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Clouds Based Smart Video Transcoding System

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Abstract: Cloud computing became quite a mature technology and is being adopted for every kind of applications in the real world; video transcoding is one of them. Cloud computing is the collection of computing resources that can only access via digital network like WAN, Internet etc. The users may access the computing resources by using computer, tablet, notebook, smart phone, pad computer or other devices. The cloud server provides and manages the applications and also storing the data remotely in cloud. User interaction and integration of video files using computers, networks, cellular mobiles, Internet TV, iPod and other PDA are becoming more important tasks in research due to the increased number of distinct video formats. This paper expresses the brief introduction of cloud computing and its current trends for video transcoding. We have proposed the solution that how video transcoding becomes smart and speeds-up due to the efficiency of cloud computing.

Keywords*:* component; Cloud Computing, Video Transcoding, Map-Reduce.

1. INTRODUCTION

In current and next decade, the technologies of cloud computing are expected to play a crucial role in motivating innovation in every industry like education, research, government, healthcare, media, Internet based business, manufacturing, video and audio providers etc. For instance, cloud computing is getting popular amongst the bioinformaticians (Memon, 2010; Memon, 2012). Similarly, video transcoding industry is also approaching towards cloud computing. This paper focuses on the implementation of video transcoding in cloud environment. As cloud vendor offers pool of computing resources to user publicly or can stay live within self-managed data center privately, both scenarios are using the "*Pay-as-you-go*" and "*pay-as-you-grow*" models, so it is needed to make cloud applications smarter.

The transcoding applications have innovative group of services which can launch on different types of devices such as smart phones, tablets, desktops, laptops, etc. And that system can work as cloud based application for user consultation, service migration, performance management, technical audit, easy maintenance and support, easy to scale the traffic, data storage and knowledge based services. All these innovative interfaces are conceded for making smart application through cloud environment. 200 million of Chinese users and billions of world's internet users watch the videos over the internet. For instance, Youtube and Google provide portal for online videos. Similarly, China CCTV network, Shanghai media group, Hunan radio and TV, Shenzhen and other domestic radio and TV broadcasting in China has launched "Internet TV". In some of the world's special occasions, like the spring festival in china, all media providers largely involved in providing online video as well as audio. In the next few years, a drastic increase in number of video operators is expected and every organization will need to build their own setup for video transcoding which will require more investment (billions of funding). This cost would exceed the total cost of investment of the established system. So this duplication would cause huge loss of national economics and heavy burden on network quality of video services would be created as well. In this case, a unified solution is required for these problems; that is, first create a model and then establish a centralized video transcoding system in cloud environment.

The main theme of this paper is to present all the cloud features to support video transcoding system, which would facilitate different kinds of users accessing any of the video services on different kinds of network technologies and devices. It can provide videos for all network operators with wide adaptability, easy maintenance, low-cost bandwidth and multimedia-based platform. On the other hand, it can avoid low-level duplicated construction. Some video file formats do not support efficiency in transmission because of many new players and storage devices. These devices take long time in transmission and they need strong compression and multi format conversion. Some video viewers are using devices with different size of screen

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to watch videos, for example, different mobiles have different screen resolutions. Speedy transcoding algorithm and knowledge based system can help in designing a very smart video transcoding model through cloud environment.

To maximize the speed of video transcoding system, more focus on different encoding format, size, coding rates and media servers are needed. The efficiency of these systems are important because video requests from smart computing devices need internet and they definitely work on different bandwidths, terminal play equipments and softwares. Transfer data stream processing in cloud environment is required data rate which must have low latency provided by data stream application even when the incoming data rate fluctuates widely (Ishii, 2011). Knowledge based system provides user friendly features so users do not need to install any software on their device; all possible types of services should be available for user's need. Scales dynamically means it could be added scalability and cost management features to cloud which are most beneficial for cloud user as well as cloud itself such as fixed cost or package for user; cost should vary for same service for different kind of users depend on file size, saving unnecessary use of cloud resources from cloud environment is called cost saving.

Fundamentals Of Cloud Computing

There is not a single universal definition of cloud computing as yet; it could be defined in different perspective by different researchers and experts. Everyone has explained the cloud computing in their own perspective (Foster, 2008; Rosenberg, 2010; Mell, 2011; Marston, 2011). According to NIST (Mell, 2011), 'the cloud computing is a model for enabling ubiquitous, convenient, on-demand network access to shared pool of configurable computing resources (e.g., networks, servers, storage, applications and Services) that can be rapidly provisioned and released with minimal management effort or service provider interaction". Similarly, Rosenberg described the cloud computing in (Rosenberg, 2010) as there are some main principles of cloud computing including (i) it is the pool of resources available for subscribed users, (ii) it has the virtualized resources to maximize the hardware utilization, (iii) it is elastic so can scale up and down for user needs, (iv) it creates the new virtual machines as well as delete exist one automatically, and make a bill only on its usage.

Cloud computing is not a new concept but it is a mixture of several existed technologies. Cloud computing is a buzzword and umbrella term applied to several emerging trends in IT (Hilley, 2009). Distributed Computing, Utility Computing, Grid Computing, Service Computing, and Parallel Computing are providing all their features to support wide infrastructure which is called Cloud Computing (Garfinkel, 2007; Armbrust, 2009; Armbrust, 2010). Cloud computing is a centric approach rather than computing on personal computers. It has everything in conceal environment; users and companies can easily access the services without to know hardware and software location and how the network is structured in cloud environment. Many groups of people from cloud community (Edmonds, 2011) are considering the cloud computing into various fields of IT and there are raising standard demands of interoperability, integration, portability, monitoring and Vendor Lock-in would be added in clouds (Dowell, 2011).

Architecture of Cloud Computing

Cloud architecture can be explained in two prospective: (1) Organizations perspective that categorizes the architecture in three different deployment models. The first deployment model, *Public Cloud*, is available for general public and any large group of industries. Google App Engine, Microsoft Windows Azure, IBM Smart Cloud, Amazon EC2 are best examples of Public Clouds. The second deployment model, *Private Cloud*, is operated and managed for an organization. Eucalyptus, Amazon VPC, VMware, Microsoft ECI data center are the examples of private clouds. The last one, *Hybrid Cloud*, is a mixture of two or more clouds (Public and Private) for unique domain. Windows Azure and VMware vCloud are Hybrid Clouds. (2) Technical perspective provides three major service models for deployment in cloud environment. First model, *Infrastructure as a service* (IaaS), provides to user an access and usage of abstracted view on centralized located hardware, computers, mass storage system, networks, etc. Most popular vendors of IaaS service are IBM, Amazon EC2, Eucalyptus, Nimbus, OpenNebula. *Platform as a service* (PaaS) model is the second service model, only focused to developers, neither to end-users. It has environment for programmer and execution. Some PaaS providers are GoogleAppEngine, Microsoft Azure, etc. The last service model, *Software as a service* (SaaS), is unlikely PaaS directly address to end-user. This model let the end-user to not install any application software on local computer. SaaS layer is performing the services and these are rented software by services providers that are why it is called on-demand applications over the Internet. GoogleMap, Google Docs, Microsoft windows live, Salesforce.com are popular examples of SaaS.

Technologies of Cloud Computing

Cloud computing environment is supporting three major technologies: Virtualization, Service

Oriented Architecture (SOA) and MapReduce. (1) The heart of most cloud architectures is virtualization. The basic concept is an abstract and logical view of the physical resources including servers, data stores, networks and software. In IT service providers' perspective, the usage of virtualization techniques have many advantages like resource usage, management, consolidation, energy consumption, less space required, emergency planning, dynamic behavior, availability and access (Bun, 2011). The virtualization concept stands on different technologies for implementation and relevance to practical usage such as operating system virtualization, platform virtualization, store virtualization, network virtualization and application virtualization. (2) Like virtualization, SOA is one of the fundament prerequisite for Cloud Computing. It is a software architecture that defines how services are offered and used, and then services could be used by customers, applications and other services. SOA is providing the way of design, deployment, development and management of business logic such as functions, messages and services in IT industries over the Internet. The SOA services are scalable, flexible and loosely coupled (Viana, 2009). In our previous work (Chandio, 2012), SOA has been implemented as a service orchestration on Web to provide way for best realizing SOA architecture. (3) MapReduce is framework to perform high performance computational jobs in parallel. Jobs are computation requests issued by user, each job splits into several tasks. Before job completion, the entire tasks are finished. Jeffrey Dean has clear explained to MapReduce in his paper (Dean, 2008).

Video transcoding

The actual process of video transcoding is to convert a compressed video file into another compressed video file with different format such as different bit rate, frame rate, frame size, or even compression standards. It produces comparable video quality with direct encoding, for instance, a user wants to transmit a MPEG-2 bit stream on 4Mbps bit rate via any transmission type which has capacity of 2Mbps. In this case the user must need to reduce it to 2Mbps.

There are three most common scenarios available for transcoding: Homogeneous, Heterogeneous and additional functions (Ahmad, 2005). Homogeneous transcoding process applies on same type of standard file with different parameters like different bit-rates, frame-rates and resolution of video stream. High level quality standard source video file can be transcoded in low level quality standard with different temporal and spatial resolution. In contrast to homogeneous, the heterogeneous process is conversion between different standards as well as its parameters such as H.264 to MPEG-4, MPEG-2 to MPEG-4 and MPEG-4 to H.264. The last one is an additional function transcoding such as error-resilience and logos are watermarking insertion. (Ahmad, 2005) has clearly mentioned transcoding types and its techniques (Ahmad, 2005).

Bandwidth is one of the most essential factors for video quality because high bandwidth deals with the high video quality whereas low bandwidth is required for compressed video. That's why many media applications and devices use compressed video files over the Internet. Compressed video can save bandwidth, transmitted faster and give better video quality in same bandwidth. Many researchers have used adaptive techniques to transcode original multimedia content according to the user's preferences and device's restrictions (Dogan, 2004). The content adaptation can be achieved by three well known techniques in the context of video delivery. In one of these methods, video sender provides different copies of same video; each copy is based on different bit-rate and quality. The content provider is able to select one of them, as to which version should best fit for the user's and device's needs. The main drawback of this technique is the need of a large amount of storage space on the video sender and if new devices will be released in the market, then it could not be served by this transcoding technique. The second technique is recoding (re-encoding) technique. It re-compresses the pre-encoded video. This technique works in three steps: (1) Video source file is sent as a compressed file to decoder, (2) Decoder will de-compress it and store un-compressed video in memory and (3) Encoder will compress the un-compressed video to client. Recoding is most suited when video would be edited one time or repeatedly but it requires a large number of computations for processing. Another technique is known as transcoding method. It is different than encoder and decoder. The compressed video is processed in the both input and output side. That is why transcoding technique requires less computation time for processing than re-encoding technique. It is more efficient and flexible than other techniques because it can adapt video contents in real-time to match the capabilities and constraints of device. In transcoding method, the video format is recorded into another new video stream with new features, and matching frame/bit-rates and/or frame size restrictions (Li, 2001; Dogan, 2004; Ahmad, 2005; Goularte, 2007).

Video compression is very important before the transcoding process; without editing in file format it is really difficult to send a file on Internet or different devices, due to many factors such as large file size, integration of different networks and different devices

have different requirement for file formats. Compression technique can discard information and remove unnoticeable details from video in order to reduce and shrink over all file size. Wu in 2011has worked on compression algorithm in the field of image and video coding. In transcoding process of compression three components *container*, *codec* and *bit- rate* need to be focused for selection.

- *Container* means File Format; a large number of file formats is available for video files that can be used via internet. After the compression, data is to be structured in container format to transfer from one place to another, and to decrease file size before it is sent to other party. There are many player softwares and devices available that support different file formats such as Avi, MP4, MOV, AVCHD, Flv, DV, WMV, and MSWMM.
- *Codec* stands for coder and decoder. The container is structured via specific coded standard. Codec can be selected in terms of speed of network, size of video file and quality of video file. These are three common types of codecs. (1) Divx/Xvid is good for compression, size of video and quality ratio. (2) X264 is great for video streaming with MP4 container. Youtube mostly uses this codec technique. (3) FFMPEG is the open source library for decoding and encoding any type of video, it is called one shop for video. FFMPEG is most suitable in linux distribution but it also compatible for mac and windows.
- *Bit rate* measures the amount of data that is transmitted to devices via any type of network in a particular amount of time. It commonly measured bits per second (bps), kilobits per second (kbps) and megabits per second (mbps). Multiple scenarios in video transmission can transfer data in different data rate such as online conference video streaming involves 256 kbps, video cd's 1375 kbps, DVD quality 5mbps, HDTV 10 mbps and bluray 40 mbps.

The rest of this paper is as follow. The next section describes the proposed model of video transcoding and its solution. Section 3 is about the results and discussion. Finally, the conclusion is given in the last section.

2. MATHODS AND MATERIALS

User interaction and integration of video files with computers, networks, cellular mobiles, Internet TV, iPod and other PDA are becoming important tasks in research in terms of an increasing number of video formats. For the intelligent enterprise, today's organizations have a need to adapt advanced analytic capabilities, methods, tools and techniques which must provide superior insight and predictability to support management to make better decision and actions. IBM believes on making analytics core and thinking on explosion "everyone – and everything – is leaving real-time data tracks" can really get smarter system (LaValle, 2009). It has been recognized by high competitive business that information and data service can be critical while traveling over the Internet. Right information and data service access at the right time enables the smart system to make the right decision in a timely fashion. IBM introduced smart analytics cloud that make business as smarter, empowering organizations and providing easy way for all employees to make a better decision and delivery of business intelligence in private cloud deployment (Parziale, 2010). Intelligent smart cloud computing (ISCC) model provides different personalized contents to each of the user through intelligent processing which is based on 4S/3R (Smart Pull, Smart Push, Smart Content, Smart Prospect, Right route, Right view, Right time) (Song, 2010).

Different kind of internet users have different demands for cloud services and it is difficult for system to provide and find out the exact service that a user needs, so understand the meaning of user's requirements is very important (Wu, 2012). For example one smart device wants to send video file to another device, both have different parameters to play the video file because of the requirements of different players like screen size, resolution, etc. There are two mechanisms for delivering service to user: (1) Static approach: it is a set of pre-computed formats users only select according to their requirements. It is an efficient approach in terms of retrieval of information. (2) Dynamic approach: it has run-time computing parameters according to user's device profile. It is most smart mechanism that provides the services intelligently.

Due to different kinds of multimedia applications and current communication infrastructure comprised on different network protocols, there has been demand for inter-network multimedia communications over heterogeneous networks. The rising heterogeneity in available networks, multimedia terminals, user profiles as well as applications and services are facing the problems while accessing the multimedia content anytime, anywhere, and with any device. Over the Internet, most of the users want to access the video files in the shape of movie clips. Every user is demanding the uninterrupted delivery of video in high quality results, and they can use network via wire-line or wire-less. Youtube, Hulu, Baidu and many other media providers are continuously modifying their systems to make their systems more efficient in the process of video transcoding.

There is a greater need of cloud computing infrastructure for on demand video transcoding process to challenge high latency and long processing time. Video transcoding is expecting to do more to become a smart system such as improve the quality of services, deliver new services that help the system to grow and increase ability of quick delivery. Important issues rise from multimedia applications such as dynamic end-user characteristics including decoding and display capabilities, heterogeneous and network bandwidth limitations.

There are lots of areas that still need to overlook the video transcoding such as accessing different types of video file format with large size over the internet and its codec incompatibilities; it creates slow process during encoding and decoding process even this process performs on modern core processor. Every video files are different than others even they have same time duration in clip because they have different contents, that's why they are demanding different computational time (Huang, 2011).

Currently many intelligent video processors have been proposed and still are working for video scene understanding or objects recognition (Wu, 2011). Only image processing (Kim, 2011) has been solved on cloud computing by media processing so video transcoding in cloud environment still has not been done. Very fewer examples are available of cloud based video transcoding. Which are used as commercially and the transcoding services are integrated with Amazon web service's products such as VideoToon by HP's Lab (http://www.hpl.hp.com/open_innovation/cloud_collaboration/cloud_demo_transcript.html), HDCloud.com and encoding.com, CloudFront, Ankoder, transloadit and zencoder.

Problem Formulation

The proposed research direction defines transcoding system as much smartly with help of cloud infrastructure;

- by adding new innovative adaption which is useful not only for users but for transcoding system itself as well. The innovative adoption will enable the transcoding system as knowledge based system.

- After implementation of cloud features in transcoding system, it would be able to provide automatic infrastructure for users even they have different requirements such as, users are using different kind of devices and all devices are of different screen resolution.

3. RESULTS AND DISCUSSIONS

The main goal of this research is to understand the behavior of users' devices along with all their needs so that the device can provide the best services with required time constraints and can decrease the long transcoding processing time.

We have found some solutions for video transcoding which are quite helpful for creating smart video transcoding using cloud computing environment (Dogan, 2004; Garcia, 2010; Franke, 2011; Garcia, 2011; Zheng, 2011; ffmpeg Tutorial: http://www.ffmpeg.org/ffmpeg.html).

The contribution of parallel computing (Dean, 2008) and MapReduce (Dean, 2008) is the core idea of cloud environment, so we utilize their benefits to achieve the goal. Cloud transcoding system can perform parallel encoding and multiple video clips could be computed or transcoded on the nodes under the different MapTimes, First-task First-serve scheme introduce unbalanced computational load on the nodes which is called transcoding jitter. This is degrading the encoded video quality due to down speed in video encoding process and many others.

As Mentioned Earlier That The Mapreduce Is The Framework That Is Capable Of High Performance Computational Jobs In Parallel So The Major Step Of Our Contribution Is To Fix The Programming Transcoding Technique In Mapreduce Programming Model. Mapreduce Splits The Code In Small Portion For Forwarding To Different Nodes In Cloud Environment And All The Small Portion Of Code Is Executed In Parallel. Transcoding System In Mapreduce Can Easily Achieve The Goal To Handle Big Video File And Will Speedup The Transcoding Method. For Creating Smart Transcoding System In Term Of Storage, We Get The Full Usage Of Latest Data Storage Technologies Where Cloud Environment Provides This Facility. There Are Many Data Base Tools For Data Storage, One Of Which Is HBASE Technology In Cloud Environment. HBASE Is Superior And Better Than Others In Many Cases; It Not Only Stores Large Data Sets But It Is Also Good In Query Performance And Scalability (Franke, 2011). Garcia In (Garcia, 2010) Has Proposed Three Experimental Ways That are Focused on Procedure Time and Transmission Time For Speedup Transcoding:

HDFS TO HDFS,
HDFS TO CE AND
CE TO CE.

The best experimental way found to be CE to CE where transcode input and output should be available on CE (common external) external storage that can be accessed by all cloud nodes as well as web servers.

It is one of the solutions of our problem (Gracia, 2010). For experiments we used ffmpeg media convertor library in MapReduce, it is a very fast convertor for both media type video and audio, and it can also be used from a live audio/video source (http://www.ffmpeg.org/ffmpeg.html). The ffmpeg can lead the solution of many problems such as clients may have lower screen resolution than the original video, thus the video bit-rate can be further reduced by reducing the video resolution. The proposed model is performing successful video transcoding on cloud environment; however the complexity of the model will be analyzed in future.

4. CONCLUSION

Cloud computing is becoming a popular choice in every kind of fields in real world, video transcoding is one of them. The server resources can be accessed by different user devices including computer, tablet, notebook, smart phone, pad computer or other devices. User interaction and integration of video files using different devices are becoming important tasks in research in terms of increasing number of video formats.

This paper expresses a brief introduction of cloud computing and its current trends in field of video transcoding. We have proposed the solution that makes video transcoding smart and speeds it up by using the efficiency of cloud computing. It is aimed to provide performance evaluation of the proposed system in future.

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