DEVELOPMENT OF DELAY TOLERANT NETWORK WITH AUTOMATIC AD-HOC MODE

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To my beloved mother and father,
to my lecturers, for their guidance and encouragement.

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ABSTRACT

Delay Tolerant Network (DTN) is known as a solution to an Internet network where connectivity is an issue. Bytewalla is an existing application which uses smartphone as a physical transport of data between these intermittent networks. However, the application depends solely on infrastructure to establish network connectivity. Because of this, data packets will only be transferred to users and servers through an access point which limits the ability to multi hop instantaneously to nearby user resulting in less reliable data transfer. To overcome this problem, Bytewalla needs a mechanism which enables each user to connect to each other to send and forward data automatically without using an access point. An automated mechanism is proposed for ad hoc connectivity between smart-phones to ensure connectivity with high successful transfer rate. This thesis presents an automated mechanism called Delay Tolerant Network with Automatic Ad hoc (DTN-AAH). In comparison to Bytewalla, DTN-AAH shows shorter delay since nodes are able to cross-connect to other platform (infrastructure/ad hoc) that improves reliability. This thesis also presents simulation studies on DTN-AAH to investigate the performance of the system. A DTN-AAH Network Management Tool was created to ease users to perform DTN related functions such as sending and reading messages without hassle by creating a user-friendly web-based interface.

ABSTRAK

Rangkaian Dapat Terima Lengah (DTN) dikenali sebagai penyelesaian kepada rangkaian internet di mana penyambungan adalah satu isu. Bytewalla adalah satu aplikasi tersedia yang menggunakan telefon pintar sebagai pengangkutan fizikal data di antara rangkaian yang terputus–putus. Tetapi, applikasi ini hanya bergantung kepada infratruktur untuk mengadakan hubungan rangkaian. Disebabkan ini, paket data hanya akan dipindahkan ke pengguna dan pelayan menggunakan titik capaian yang akan menghadkan kebolehan pelbagai hop serta-merta kepada pengguna yang berdekatan yang akan mengakibatkan pemindahan data yang reliabiliti yang rendah. Untuk mengatasi masalah ini, Bytewalla memerlukan mekanisme yang membolehkan setiap pengguna berhubung antara satu sama lain untuk menghantar dan memindahkan data secara automatik tanpa menggunakan titik capaian. Satu mekanisme berautomatik diusulkan untuk hubungan ad hoc di antara telefon pintar untuk memastikan sambungan yang membawa kepada kadar pemindahan berjaya yang lebih tinggi. Tesis ini membentangkan mekanisme automatik yang dikenali sebagai Rangkaian Dapat Terima Lengah Dengan Ad Hoc Automatik (DTN-AAH). Apabila dibandingkan dengan Bytewalla, DTN-AAH menunjukkan lengah yang lebih rendah kerana setiap nod berupaya untuk berhubung sesama pelantar yang berlainan (infrastruktur/ad hoc), justeru meningkatkan reliabiliti. Tesis ini juga membentangkan kajian simulasi berkaitan DTN-AAH untuk mengkaji prestasi sistem ini. Alat Pengurusan Rangkaian untuk DTN-AAH dibina bagi menyenangkan pengguna untuk melakukan fungsi-fungsi DTN seperti menghantar dan menerima mesej tanpa kesusahan dengan menggunakan antara muka berasaskan sesawang yang mesra pengguna.

TABLE OF CONTENTS

LIST OF TABLE

LIST OF FIGURES

LIST OF ABBREVIATIONS

IP	-	Internet Protocol
TCP	-	Transmission Control Protocol
DTN	-	Delay-Tolerant Networking
DTNRG	-	Delay-Tolerant Networking Research Group
PRoPHET	-	Probabilistic Routing Protocol for Intermittently Connected Networks
IPN	-	Interplanetary Internet
EID	-	Endpoint Identifiers
TTL	-	Time to live
DTN-AAH	-	Delay Tolerant Network with Auto Ad-Hoc
AP	-	Access Point
OS	-	Operating System
ID	-	Identification
NMT	-	Network Management Tool
ONE	-	Opportunistic Network Environment
GUI	-	Graphical User Interface

CHAPTER 1

INTRODUCTION

1.1 Overview

Internet plays an important role to connect people with each other, regardless of distance. People can utilize the Internet for a lot of different purposes such as for business, entertainment, emergencies etc. However, not everyone has the opportunity to use the Internet, because lacking of technical facilities and infrastructural. Areas that are less reachable by the services providers and with low income are usually the unfortunate ones. Hence, Delay tolerant Network (DTN) is introduced, which is known as the solution to a network where connectivity is an issue. Issues which involved the cost and supplies needed to provide a communication infrastructure. Thus, exist project which uses DTN approach to apprehend these challenges [1] [2] [3].

Among these projects, there is one project that utilizes Android devices in DTN which is Bytewalla [4]. Bytewalla is an application which enables data to be carries by user with Android device from the source to the destination. The idea is by having a user with Android device to carry data from village server and transfers it to the city, which has internet access, as shown in Figure 1.1. However, there is still other important aspect that needs to be addressed and improved asides from the basic functionalities.

In a wireless network, there are two configurations which are infrastructure based and ad hoc based. An infrastructure based network requires an access point for

two or more nodes to connect consist of creator and joiner. A creator is the node that creates the access point allowing one or more joiner to connect with the creator. A creator will not be able to connect with other creator and joiner will not be able to connect with other joiner which affects the reliability of data transfer. The existing DTN application currently uses the infrastructure network which creates issues. Since, the reliability of data transfer is essential, a solution needs to be introduced in order to tackle the issue. The solution proposed will surely enhance existing DTN with high reliability data transfer as well as low transmission delay.

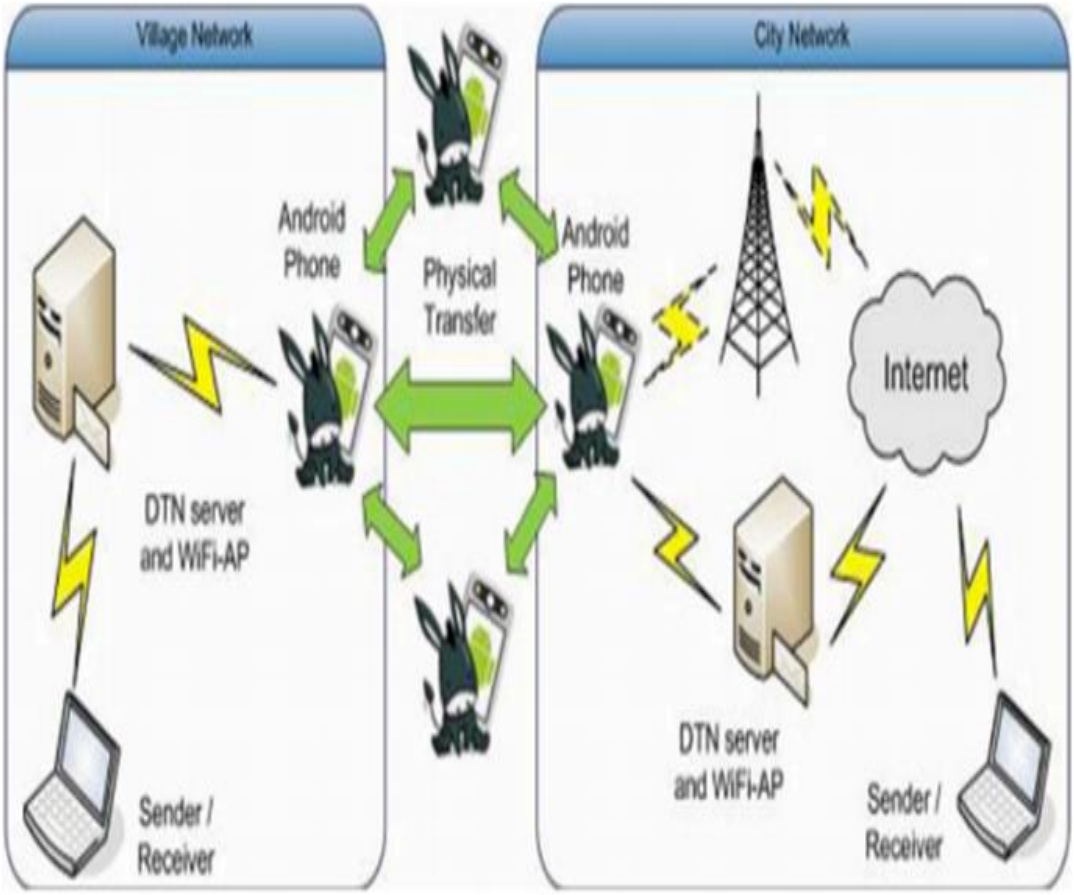

Figure 1.1: Bytewalla Network Architecture

1.2 Problem Statement

Bytewalla, the existing DTN software, depends solely on infrastructure to establish network connection. Because of this, data packet will only transfer to the users and servers through an Access Points. Users need to manually connect to those Access Points which limits the ability to multi hop instantaneously to nearby user on-the-go resulting in less reliable data transfer. Less reliable data transfer causes possibilities of data from the sender failed to be received from the receiver.

Sending messages, reading messages and other functions of DTN2[1] is a vital operation. However, the existing method of executing those operations requires lengthy commands that need to be remembered which leads to a time consuming and lesser user-friendly system.

1.3 Research Objectives

The main objective of the work is to enhance Bytewalla by ensuring better reliability and minimizing transmission delay. In order to enhance Bytewalla, the specific objectives of the work include:

- To develop an Auto Ad-Hoc configuration for delay tolerant network.
- To develop user-friendly Network Management Tool by adding several essential DTN functions on the GUI.
- To evaluate the performance in terms of delays and delivery probability with ONE simulator.

[1] DTN2 is a robust and flexible software framework for experimentation and real-world deployment

1.4 Scope of Work

In order to achieve the objectives, the scope of the study has been confined as follows:

1. Research is conducted in a simulation and on a real test bed experiment. The test bed consists of three Android devices and two laptops running Ubuntu. The auto ad hoc configuration for delay tolerant network will be created based on the existing DTN application (Bytewalla).
2. The test bed results and the simulation results are compared.
3. The user-friendly Network Management Tool GUI will be created based on the existing Network Management Tool which runs on Ubuntu.

1.5 Significant Contribution of Research

This thesis describes the development and implementation of a system which provides more reliable data transmission and lower transmission delay by improving the existing system. The contributions of the thesis are listed below:

- Development and implementation of Auto ad hoc for DTN, Android software that can run DTN on infrastructure and ad-Hoc which are able to switch automatically between the two modes. This ensures higher reliability data transmission.
- Development of an improved Network Management Tool, a user-friendly interface capable of executing the main functions of DTN such as listing, read and send message. The time and effort needed are greatly reduced to achieve similar results.

1.6 Organization of the Thesis

This thesis consists of six chapters and is organized as follows:

The first chapter discuss on the problem of the research, the objective of the research, the scope of the research and the significance of the research.

The second chapter presents related work and facts related to the research. The research is related to DTN, its origins and its applications, Bundles, Routing, One Simulator, DTN Network Management Tool and Android OS.

The third chapter discusses the design of the auto ad hoc configuration for DTN and the user-friendly Network Management Tool. The chapter provides detailed design on the concept, such as the proposed framework and architecture used. All flow charts explaining the flow and network model design are also included.

The fourth chapter presents the simulation studies of the auto ad hoc configuration for DTN. This chapter explains the software setup of the simulator and also explains the use of custom map and programming in ONE simulator. Then, the simulation analysis of the simulator and the test bed is compared.

The fifth chapter presents the implementation of the auto ad hoc configuration for DTN and the user-friendly Network Management Tool. First part of the chapter explains the hardware setup of the test-bed and also elaborates the implementation and its components. Then, the chapter will explain the user-interface of the user-friendly Network Management Tool and its implementation.

The final chapter discusses on the conclusion of the research, the limitation and problem occurred in the research and proposes new ideas for future works

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