UNIVERSITI PUTRA MALAYSIA

FAST DATA TRANSFER TECHNIQUE FOR LARGE DATA IN GRID ENVIRONMENT

CHONG MIEN MAY

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FAST DATA TRANSFER TECHNIQUE FOR LARGE DATA IN GRID ENVIRONMENT

By

CHONG MIEN MAY

Thesis Submitted to the School of Graduate Studies, Universiti Putra Malaysia, in Fulfilment of the Requirements for the Degree of Master of Science

April 2015

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Abstract of thesis presented to the Senate of Universiti Putra Malaysia in fulfillment of the requirement for the Degree of Master of Science

FAST DATA TRANSFER TECHNIQUE FOR LARGE DATA IN GRID ENVIRONMENT

By

CHONG MIEN MAY

April 2015

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Nowadays, multimedia files such as videos and images are being improved in terms of their quality, where the dimension of the video or image is improving from two dimensional (2D) to become three or four dimensional (3D or 4D). These quality improvements have also increased the size of the multimedia data. Thus, the large size of video data has used a lot of time to transmit through the network. To solve the problem, in our research, we proposed a new video splitting technique, which is the "Exponential-and-Uniform-based (ExpoNUni) Splitting Technique" to improve the transmission time and maintain the quality of the data.

Our "ExpoNUni" Splitting Technique has performed a better result compared to the existing techniques such as Fibonacci-based Splitting with V1min Technique and Uniform-based Splitting Technique. For the Initial Delay, overall, our splitting technique by average has 26.23 % lesser initial delay time for comparing with the existing Fibonacci-based Splitting with V1min Technique. It shows an 11.62% average of initial delay time lesser comparing to Uniform-based Splitting Technique.For download time, the overall result that compared with the existing Fibonacci-based Splitting with V1min Technique, our splitting technique by average 1.43% lesser time for downloading a complete video file to the user's PC from the grid storage, while the Uniform-based Splitting Technique, it shows 1.67% decrement of average downloading time.

To prove the Exponential-and-Uniform-based splitter component is able to reduce the transmission time in a Grid-based Video Storage Framework, we also compare the uploading time and downloading time between the framework without the splitter component and the framework with our splitter component. The results show that the framework with our splitter component proofs it takes lesser data transmission time, where overall with an average of 9.86% lesser time for the uploading time and overall with an average of 12.24% lesser time for the downloading time. Besides, the

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MATLAB tool proves that our splitting technique did not affect the quality of the retrieved data

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Abstrak tesis yang dikemukakan kepada Senat Universiti Putra Malaysia sebagai memenuhi keperluan untuk ijazah Sarjana Sains

TEKNIK PEMINDAHAN DATA YANG CEPAT UNTUK DATA YANG BESAR DALAM ALAM PERSEKITARAN GRID

Oleh

CHONG MIEN MAY

April 2015

Pengerusi : Rohaya Latip, PhD
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Pada masa kini, fail multimedia seperti video dan imej sedang meningkat tahap kualiti mereka, di mana dimensi video atau imej telah bertukar daripada dua dimensi (2D) kepada tiga atau empat dimensi (3D atau 4D). Peningkatan kualiti ini juga telah meningkat saiz data multimedia. Oleh itu, video yang bersize besar telah menggunakan banyak masa semasa dihantar melalui rangkaian internet. Untuk menyelesaikan masalah ini, dalam kajian kami, kami mencadangkan teknik pemisahan video yang baru bernama "Eksponen-dan-seragam berasaskan (ExpoNUni) Pemisahan Teknik". Teknik ini digunakan untuk meningkatkan masa penghantaran data dalam rangkaian internet dan juga digunakan untuk mengekalkan kualiti data.

Teknik Pemisahan "ExpoNUni" kami telah memberikan keputusan yang lebih baik berbanding dengan Teknik Pemisahan berasaskan Fibonacci V1min dan Teknik Pemisahan berasaskan Uniform. Secara keseluruhannya, Teknik Pemishan "ExpoNUni" kami telah berjaya menurunkan purata 26.23% masa kelewatan berbandingan Teknik Pemisahan berasaskan Fibonacci V1min dan menurunkan purata 11.62% masa kelewatan berbandingan Teknik Pemisahan berasaskan Uniform. Bagi masa muat turun, berbandingan Teknik Pemisahan berasaskan Fibonacci V1min, teknik pemisahan kami telah berjaya menurunkan purata 1.43% masa muat turun, manakala berbandingan Teknik Pemisahan berasaskan Uniform, teknik kami berjaya menurunkan purata 1.67% masa muat turun.

Untuk membuktikan komponen splitter berdasarkan "ExpoNUni" mampu mengurangkan masa penghantaran data dalam Rangka Kerja Penyimpanan Video berasaskan alam sekitar Grid, kami juga membandingkan masa muat naik dan masa muat turun di antara rangka kerja tanpa komponen splitter dan rangka kerja dengan komponen splitter kami. Keputusan menunjukkan bahawa rangka kerja yang membawa komponen splitter kami telah mencapaikan purata kekurangan 9.86% untuk masa muat naik dan purata kekurangan 12.24% untuk masa memuat turun. Selain itu, alat

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MATLAB juga membuktikan bahawa teknik pemisahan kami tidak memberi sebarang kesan negative kepada video data.

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THANK YOU TO ALL ~

Chong Mien May

21ST JULY 2015

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I certify that a Thesis Examination Committee has met on 15 April 2015 to conduct the final examination of Chong Mien May on her thesis entitled "Fast Data Transfer Technique For Large Data In Grid Environment" in accordance with the Universities and University Colleges Act 1971 and the Constitution of the Universiti Putra Malaysia [P.U.(A) 106] 15 March 1998. The Committee recommends that the student be awarded the Master of Science.

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LIST OF ABBREVIATIONS

AVC	Advanced Video Coding
BIRN	Biomedical Informatics Research Network
CDs	Compact Disks
CT	Computed Tomography
ExpoNUni	Exponential-and-Uniform-based
HPC	High Performance Computing
HUKM	Hospital Universiti Kebangsaan Malaysia
IS	Information System
MAD	Mean Absolute Differences
MAP	Maximum A Posteriori
MBs	Macro-Blocks
MediGrid	Medicine Grid
MPEG	Motion Picture Experts Group
MRF	Markov Random Field
MRI	Magnetic Resonance Imaging
MSE	Mean Squared Error
MV	Motion Vector
NM	Nuclear Medicine
PACS	Picture Archiving Communication System

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PC	Personal Computer
PHP	Hypertext Preprocessor
RAM	Random Access Memory
SAD	Sum of Absolute Differences
SE	Storage Element
UiTM	Universiti Teknologi MARA
UPM	Universiti Putra Malaysia
US	UltraSound
VO	Virtual Organization
VOMS	Virtual Organization Management System
VOs	Virtual Organizations
WMS	Workload Management System

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CHAPTER 1

INTRODUCTION

1.1 Research Background

Grid computing is the service-oriented distributed systems that generally are with the high performance computational computers. It normally composed of heterogeneous resources (Hussin & Latip, 2013). Today, it has become a new technology that able to bring the high performance distributed infrastructure for the community (Bruneo et al., 2009). Grid computing is giving a best way for the community to solve a number problems.

Thus, nowadays, there are a lot of applications integrated with the grid computing technology. These applications includes drug diagnostics applications (Lee & Park, 2014; Redolfi et al., 2009), protein folding applications (Desell et al., 2010), financial modeling applications (DAWSON et al., 2014; Jacob et al., 2005), earthquake simulation applications (Cinquini et al., 2014; Cossu et al., 2010; Dabas & Arya, 2013; Fernández-Quiruelas et al., 2011; Renard et al., 2009), climate or weather modeling applications (De & Nationale, 2014; Sper de Almeida, 2012) and other applications. In medical area, there are a lot of the projects running under the grid environment, such as BIRN Projects (Astakhov et al., 2005; Glover et al., 2012; Grethe et al., 2005; Keator et al., 2008), MammoGrid Projects (S. R. Amendolia et al., 2004; S. Amendolia et al., 2004; Warren et al., 2007), MediGrid Projects (Bertero et al., 2003; Boccia & Guarracino, 2005; Krefting et al., 2009; Weisbecker, Falkner, & Rienhoff, 2009) and other projects (Kumar et al., 2008).

Since there are a number of applications using the grid computing to execute their works, there is a need to study on the issue of the grid service's quality. As what's presented in the paper of Bruneo et al., 2009, to provide a better service in the grid environment, the requirements for the Quality-of-Service (QoS) must be focused and studied, such as the delay perceived by the user, the time for uploading or receiving a data from the grid storage. Thus, it is important to study on the issue of data transmission.

Text, audio, video, and image graphics are the data that normally transmit in the network. Among these data, video has become one of the important mediums for the area of communications and entertainment (Thampi, 2013). Like what have been presented in the paper of Toharia et al., 2008, many fields such as the news broadcasting (news, shows, series, etc.), advertising, and medical applications, are using the large amount of video. Thus, to enhance the video clarity and quality, nowadays, the video has been improved from the two dimensions (2D) video images into three dimensional (3D) or four dimensional (4D) video images.

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However, the improvement of the video dimension also increased the size of the video. Thus, video has become the data that takes up a lot of space and time during the transmission and storage session. To reduce the data transmission time for a large multimedia data, such as video, normally there are using two ways to reduce the size of the video before transmit through the network, such as the video compression technique or video splitting technique.

There researchers that worked on the video compression techniques are included Ahmed et al., 2011, Anand Deshpande & Rao, 2014, Ismail et al., 2012, D. Kim et al., 2006; N.-J. Kim et al., 2009, Okade & Biswas, 2013; Shen, 2005; Shenolikar & Narote, 2009; Xiang et al., 2013. Although video compression is able to reduce the size of the video, however, this technique still facing some limitations, such as the video quality problem (noise problem) and also the algorithm computation time problem.

In the papers of Bruneo et al., 2009; Jin et al., 2014; Nithya & Shanmugam, 2010; Shenoy & Vin, 1997; Sidhu & Singh, 2010, they are focusing on the video splitting technique. They introduced some splitting techniques, such as the Uniform-based Splitting Technique, Fibonacci-based Splitting Technique, and Fibonacci-based Splitting with V^1_{min} technique. By using the Uniform-based Splitting Technique, Fibonacci-based Splitting Technique, and Fibonacci-based Splitting with V^1_{min} technique, they were found that the transmission time for large video is able to reduce.

By studying the video splitting techniques, we found that unlike the video compression techniques, video splitting techniques not only reduce transmission time, they also maintain the quality of the video. In short, after studying some previous papers, we decided to introduce a new video splitting technique that is capable of reducing video data transmission time and maintaining the quality of the video data. Besides, to test the video splitting technique, the Video Storage Framework was also introduced under the Academic Grid Environment. The proposed splitting technique was applied in the framework.

1.2 Problem Statement

In a network, transmitting large data on a limited bandwidth is very critical. There are two common techniques used to reduce the video data transmission time, which are the video compression techniques and video splitting techniques. Video compression techniques can reduce the size of the video, however, this techniques also reducing the quality of the video, such as removing the pixels or the detail of the video images. Thus, video compression technique is not the best solution to reduce the size for some critical and important video such as the medical video data because medical data must be accurate for diagnosing the patient's illness.

To prevent the pixels removed from the video images, we choose to study on the video splitting technique. However, from the previous Uniform-based Splitting Technique, and Fibonacci-based Splitting with V^1min Technique, we found that the techniques

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have some limitations. In Uniform-based Splitting Technique (Bruneo et al., 2009; Jin et al., 2014; Shenoy & Vin, 1997; Sidhu & Singh, 2010), the delay time is high; while for the Fibonacci-based Splitting with V^1min Technique (Bruneo et al., 2009), it used a lot of time on the complex mathematical algorithm where searching the first chunk size is needed before starting the splitting process. Thus, Fibonacci-based Splitting with V^1min Technique also increasing the data transmission time. To reduce the data transmission time and maintain the quality of the video images, a new splitting technique should be proposed.

In paper of Toharia et al., 2008; Toharia et al., 2010, presented that many fields such as the news broadcasting (news, shows, series, etc.), advertising, medical applications, educational field and others fields, all requires large video storage to store a large amount of video data. However, due to the size of video, the storage space on the server for storing the large video data has become an issue.

To solve the storage problem, there are some Grid-based Videos and Images Storage Frameworks developed, such as the Distributed Mammographic Database Framework in the MammoGrid Project (Warren et al., 2007), the Grid-based E-learning System Framework for the educational video purpose (Mitra, Das, & Roy, 2015), and others framework. By using the grid computing storage, the space storage can be more manageable and could overcome the limited storage of the server. Besides, the video images data is more reliable and available due to the replication function inside the grid storage. However, there is a limitation for these frameworks, where their framework do not have a splitter function at the server that can reducing the data transmission time in the grid environment.

In paper of Jin et al., 2014 and Liao & Jin, 2005, they worked on the clustered video servers. They using the video splitting and distributed placement scheme for their clustered video servers, where the scheme is dividing the movie into several parts with the same time length of same file size (Uniform-based Splitting Technique) based on the requirements of the clients. However, in first problem statement, we found that the Uniform-based Splitting Technique is having a high delay time. Thus, the delay time problem is becoming a limitation for this framework. Besides, the other limitation is the framework is working on the cluster based technology and not the grid computing technology. Since grid computing sharing the computer power and data storage capacity over the Internet, thus, the grid computing can provide more storage than the cluster computing.

Based on the limitations found in the previous studies, in this research, a new Grid-based Video Storage Framework with the Exponential-and-Uniform-based Video Splitter Server was developed.

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1.3 Research Objectives

First, the main objective of this research is to propose a new video splitting technique for reducing the data transmission time in grid environment. The new video splitting technique must be able to reduce the initial delay time and total download time for the Video Download Service in the grid environment. Besides, it should maintain the quality of the video after the splitting and reconstruction process have been done.

The secondary objective of this research is to develop a framework for managing the large video data inside the grid environment. The new technique, named as Exponential-and-Uniform based Splitting Technique will be embedded in the framework. This framework runs on the Academic Grid testbed to store all the large video data.

1.4 Research Scope and Limitation

The scope of this research is to propose a new video splitting technique, which can reduce the initial delay time and the download time for a video download from the grid storage. Besides, the Grid-based Video Storage Framework is built and run on the Academic Grid testbed. Academic Grid is known as the A-Grid, which is a learning and discovery grid. Figure 1.1 shows the diagram of the Academic Grid Environment. There are more than three terabytes of storage spaces are made available to grid users to store their data in the Academic Grid Storage. The members of the Academic Grid Malaysia include the Biruni Grid of Universiti Putra Malaysia, the Crystal Grid of Universiti Malaysia, and the Grid of Universiti Teknologi Malaysia.

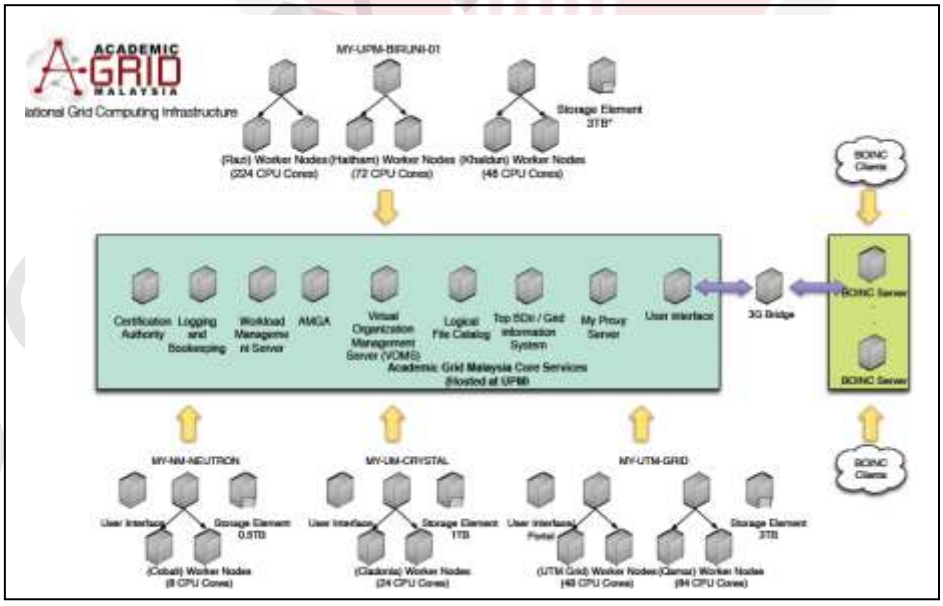

Figure 1.1. Academic Grid Environment

Besides, the research is focused mainly on the 600MB video file as the dataset. This is because of the previously studies (Bruneo et al., 2009; Nithya & Shanmugam, 2010), are using 600MB video data for testing. Thus, to have an accurate comparison analysis with the previous techniques, a 600MB video file is chosen as our dataset. There are five 600MB video files with the same video format but different video contents were used in the experiments.

1.5 Organization of Thesis

CHAPTER 1: INTRODUCTION
In this chapter, a brief description of the research area is presented, followed by a presentation of the problem statement and the objectives of the research. The outline of the thesis is as follows.

CHAPTER 2: LITERATURE REVIEW
In Chapter Two, an overall assessment of different theories connected to the research is presented. It included the Grid Computing's Background, and also the review of the existing video splitting techniques. Besides, this chapter also discussed on the data transmission's issues

CHAPTER 3: METHODOLOGY
This chapter covers the test bed design and the planning for the implementation processes. This section explained the work and process flow of the research as well as the methods and the techniques used in the research.

CHAPTER 4: EXPONENTIAL-AND-UNIFORM-BASED (*ExpoNUni*) SPLITTING TECHNIQUE AND GRID-BASED VIDEO STORAGE FRAMEWORK
This chapter covers the details of the Exponential-and-Uniform-based (*ExpoNUni*) Splitting Technique and development and design of the framework. In this section, all the technical process of the research and the framework will be explained.

CHAPTER 5: RESULTS AND DISCUSSIONS
In this chapter, it covers the details of the test bed implementation, and also the experiments' results in the real test bed.

CHAPTER 6: CONCLUSIONS AND FUTURE WORKS
A discussion and conclusion of the research are found in Chapter Six. In this chapter too, there are some future works has been discussed too.

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