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A Framework of Adaptive Mobile Video Streaming and Efficient Social Video Sharing in the Clouds

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Abstract: While demands on video traffic above mobile webs have been souring, the wireless link capacity cannot retain up alongside the traffic demand. The gap amid the traffic demand and the link capacity, alongside alongside time-varying link conditions, aftermath in poor ability quality of video streaming above mobile webs such as long buffering period and intermittent disruptions. Leveraging the cloud computing knowledge, we counsel a new mobile video streaming framework, dubbed AMES-Cloud, that has two main parts: AMoV (adaptive mobile video streaming) and ESoV (efficient communal video sharing). AMoV and ESoV craft a confidential agent to furnish video streaming services effectually for every single mobile user. For a given user, AMoV lets her confidential agent adaptively adjust her streaming flow alongside a scalable video coding method established on the feedback of link quality. Likewise, ESoV monitors the communal web contact amid mobile users, and their confidential agents endeavor to prefetch video content in advance. We apply a prototype of the AMES-Cloud framework to clarify its performance. It is shown that the private.

Keywords: Scalable Video Coding, Adaptive Video Streaming, Mobile Networks, Social Video Sharing, Cloud Computing.

I. INTRODUCTION

Over the past decade, increasingly more traffic is accounted by video streaming and downloading. In particular, video streaming services over mobile networks have become prevalent over the past few years [1]. While the video streaming is not so challenging in wired networks, mobile networks have been suffering from video traffic transmissions over scarce bandwidth of wireless links. Despite network operators' desperate efforts to enhance the wireless link bandwidth (e.g., 3G and LTE), soaring video traffic demands from mobile users are rapidly overwhelming the wireless link capacity. While receiving video streaming traffic via 3G/4G mobile networks, mobile users often suffer from long buffering time and intermittent disruptions due to the limited bandwidth and link condition fluctuation caused by multi-path fading and user mobility [2] [3] [4]. Thus, it is crucial to improve the service quality of mobile video streaming while using the networking and computing resources efficiently [5] [6] [7] [8].

Recently there have been many studies on how to improve the service quality of mobile video streaming on two aspects:

A. Scalability:

Mobile video streaming services should support a wide spectrum of mobile devices; they have different video resolutions, different computing powers, different wireless links (like 3G and LTE) and so on. Also, the available link capacity of a mobile device may vary over time and space depending on its signal strength, other users traffic in the same cell, and link condition variation. Storing multiple versions (with different bit rates) of the same video content may incur high overhead in terms of storage and communication. To address this issue, the Scalable Video Coding (SVC) technique (Annex G extension) of the H.264 AVC video compression standard [9] [10] [11] defines a base layer (BL) with multiple enhance layers (ELs). These substreams can be encoded by exploiting three scalability features: (i) spatial scalability by layering image resolution (screen pixels), (ii) temporal scalability by layering the frame rate, and (iii) quality scalability by layering the image compression. By the SVC, a video can be decoded/played at the lowest quality if only the BL is delivered. However, the more ELs can be delivered, the better quality of the video stream is achieved.

B. Adaptability:

Traditional video streaming techniques designed by considering relatively stable traffic links between servers and users, perform poorly in mobile environments [2]. Thus the fluctuating wireless link status should be properly dealt with to provide 'tolerable" video streaming services. To address this issue, we have to adjust the video bit rate adapting to the currently time-varying available link bandwidth of each mobile user. Such adaptive streaming techniques can effectively reduce packet losses and

bandwidth waste. Scalable video coding and adaptive streaming techniques can be jointly combined to accomplish effectively the best possible quality of video streaming services. That is, we can dynamically adjust the number of SVC layers depending on the current link status [9] [12].
However most of the proposals seeking to jointly utilize the video scalability and adaptability rely on the active control on the server side. That is, every mobile user needs to individually report the transmission status (e.g., packet loss, delay and signal quality) periodically to the server, which predicts the available bandwidth for each user. Thus the problem is that the server should take over the substantial processing overhead, as the number of users increases.
Cloud computing techniques are poised to flexibly provide scalable resources to content/service providers, and process offloading to mobile users [13] [14] [15] [16] [17] [18].

Thus, cloud data centers can easily provision for large-scale real-time video services as investigated in [9]. Several studies on mobile cloud computing technologies have proposed to generate personalized intelligent agents for servicing mobile users, e.g., Cloudlet [18] and Stratus [17]. This is because, in the cloud, multiple agent instances (or threads) can be maintained dynamically and efficiently depending on the time-varying user demands. Recently social network services (SNSs) have been increasingly popular. There have been proposals to improve the quality of content delivery using SNSs [11] [12]. In SNSs, users may share, comment or re-post videos among friends and members in the same group, which implies a user may watch a video that her friends have recommended . Users in SNSs can also follow famous and popular users based on their interests (e.g., an official facebook or twitter account that shares the newest pop music videos), which is likely to be watched by its followers. In this regard, we are further motivated to exploit the relationship among mobile users from their SNS activities in order to prefetch in advance the beginning part of the video or even the whole video to the members of a group who have not seen the video yet. It can be done by a background job supported by the agent (of a member) in the cloud; once the user clicks to watch the video, it can instantly start playing.

In this paper, we design a adaptive video streaming and prefetching framework for mobile users with the above objectives in mind, dubbed AMES-Cloud. AMES-Cloud constructs a private agent for each mobile user in cloud computing environments, which is used by its two main parts: (i) AMoV (adaptive mobile video streaming), and ESoV (efficient social video sharing). The contributions of this paper can be summarized as follows, AMoV offers the best possible streaming experiences by adaptively controlling the streaming bit rate depending on the fluctuation of the link quality. AMoV adjusts the bit rate for each user leveraging the scalable video coding. The private agent of a user keeps track of the feedback information on the link status. Private agents of users are dynamically initiated and optimized in the cloud computing platform. Also the real-time SVC coding is done on the cloud computing side efficiently. AMES-Cloud supports distributing video streams efficiently by facilitating a 2-tier structure: the first tier is a content delivery network, and the second tier is a data center. With this structure, video sharing can be optimized within the cloud. Unnecessary redundant downloads of popular videos can be prevented.
Based on the analysis of the SNS activities of mobile users, ESoV seeks to provide a user with instant playing of video clips by prefetching the video clips in advance from her private agent to the local storage of her device. The strength of the social links between users and the history of various social activities can probabilistically determine how much and which video will be prefetched.

The rest of the paper is organized as follows. We first introduce related work in SectionII, and explain the AMES-Cloud framework in Section III. The adaptive video streaming service and the efficient social video sharing will be detailed in Sections IV and V, respectively. Then the operations of AMES-Cloud is illustrated in Section VI. Finally, we evaluate the prototype implementation in Section VII, and conclude the paper in Section VIII.

II. RELETED WORK

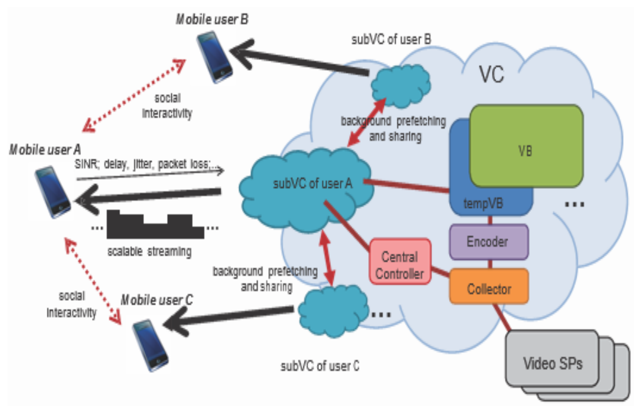

Fig1. An illustration of the AMES-Cloud framework.

A. Adaptive Video Streaming Techniques

In the adaptive streaming, the video traffic rate is adjusted on the hover so that a user can experience the maximum probable video quality established on his or her link's time-varying bandwidth capacity [2]. There are generally two kinds of adaptive streaming methods, reliant on whether the adaptivity is manipulated by the client or the server. The Microsoft's Flat Streaming [17] is a live adaptive streaming ability that can switch amid disparate bit rate segments encoded alongside configurable bit rates and video resolutions at servers, as clients vibrantly appeal videos established on innate monitoring of link quality. Adobe and Apple additionally industrialized client-side HTTP adaptive live streaming resolutions working in the comparable manner. There are additionally a little comparable adaptive streaming services whereas servers control the adaptive transmission of video segments, for example, the Quavlive Adaptive Streaming. Though, most of these resolutions uphold several duplicates of the video content alongside disparate bit rates, that brings huge burden of storage on the server. Regarding rate adaptation manipulating methods, TCP-friendly rate manipulation methods for streaming services above mobile webs are counseled [17] [15], whereas TCP throughput of a flow is forecasted as a purpose of packet defeat rate, round journey period, and packet size. Thinking the approximated throughput, the bit rate of the streaming traffic can be adjusted. A rate adaptation algorithm for conversational 3G video streaming is gave by [10]. Then, a insufficient cross-layer adaptation methods are debated [12] [13], that can buy extra precise data of link quality so that the rate adaptation can be extra precisely made. Though, the servers have to always manipulation and therefore tolerate from colossal workload.

Recently the H.264 Scalable Video Coding (SVC) method has obtained a momentum [10]. An adaptive video streaming arrangement established on SVC is used in [9], that studies the real-time SVC decoding and encoding at PC servers. The work in [12] proposes a quality-oriented scalable video transport employing SVC, but it is merely tested in a simulated LTE Network. Considering the encoding presentation of SVC, CloudStream generally proposes to hold high-quality streaming videos across a cloud-based SVC proxy [10], that discovered that the cloud computing can considerably enhance the presentation of SVC coding. The above studies inspire us to use SVC for video streaming on top of cloud computing.

B. Mobile Cloud Computing Techniques

More presently, new sketches for users on top of mobile cloud computing settings are counseled, that virtualize confidential agents that are in price of satisfyinh the necessities (e.g. QoS) of individual users such as Cloudlets [11] and Stratus [12]. Thus, we are motivated to design the AMES-Cloud framework by employing adjacent a gents in the cloud to furnish adaptive video streaming services. centers, as well as the capable links among the data centers, the “copy” of a large video file takes tiny delay [16].

III. VI D E O STO R AG E A N D ST R E A M I N G FL OW BY AMOV A N D EMO S

The two parts, AMoV and EMoS, in AMES-Cloud framework have tight connections and will together service the video streaming and sharing: they both rely on the cloud computing platform and are carried out by the private agencies of users; while prefetching in EMoS, the AMoV will still monitor and improve the transmission considering the link status; with a certain amount of prefetched segments by EMoS, AMoV can offer better video quality. With the efforts of AMoV and EMoS, we illustrate the flow chart of how a video will be streamed in Fig. 5. Note that in order to exchange the videos among the localVBs, subVBs, tempVB and the VB, a video map (VMap) is used to indicate the required segments. Once a mobile user starts to watch a video by a link, the localVB will first be checked whether there is any prefetched segments of the video so that it can directly start. If there is none or just some parts, the client will report a corresponding VMap to its subVC. if the subVC has prefetched parts in subVB, the subVC will initiate the segment transmission. But if there is also none in the subVB, the tempVB and VB in the center VC will be checked. For a non-existing video in AMES-Cloud, the collector in VC will immediately fetch it from external video providers via the link; after re-encoding the video into SVC format, taking a bit longer delay, the subVC will transfer to the mobile user.

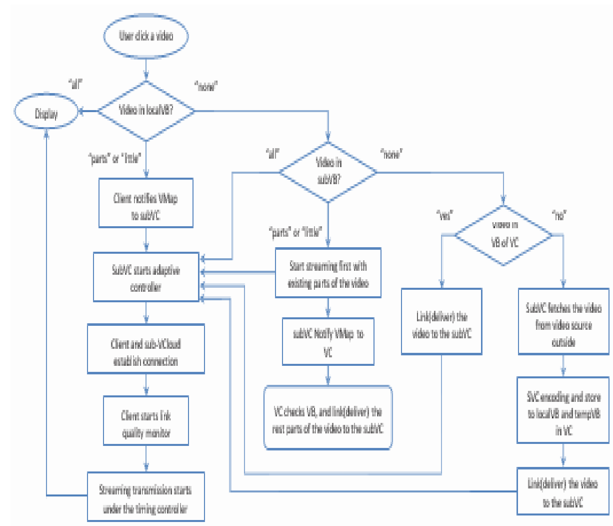

Fig2. Working flow of video streaming in the subVC and VC of AMES-Cloud framework.

Also in AMES-Cloud, if a video is shared among the subVCs at a certain frequency threshold (e.g., 10 times per day), it will be uploaded to the tempVB of the VC; and if it is further shared at a much higher frequency (e.g., 100 times per day), it will be stored with a longer lifetime in the VB. In such a manner, which is quite similar to the leveled CPU cache, the subVB and VB can always store fresh and popular videos in order to increase the probability of re-usage.

IV. EXPERIMENTAL RESULT

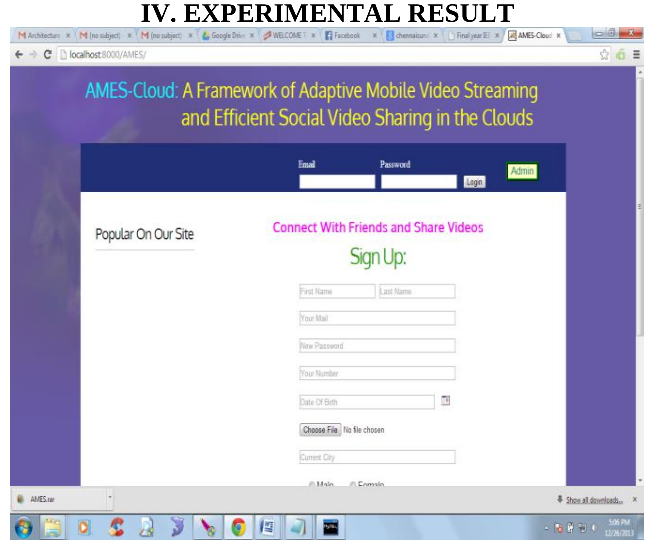

Fig3. Sign up Page.

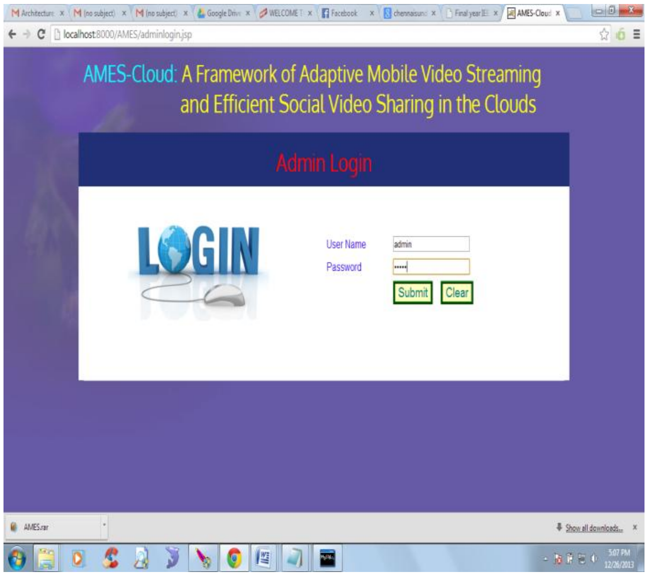

Fig4. Login Page.

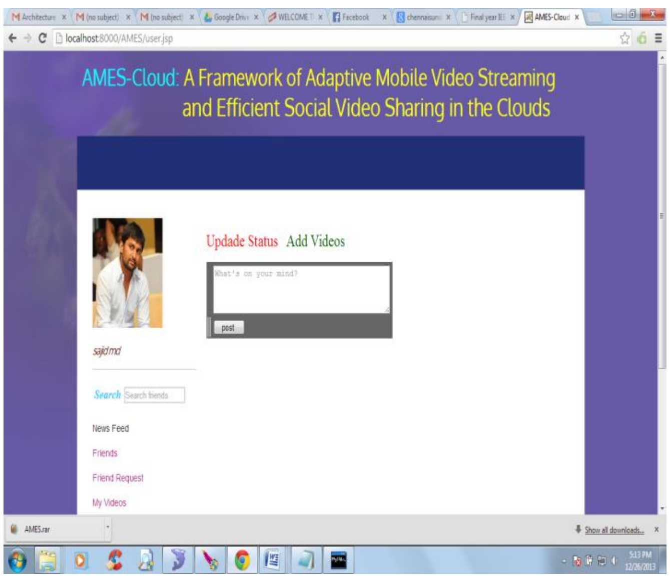

Fig5. Video Upload.

V. CONCLUSION

In this paper, we discussed our proposal of an adaptive mobile video streaming and sharing framework, called AMES-Cloud, which efficiently stores videos in the clouds (VC), and utilizes cloud computing to construct private agent (subVC) for each mobile user to try to offer "non-terminating" video streaming adapting to the fluctuation of link quality based on the Scalable Video Coding technique. Also AMES-Cloud can further seek to provide "non-buffering" experience of video streaming by background pushing functions among the VB, subVBs and localVB of mobile users. We evaluated the AMES-Cloud by prototype implementation and shows that the cloud computing technique brings significant improvement on the adaptivity of the mobile streaming. The focus of this paper is to verify how cloud computing can improve the transmission adaptability and prefetching for mobile users. We ignored the cost of encoding workload in the cloud while implementing the prototype. As one important future work, we will carry out large-scale implementation and with serious consideration on energy and price cost. In the future, we will also try to improve the SNS-based prefetching, and security issues in the AMES-Cloud.

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