**Abstract**

This thesis studies the modern solutions for multimedia home networking (MHN), especially the popular ones follow the Digital Living Network Alliance standard. By conducting a research on the features and implementations of these existing solutions, our team developed a suitable mobile solution for MHN which takes advantage of AirPlay, DIAL and DLNA on the Android platform.

Firstly, the thesis provides an overview of the popular streaming technologies, including AirPlay, DLNA, Miracast and Chromecast. By analyzing the features and capabilities of these streaming technologies, a universal solution is proposed for MHN in the hope of supporting multiple protocols and bridging different platforms.

Secondly, different multimedia solutions are tested and a mobile Application for home networking on Android is implemented. The corresponding system architectures, features and analysis methodologies are also discussed. In terms of practical contribution, an online channel proxy is made in our "Streambels" application to fulfill our target of streaming online channels such as YouTube. By implementing this online channel proxy, home networking and Internet resources are effectively bridged together.

Based on this thesis study, an Android application for Tuxera Inc. has been published. Over the 16 months after launching this application on Google Play Store, we have been able to generate a statistic report on how users utilize this app. By making analysis on the collected statistics, a short summary of the user behavior is presented and some recommendations are given to help improve the user experience.

Lastly, a discussion on the possible further development of multimedia home networking is conducted to conclude this thesis study.

**Preface**

This document is my master’s thesis of Communications Engineering majoring in Networking at Aalto University. All research and development of this thesis was conducted at Tuxera Inc. in Helsinki from January 2013 to June 2014. Tuxera is a high-tech startup that develops kernel-level file systems and multimedia solutions for leading software, hardware and electronics companies.

During this project I worked together with my colleagues at Tuxera, I started to work on DLNA project for the first few months during which period I learned DLNA architecture and made a research about Digital Media Server solutions. After that I worked on an Android project to develop a universal solution for multimedia home networking.

**Acknowledgements**

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**3 Developing a solution for multimedia home networking**

To fulfill the need of interoperability among devices in home networking, Tuxera Inc. started a project named Streambels (later renamed as AllConnect). The project aims to solve the interoperability issue in multimedia home networking by making a universal solution that can connect all available devices at home and make them work together regardless of what protocol they use.

Most devices at home are embedded solutions and have their own firmwares, it is hard to update or even impossible to upgrade the software running on these devices. On the other hand, most home network users are not knowledgeable enough to manually set up the more advanced network features to achieve certain degree of device interoperability. Plus most of these network infrastructures are not designed to be easily configured. Due to these reasons, building interoperability among different devices through a mobile device seems to be the most straight forward solution, for mobile devices can serve as a very flexible and programmable portal for home-networking. Other advantages of mobile devices include their great processing power, networking capabilities and their wide adoption and availability. Through the available platforms and tools, a mobile application could possibly be developed to control all multimedia streaming data flows and act as a personal access portal for home networking.

After a year of development, our team has built up an Android application that can be used to control and connect every known type of multimedia device at home. Encouragingly, the number of our application users have grown to nearly one million so far, providing a strong proof of the effectiveness of our solution.

**3.1 Architecture overview**

In order to solve the multimedia home networking interoperability problem, the system should be designed to control media playback sessions. Consequently, content navigation, manage receiver device, and media playback should be the most important three components. In our solution, the system architecture consists of three major parts: device discovery, content management and streaming.

The discovery component is responsible for device discovery. As discussed in 2.2.1.1, UPnP/DLNA devices and DIAL devices use Simple Service Discovery Protocol (SSDP) for device discovery. An application firstly sends a M-Search request over UDP to the IPv4 multicast address 239.255.255.250 and UDP port 1900. Then the application listens to other devices’ responses. A DIAL device will return a response with an Application URL header, while the UPnP/DLNA devices will return a message with a XML body, which provides detailed service URLs and description URLs.

Instead of using the SSDP discovery, Apple’s products, in comparison, use Multicast DNS for device and service discovery. Obviously, in order to support the three types of devices, namely the UPnP/DLNA devices, the DIAL devices and the Apple Airplay devices, we need to integrate these two mentioned discovery mechanisms, namely, the SSDP mechanism and the Multicast DNS mechanism, into our solution.

The content management component is responsible for organizing and navigating multimedia contents that can be discovered in the home network. In our solution, these content sources include both the local storage of smart phones and DLNA digital media servers that are connected to home network. As long as the discovered device belongs to the three device types that we support, its content could be streamed using our application solution.

The streaming component is responsible for streaming multimedia content to the selected multimedia receivers, such as TVs, wireless speakers, set top boxes, etc. In a typical home networking environment, DLNA, AirPlay video/photo and Chrome- cast all use HTTP streaming. The only exception, the AirPlay music, uses Remote Audio Output Protocol (RAOP). Because of this, we integrate two types of media servers inside our application solution. With our application, the built-in RAOP server would handle the AirPlay music streaming and the built-in HTTP media server would handle streaming of all other types.