May 23, 2007

Mr. Lakshman One
School of Engineering Science
Simon Fraser University
8888 University Drive
Burnaby, BC V5A 1S6

Re: ENSC 440 Project Post Mortem for Internet Media Streaming on TV

Dear Mr. One:

Ensight Solutions would like to present to you our post mortem for the ENSC 440 capstone project, outlined in the attached document, *Post Mortem for a Next Generation IPTV Set-Top Box*. Our proof-of-concept project is to realize an application running on an ARM/DSP development board in order to display internet media streams on a standard television without a personal computer. This project is done under the guidance and support of Dr. Farid Azhar of Varietize Technologies.

The post mortem presents you with an overall idea of our team dynamics, such as each members' testimony and opinion regarding the last five months, along with description of the final status of our project. Furthermore, each project member will discuss valuable skills learned and acquired and their personal contribution and technical developments involved.

Ensight Solutions is comprised of four undergraduate engineering students: Allen Lai, Hugo Kwok, David Shen, and Jimmy Jeong. If you require more information, please do not hesitate to contact me by phone at (778) 883-3376 or via e-mail at ensc440-group10@sfu.ca.

Sincerely,

Allen Lai
President and CEO
Ensight Solutions

Enclosure: *Post Mortem for a Next Generation IPTV Set-Top Box*

Post Mortem for a

NEXT GENERATION IPTV SET-TOP BOX

Project Team: Allen Lai
Jimmy Jeong
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Submitted To: Lakshman One – ENSC440
Steve Whitmore – ENSC305
School of Engineering Science
Simon Fraser University

Submission Date: May 22, 2007

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1 Introduction

In the past five months, Ensight Solutions has been researching and developing a proof-of-concept model for the next generation IPTV set-top box which will ultimately be capable of handling streaming signals from any IPTV service provider. Much effort was directed towards research and implementation of existing open source software code to result in gaining insights into the design and integration of our system.

For our application, the input media is in Real Media format, from any remote streaming server on the Internet using the RTP/RTSP protocol. The ARM and C6000 based system will stream Real Media formats and display it on a connected TV in real time. Through this proof-of-concept, we wish to assist our supporting company, Varietize Technology, with the tools necessary to become one of the leaders in IP technology and commercialize a functional prototype in the near future.

The latter part of this post mortem documentation will describe in details the different development phases to our final proof-of-concept product, the deviations from our original plan as documented in previous proposals and specifications, summarized with recommendations and future plans for our next generation IPTV set-top box. Furthermore, we will summarize with an outline of our incurred budget and time constraints. Lastly, each member will explain and discuss the interpersonal and technical experiences gained from the scope of this project.

1.1 Acronyms

AAC	A lossy data compression scheme for streaming audio
ARM	Advanced RISC Machine
AV	Audio and Video
DEVM	Digital Video Evaluation Module
IP	Internet Protocol
IPTV	Internet Protocol Television
LAN	Local Area Network
LCD	Liquid crystal display
MPEG	Moving Picture Experts Group
MPEG2	A standard from the Motion Picture Expert Group which define for digital television
MPEG4	A standard from the Motion Picture Expert Group which define for multimedia applicaiton
POC	Proof-of-Concept
RM	Multimedia container foRMat created by RealNetworks
RTP	Real Time Protocol
RTSP	Real Time Streaming Protocol
TV	Television
VOD	Video On Demand
WAN	Wide Area Network

2 Current State Of The Project

2.1 System Overview

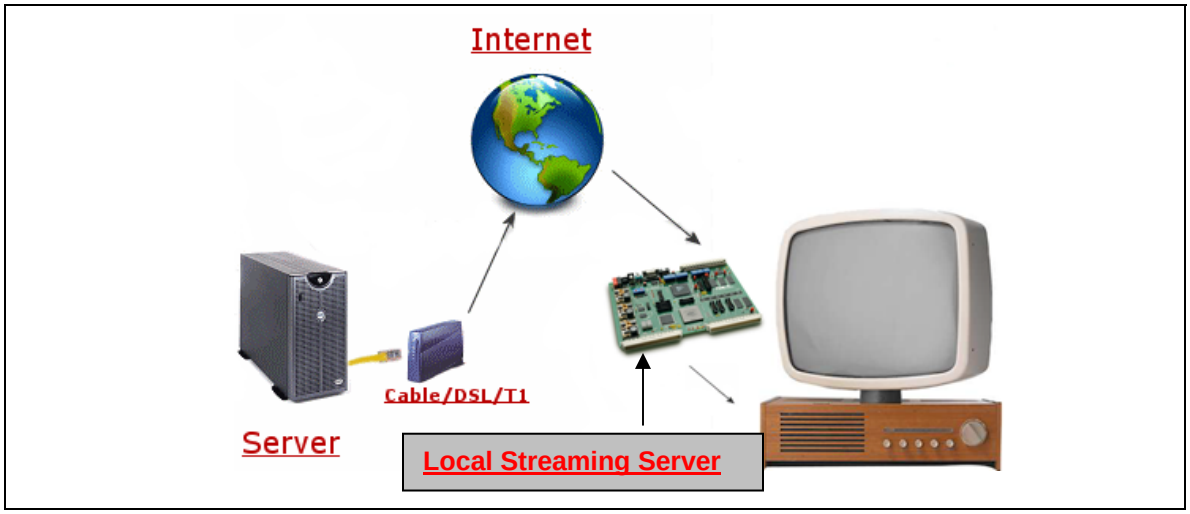

Figure 1: Illustration of System Overview

Figure 1 shows the current system diagram, in which the system can read media files from a local streaming server and also read data from local storage. However, due to the time constraints, the current system can only read media files in the Real Media format.

2.2 Software Modules

The main functionality of our software module is to decode an incoming media file, such that it can play voice and video data on a standard TV and also to encode the raw video and audio data into MPEG4 format.

2.2.1 Encoder

The encoding function is implemented by porting open source MPlayer to our development board, which is running a Linux on an ARM9 processor.

2.2.2 Encoder

The decoding function has not been implemented on the development board at this state. Also, the lower processing power of ARM9 processor cannot handle encoding function at a satisfactory rate. Therefore in our future development, the encoding function will be migrated to the C6000 DSP chip, which is capable of providing more processing power.

2.2.3 Conversion Block

As proposed in our design specification document, one of the objectives in our project is to convert different media file into MPEG4 format. However, due to difficulties with codecs, and the slow processing speed of the ARM9, the conversion process could not be migrated to our development board. At this state, the conversion process successfully

runs on x86 perform, which provides more processing power compared to the ARM9. In our future development, we will migrate the conversion process to C6000 DSP chip.

3 Deviation From Original Functional Specification

As we were unable to correctly compile the required codec to decode a RealMedia file in the ARM9 processor, we demonstrated the functionality of this proof of concept on the x86 platform instead. The codec that we used was the version that is readily available for the PC, which came with the Mplayer package. Had we been successful in compling the codec for the ARM9, our current design and implementation would have been transferable to the development board, and functioned correctly.

4 Budget

As seen in Table X, our budget for this project is at zero dollars. This is due to the generous support of Dr. Azhar of Varietize Technologies in lending us the development board in the testing and integration phases of our product. We were very grateful as this resulted in lifting a significant financial burden off our team as the development board is approximately valued at a few thousand dollars. The time to locate, buy and ship a similar board if we were to provide it ourselves would also cut into our time in the development cycle.

Basic equipment such as desktop PC system and wireless internet router to provide a static IP address were self supplied from our group members as these are everyday essentials and does not justify budget allocation for the purpose of this project.

We were fortunate to be able to access all the software we need from open source available in the internet, which is one of the advantages of working with a unix based development operating system.

In the end, our team was able to maintain our initial budget and personal contributions were not necessary.

Equipment	**Cost**
DaVinci System-on-Chip Development Board	Provided by Varietize Technologies
Software: OpenSuse Linux, MPlayer/MEncoder, Eclipse IDE, Helix Server, Various Source Codes	Free since all open source and available online
Desktop PC, Wireless Internet Router	Self-provided
Total	**$0**

5 Time Constraint

Our group had difficulty making progress because this project, primarily involving research and development work, has made it tricky to estimate and schedule our deliverables. Thus, we were unable to finish the project within the initial timeframe and had to extend it for approximately three weeks. In addition to the extension, we also had to narrow the scope so that we can finish the project by the new deadline.

6 Recommendations and Future Plans

6.1 Migrating to C6000 DSP CPU

The DaVinci System-on-Chip development board is comprised of two CPUs, an ARM9 and a C6000 DSP. Due to the application of our proof of concept design with Real Media, our group utilized the ARM9 CPU in our development process. ARM9 is small and very power efficiency and is integrated into many portable electronics that is common today such as the palm handheld, Nintendo DS and various Motorola cellular phones.
Since the ARM9 CPU clock speed is only estimated in the few hundred megahertz range, it is indeed too slow for streaming applications, if resolution was to increase in the output such as a LCD or TV screen. This will result in slow frame rate, or possibly dropped frames, in addition to unsynchronized visual display with audio output.

One of the future plans for this project is to eventually migrate the whole system to its neighbouring C6000 CPU, which is capable of handling much faster processing and calculations compared to the ARM9. In return, this will provide smoother processing of the audio/video streams with larger resolution, as this will supply an appropriate output format to television sets which is the ultimate goal of the set-top box.

6.2 Accommodating all different input media formats

Another goal of our project is make our set-top box compatible for multiple service providers, for different inputting media formats. In other words, the ambition of our product is to be able to implement streaming of all media formats, including real media, into one universal format that we chose to be MPEG4. Therefore, our set-top box will act as an all-in-one media device and all IPTV service providers will be able to buy the same box with identical standards.

6.3 Development of GUI

A more user friendly GUI is planned for the development board, which will act as a compliment to the Video On Demand (VOD) feature of IPTV. Users will be able to easily select what they want to watch and when to watch it with the remote control. They will be able to rewind, fast forward, pause or stop with ease along with other basic functionalities related to media.

7 Interpersonal and Technical Experience

7.1 David Shen

The scope of this project provided me with a learning curve that could not be replaced from the routine of lectures, homework and midterms. I was finally able to utilize the last five months to apply all the knowledge I had learned during my academic career, and assisted me in prioritizing my schedule accordingly. At the end, it was a great learning experience. Although the start of the project presented many barriers and obstacles, our group as a whole overcame them and beat out the odds. The scope of the project became narrower as time progressed as we realized we had initially underestimated the complexity of this project. In my opinion, this project readily simulates the "real" workplace where adapting to tight deadlines and modifying plans constantly on the fly is a crucial part to the overall success of a project.

Team dynamics was what I valued the most in the course of this project. Even with two of the four members (including myself) on co-op, we were able to meet consistently throughout the semester and setup structured and organized meetings. I especially appreciate my team members coordinating with my work schedules to meet late at night on weekdays. In addition, having the chance to interact with Dr. Azhar and reporting to him on a weekly basis ensured our group was staying on track, and provided guidance and motivation along the way. I believe these soft skills will be advantageous to my future endeavours.

Although the development of our technology was hindered to a very researched based approach, it still exposed me to various technical knowledge such as the usage of unix based development platform and the different theories and concepts behind each codec available in the IP industry. I gained a basic understanding of open source softwares such as MPlayer and MEncoder, its development code and the functionality behind the program. One of the most profound concept I learn discovered for research based projects is that a significant amount of time should be invested in gathering and researching background information before the start of the implementing stage. Project members in essence should explore and exhaust all the possible avenues and possibilities in your design, to avoid less pain and frustration near the end. In other words, it is wiser to take the smartest route than to take the fastest route.

I would like to extend my sincere gratitude to Dr. Azhar for his tremendous support and giving us the opportunity to partake in this project.

7.2 Jimmy Jeong

Working on ENSC440 will be an experience I will never forget. I learned that setting high goals for the team sets a good destination to shoot for, but there also comes a time to realize that sometimes the initial goals you set may not be realistic. One of the toughest challenges was in communicating with fellow teammates about the progress we were making in research and development. I learned that, the more we share about what we have learned and accomplished, the more accountable we become.

I learned a lot about Mplayer and Mencoder, and how this media player functions in playing video and audio files. I also obtained a lot of knowledge on the different types of media formats that are out there, and how each requires its own codec for it to play properly. One of the biggest lessons I have learned from this project was to be persistent. This was the first time where I worked on a project that spanned one whole semester. There were times at the beginning of the project when most of the work we were doing was research based. During these times, it sometimes felt as if progress was not really being made on some days. However, after time, as little bits of knowledge gradually built up and as we made small accomplishments, I found myself realizing that we had come a long way. Later on in the work place, where a project may span for almost a year, I am sure I will be able to recall my experiences of 440 to keep myself going even during the tough times.

7.3 Hugo Kwok

It was a great experience for me to work on ENSC 305 and 440 this year. Not only did it expose me to the IPTV technology, but it also give me a chance to work in a great team. The biggest challenge during the project was time management. Since I am on co-op, the only time I was able to work on the project is after work. I really want say give thanks to my team members for their efforts to work with my schedule to work on the project late at night during the weekdays.

The most valuable lesson that I found from the project was communication and research skills. Since I am a software engineer in my group, I required doing a lot of research on IPTV technology. However, IPTV was a totally new field for me and there was so much information out there. Therefore, I have to find out what kind of information was helpful and relevant to our project. Also, I needed to transfer my knowledge to my group members. It was a great opportunity for myself to learn about how to pass along knowledge to others.

Last but not least, I really appreciate Dr Farid Azhar for letting us get involved in his project and for providing great support along the way. Without his sincere help, we could not have finished our project.

7.4 Allen Lai

I have learned a great deal working on the ENSC 305 and ENSC 440 project this past semester. As a project manager, I was the single point of contact for the project, including scheduling internal meetings with the group and also external meetings with the supervisor, advisor and instructors. I was also responsible for tracking the status of the project and assigning tasks to team members. While I was able to coordinate all of these tasks, the schedules between the group members did not work very well this semester. Two of the group's members had more free time during the day while the other two group members were on co-op placements and could not work on the project until the evening. While this scheduling was not the root cause of our obstacles, I believe it did play a role in slowing the progress of the project. Despite our bottlenecks, I was impressed by how well the team worked together. There were points during the semester where the morale and motivation was quite low, but there was always someone in the group to help us get up on our feet.

The most important lesson that I learned from this whole experience is communication. Internal communication could be improved; e-mails could have been checked more often and the turnaround time for a response could be quicker. Also, more meetings with our supervisor, advisor and instructors may also help steer the project back on track. In summary, I learned that projects will go beyond the planned budget and deviate from the schedule, but if we keep the lines of communication open among all parties, then there are no surprises and expectations can then accommodate any new developments that occur.

I would like to thank Dr. Farid Azhar for the opportunity to help him on the IPTV project, Dr. Ivan Bajic for his guidance and advice, as well as Lucky One and Steve Whitmore for their instruction and support throughout this semester.

8 Conclusion

This document encompasses all the results of our completed project detailing the development cycle and other relevant information such as the budget and time constraints. Overall, this five month project assisted all of us in preparing and polishing the skills we need to survive in the workplace after university, whether it is technical or soft skills. We learned that a balance of both skills must be achieved in order for the team members to work towards a common goal since each person is entitled to their own opinions, methods and approaches which might assist or conflict the interest of the group as a whole. We felt satisfied with the result from our semester long effort, and we hope this will aid Dr. Azhar into developing a fully functoional prototype to be commercialized later in the TV market. We truthfully wish the best of luck to his company, Varietize Technologies, and its future endeavours.

