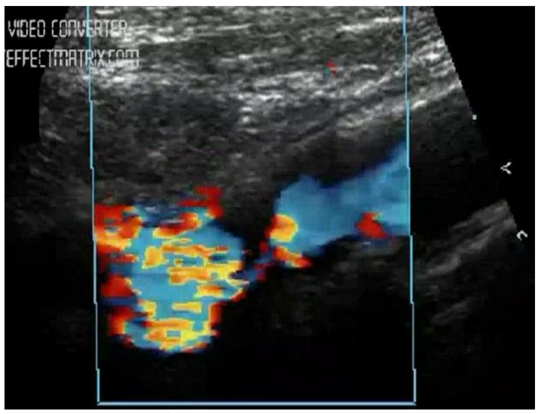

Fig.3. The capture video frame 1 With plaque accumulated at the border of artery

A series of videos (4CIF (704x480)) encoded at 15 frames/s is used to evaluate the proposed concept. To identify diagnostic regions at a pixel level and then this video transformed to a macroblock level to comply with FMO variable quality slice encoding. The corresponding quantization parameter allocation map is used by the encoder to vary quality factors. The resulting ultrasound video of the CCA aims at providing the medical expert with all the existing clinical data on the original video at a reduced bit rate. Table 1 describes the diagnostically relevant encoding parameters for LTE & WIMAX network.

TABLE I. PERFORMANCE COMPARISON OF LTE & WIMAX

Diagnostically Relevant Encoding	**LTE Transmission**	**WIMAX Transmission[2]**
Resolution	4CIF	4CIF
Method	FMO	FMP ROI RS
QP	28/28/28	38/30/28
Data set	ultrasound videos	ultrasound videos
Modulation and Coding	QPSK ½,16-QAM ¾,64-QAM ¾	QPSK ½,16-QAM ¾,64-QAM ¾
Video Streaming Location	Scenario 1(video looped over the route)	Scenario 1(video looped over the route)

VIII. IMPLEMENTATION

The JM H.264/AVC reference software [16] has been used for encoding. We investigate high-resolution video communication performance based on the scenario illustrated in Fig 4. NS3 simulator is used for modeling the mobile LTE Network [9].

Scenario: For a more realistic evaluation, the ultrasound video traffic sent through the network is modeled via trace files generated using real ultrasound video encodings. In Scenario, examine the wireless channel's performance by measuring the average QoS parameters such as PLR, end-to-end delay, and delay jitter. Here the described case of video transmission over LTE simulation test beds are 1)Transmission of high resolution (4CIF)video with encoding, in this case set the mobility model to the user equipment also set the fading model and UE having mobility 60kmph to 100kmph and evaluate the PSNR value.

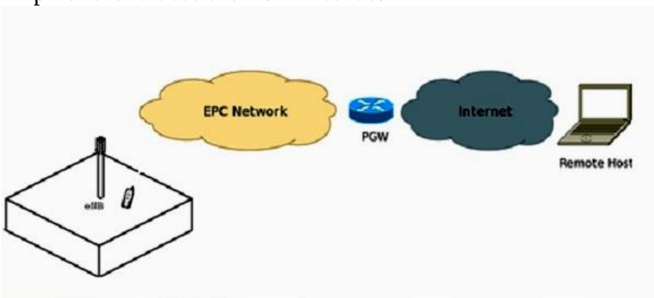

Fig.4. Typical topology for simulating video transmission over mobile LTE networks

Introduce EvalVid a framework and a tool kit for a unified assessment of the quality of video transmission. EvalVid has a modular structure, making it possible to exchange at user's discretion both the underlying transmission system as well as the codec, so it is applicable to any kind of coding scheme, and might be used both in real experimental set-ups and simulation experiments.

IX. SIMULATION RESULT

The results are obtained successfully as follows,

QoS is sometimes used as a quality measure, with many alternative definitions, rather than referring to the ability to reserve resources. Quality of service sometimes refers to the level of quality of service, i.e. the guaranteed service quality. Comparing Qos measurements in WIMAX, average end-to-end delay of transmitted packets for all three channel modulations and coding schemes examined is less than 22 ms, which is well within the acceptable bounds for medical video streaming applications. 16-QAM 3/4 and 64-QAM 3/4 depict comparable performance with PLR extending up to 5. QPSK 1/2 conveys information at 1 bit/symbol/Hz, as compared to 16-QAM 3 /4 and 64-QAM 3/4, which provide 3 and 4.5 bits/symbol/Hz, respectively (mobile WiMAX capacity is given at mega symbols per second(Msps)). As a result, QPSK 1/2 utilizes 2048 sub carriers at 20 MHz to meet the channel capacity required to transmit 4CIF resolution medical video, whereas 16-QAM 3/4 and 64-QAM 3/4 only require 512 sub carriers.

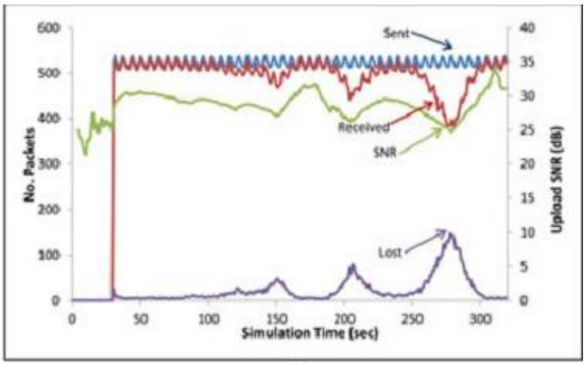

Fig.5. Packet losses for 64-QAM 3 /4 (WIMAX Network [2]).

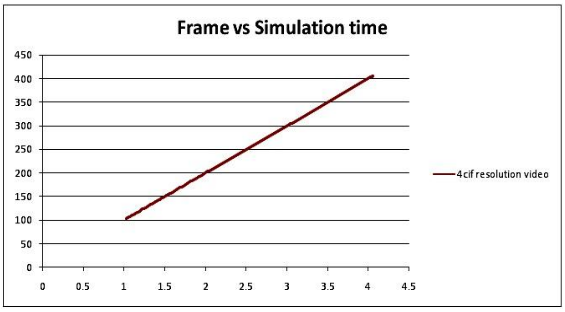

Fig 6: Comparison of frame vs simulation time of 4CIF resolution video

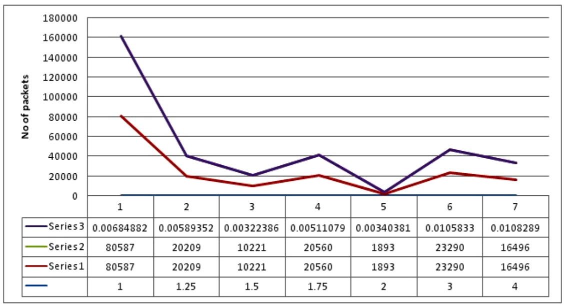

Fig 7: No of packets vs simulation time of 4CIF resolution video

A. Packet loss

Packet losses are usually calculated on the basis of packet identifiers. Consequently the network black box has to provide unique packet ids. This is not a problem for simulations, since unique ids can be generated fairly easy. In measurements, packet ids are often taken from IP, which provides a unique packet id. The unique packet id is also used to cancel the effect of reordering. In the context of video transmission it is not only interesting how much packets got lost, but also which kind of data is in the packets.

B. Determination of Delay and Jitter

In video transmission systems not only the actual loss is important for the perceived video quality, but also the delay of frames and the variation of the delay, usually referred to as frame jitter. Digital videos always consist of frames with have to be displayed at a constant rate. Displaying a frame before or after the defined time results in jerkiness. This issue is addressed by so called play-out buffers. These buffers have the purpose of absorbing the jitter introduced by network delivery delays. It is obvious that a big enough play-out buffer can compensate any amount of jitter. In extreme case the buffer is as big as the entire video and displaying starts not until the last frame is received. This would eliminate any possible jitter at the cost of a additional delay of the entire transmission time. The other extreme would be a buffer capable of holding exactly one frame. In this case no jitter at all can be eliminated but no additional delay is introduced.

Comparing Qos measurements in WIMAX, average end-to-end delay of transmitted packets for all three channel modulations and coding schemes examined is less than 22 ms. QoS parameters for LTE network we can see that the packet loss and jitter values are very lower than that of WIMAX.

TABLE II. COMPARISIN OF QOS PARAMETERS OF LTE & WIMAX

	LTE Transmission			WIMAX Transmission[2]		
QoS Parameters	***PLR***	***Delay (ms)***	***Jitter (ms)***	***PLR***	***Delay (ms)***	***Jitter (ms)***
Total Avg	0.0	15.06 6	-8.03 < 1	4.38	20.62	<1

Subjective clinical quality assessment evaluations are performed over the entire video, for objective video quality assessment, the video quality metrics are evaluated over the diagnostic video slice regions that correspond to individual clinical criteria. PSNR value evaluated using the EvalVid tool. From the scenario we can analyzed the PSNR value is 41.76 when we transmit over LTE with resolution 4CIF.

CONCLUSION

This project proposes an H.264/AVC-based framework for the wireless transmission of atherosclerotic plaque ultrasound video over mobile LTE networks. The main goal of this LTE to provide a high data rate, low latency packet optimized radio access technology, same time its network architecture has been designed with the goal to support packet switched traffic with seamless mobility and great quality of service. Comprehensive experimentation showed that low-delay high resolution 4CIF ultrasound video transmission is possible over mobile LTE networks, even at speeds of 100 km/h and distances of 1 km from the BS. The ns-3 LTE model is a software library that allows the simulation of LTE networks, optionally including the Evolved Packet Core (EPC).The performance of the system in terms of transmitted videos quality was evaluated using both subjective and objective evaluation.

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