Bytewalla IV
Implementation of Delay Tolerant Networks on the Android platform

Thesis Plan v1.0

Author:
- Michel Hognerud

Examiner:
- Peter Sjödin

Supervisors:
- Bjorn Pehrson
- Hervé Ntareme
- Danilo Gligoroski

Coaches :
- Doria Avri
- Marco Zennaro

Revision History

Version	Date	Remarks
Draft	2011-02-21	Document creation.
V1.0	2011-03-16	Updates after verification report and discussion with supervisor
V1.1	2011-03-18	Complete objectives

Table of Contents

Abbreviations used in this document

Abbreviation	Description
NordSecMob	Master's Programme in Security and Mobile Computing
KTH	Kungliga Tekniska Högskola
NTNU	Norwegian University of Science and Technology
DTN	Delay-Tolerant Network
PRoPHET	Probabilistic Routing Protocol using History of Encounters and Transitivity
SSA	Sentinel Surveillance Application

Introduction

Background

Nowadays and in many developed countries such as Sweden, Internet is omnipresent and plays a major role in the economy, people social life, research and other areas. More generally, it allows everyone to deliver and to get access to information.

However, there are still places or situations where access to Internet is extremely challenging. For instance, some rural parts of Africa have low levels of access to Internet [1]. This is mainly due to several obstacles including poor infrastructure and high costs of Internet services. Also there are situations where Internet suddenly becomes hardly available. For example, natural disaster governments firewall.

Hence, aiming to bring solutions for these situations, KTH started the development of Bytewalla. Bytewalla has already been through three iterations including two team projects and one Master's Thesis.

Bytewalla is based on Delay-Tolerant Networking (DTN). The Delay Tolerant Networking Research Group is concerned with "how to address the architectural and protocol design principles arising from the need to provide interoperable communications with and among extreme and performance-challenged environments where continuous end-to-end connectivity cannot be assumed"[2]. There are several implementations based on this research, but Bytewalla was the first to implement it a on an Android platform.

While Bytewalla 1 started the implementation on Android [3], and Bytewalla 2 focused on the security issues [4], Bytewalla 3 enhanced the implementation and developed an email application on top of the DTN protocol [5]. People can now send emails within bundles which are carried by mules from the village to the city as shown in figure 1.
In addition, another application named Sentinel Surveillance Application was built for the healthcare system. Doctors can manage and contact patients thanks to Bytewalla.
These two applications stand as proofs-of-concept.

Moreover, PRoPHET (Probabilistic Routing Protocol for Intermittently Connected Networks) was also implemented by Bytewalla 3. PRoPHET uses the history of encounters and transitivity to achieve the best case routing capabilities. Based on the history, it computes the probabilities of delivery for bundles whenever a node neighbor is discovered.

PRoPHET developed at Luleå University of Technology.

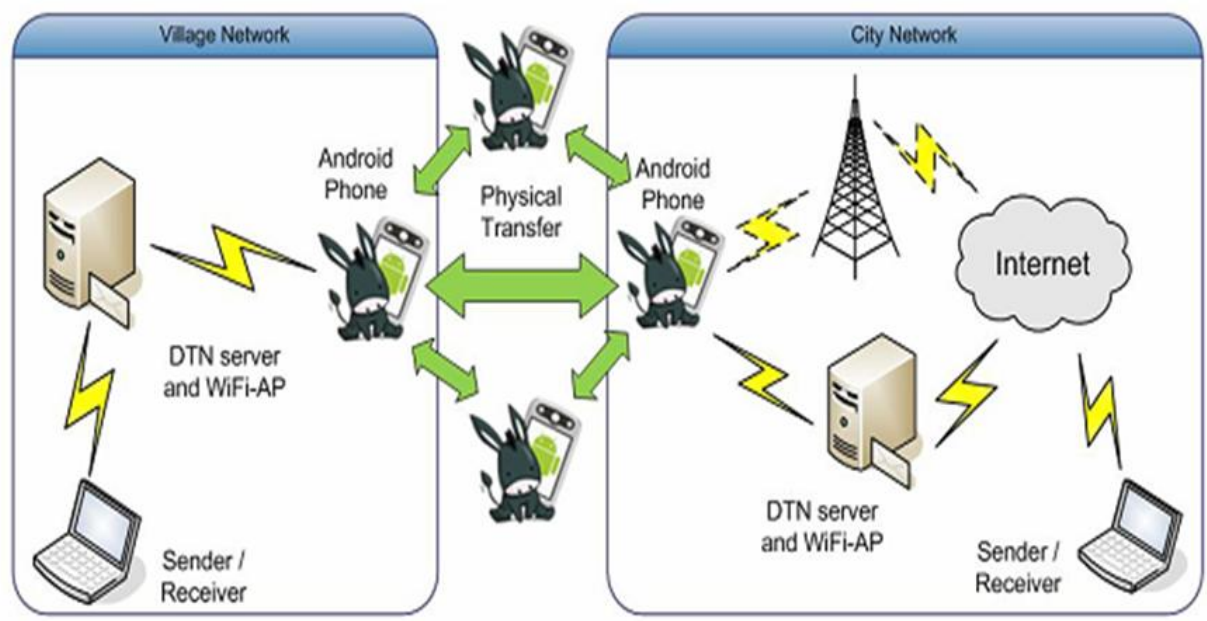


Figure 1

Motivation

Despite all the work which has already been done on Bytewalla, there is still room for improvement as DTN features haven't been implemented yet.

Basic functionalities have been implemented in Bytewalla 1, 2 and 3. However, some DTN features are still missing, such as Bundle Status Reports, Priority mechanisms etc.

The completion of Bytewalla would stand as the first proof-of-concept for DTN on Android, and would help is deployment in rural areas.

Goals

Overarching goals

One of the overarching goals of this thesis is to make the base system robust by verifying, solving and completing the existing implementation, following the DTN/Bundle/PRoPHET specifications. Along with that, there should be an investigation on how Bytewalla can be made easier to setup/use, and how it could be used in real-world situations.

Approach

As this thesis aims to enhance Bytewalla 3, the first phase will consist of studying the current system along with DTN, bundle protocol and PRoPHET. During this phase, the system will be tested in regards of Bytewalla's 3 objectives. Issues will be reported. Also, new enhancements should be proposed out of the investigations.

Then, will come the implementation part. Issues reported before and new functionalities will be implemented during this period. This period will be followed by an analysis of the results of the thesis.

In order to keep supervisors aware of the progress, documents will all be available on the thesis website.

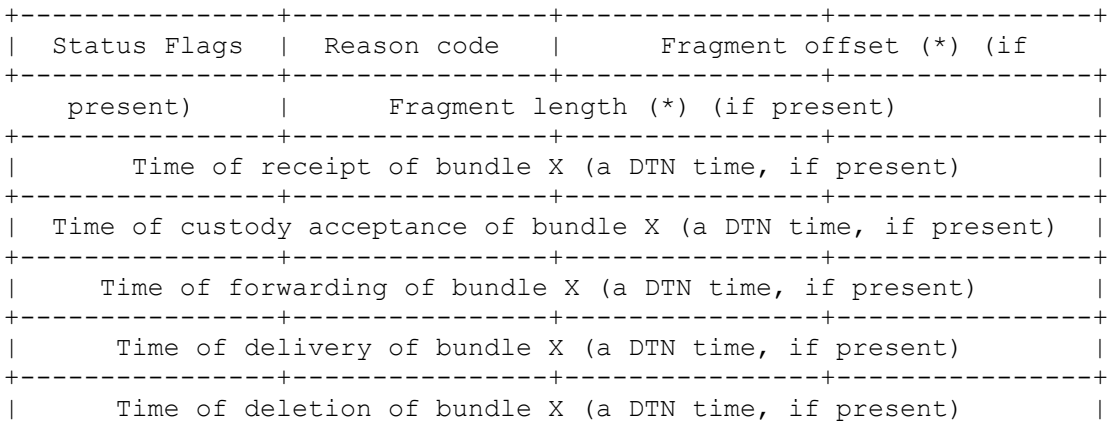
Measurable objectives

- Verification report of Bytewalla 3
  - Investigate Bytewalla 3 functionalities and issues.
  - Determine current issues, missing functionalities, and give suggestions.
- Literature Study for future implementation
- Implementation according to the verification report and specifications, as described below.

Bundle Status Reports

This kind of reports is defined in the RFC 5050 6 ("Bundle Protocol Specification"). These reports are used to provide information about how bundles are progressing through the system. For example, it may give notices of receipt, custody transfer, forwarding, final delivery and deletion to the endpoints given in the Report-To field.

Here is the format of a Bundle Status Report and the information it contains.



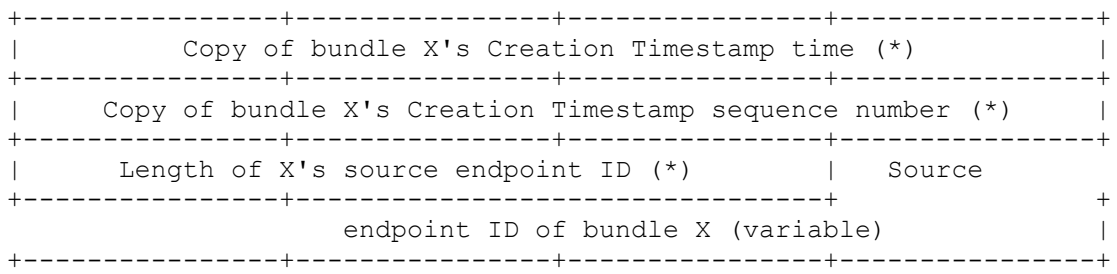


Figure 10: Bundle Status Report Format

For further details, please refer to RFC 5050 6.1.1.

This mechanism could also be used, as suggested by Bytewalla 3, to build a Mule Pay-Back system and thus, improving DTN penetration into real-world environments:

"Introduce a mule pay back system by keeping a record of the number of bundles transferred by each mule (Android Phone) and then rewarding the mule based upon this record."

Bundle priority and queuing mechanism

Due to storage limitation in mobiles, nodes may need to drop some bundles. Hence, each mode may have a queuing policy to determine which bundles to keep or to drop.

Some queuing policies have already been evaluated as part of the PRoPHET Internet-Draft:

- FIFO: Handle the queue in a First In First Out (FIFO) order.
- MOFO: Evict most forwarded first
- MOPR: Evict most favorably forwarded first
- Linear MOPR: Evict most favorably forwarded first
- SHLI: Evict shortest life time first
- LEPR: Evict least probable first

It is worth nothing that several queuing policies may be used together in an ordered set.
The queuing mechanism is defined along with PRoPHET in its Internet-Draft.

The priority here is to compare the policies and determine the most suitable ones according to situations, and to design it for Bytewalla.
Then, it will be implemented as part of the Bytewalla application.

Application Considerations

As for now, most applications are designed for relatively static environment such as Internet.

However in the case of DTN, applications have to deal with challenged networks and DTN mechanisms. For instances, the addressing is different, there is (most of the times) no immediate end-to-end connectivity implying low delivery rate and long delay.

Hence, there are some generic considerations that all "DTN applications" should be following.

This kind of considerations also implies changes to the User Interfaces as the user will not get the same experience whether the application is running over Internet or challenged networks.

So what are the important considerations to follow when developing applications for DTN, and in order to ease the development of applications for challenged networks, how to build a DTN interface and provide the tools for an application-layer over DTN?

Deliverables

Generic Deliverables

- Literature Study / Thesis Draft
- Thesis Plan
- Master's Thesis Project Website
- Final Thesis Presentation
- Final Thesis Report

Master's Thesis Project Specific Deliverables

- Verification Report of Bytewalla 3
- Source code

Resources

Space

One room containing the hardware is allocated for this thesis, in 8th floor, Forum.

Equipment

Android Phones

To transmit bundles to their destination, two phones are needed. However, to work with PRoPHET and the priority mechanisms, three phones are recommended.

As we want to customize the application to a recent version of the Android system, the phones should be on Android 2.1 or more recent.

Two HTC Wildfire 2.1 are now available as well as one HTC Tattoo 1.6.

Servers

Two servers are required. One for the village network and the other one for the city network.

The two servers which were used by Bytewalla 3 will be used as well as part on this thesis.

Here is their configuration as given by Bytewalla 3 [6]:

Specification	**Requirements**
CPU	2.26-GH Core Duo p8400
Hard Disk	300 GB or more
Network Interface	Wi-Fi compatible with IEEE802.11 b/g

Wi-FI Access Points

Three access points are required. One for the village network, another one for the city network, and the third one to setup the intermediate network for Android phones.

Three Ubiquiti Bullets are now providing the three access points.

Time Plan

Weeks	Activity Breakdown	Deliverable
1-2	• Review of previous Bytewalla projects. • Literature Study: DTN, Bundle Protocol, PRoPHET etc. • Thesis topic definition.	• Thesis plan • Thesis Website
3-6	• Testing and verifying Bytewalla system. • Continue literature study.	• Bytewalla verification report • New objectives / Updated thesis plan • Literature Study Report
7-15	• Enhancement and implementation according to verification report.	Source code
16-18	• Implementation analysis and Conclusion	Final thesis draft
19-20	• Thesis final version	• Printed version of approved final thesis • Thesis presentation

Contact Information

Royal Institute of Technology (KTH)

Examiner

- Peter Sjödin (psj@kth.se)

Supervisors

- Björn Pehrson (bpehrson@kth.se)
- Hervé Ntareme (ntareme@kth.se)

Coaches

- Doria Avri (avri@acm.org)
- Marco Zennaro (mzennaro@ictp.it)

Norwegian University of Science and Technology (NTNU)

Supervisor

- Danilo Gligoroski (danilo.gligoroski@item.ntnu.no)

References

[1] BBC, “Africa waiting for net revolution”, http://news.bbc.co.uk/2/hi/technology/7063682.stm, Last visited – Feb 21st, 2011

[2] DTNRG, http://www.dtnrg.org/wiki, Last visited – Feb 21st, 2011

[3] “Bytewalla 1: Final Report”, http://www.tslab.ssvl.kth.se/csd/projects/092106/sites/default/files/Bytewalla_Final_Report_v1.0.pdf, Last visited – Feb 21st, 2011

[4] Sebastian Domancich, “Bytewalla 2: Security in Delay Tolerant Networks for the Android Platform”, http://www.tslab.ssvl.kth.se/csd/projects/1011248/sites/default/files/Domancich%20-%20Thesis.%20Security%20in%20DTN%20for%20Android.pdf, Last visited – Feb 21st, 2011

[5] “Bytewalla 3: Final Report”, http://www.online.kth.se/csd/projects/1031352/sites/default/files/Final%20reportv1.2_0.pdf, Last visited – Feb 21st, 2011

[6] “Bytewalla 3: Project Plan”, http://www.online.kth.se/csd/projects/1031352/sites/default/files/Project_Planv2.0.pdf, Last visited – Feb 21st, 2011

Resume

MICHEL HOGNERUD

ADDRESS
Hanstavägen 883a
164 53 Kista, Sweden
(+46) 0736372946

CONTACT
www.hognerud.net
michel@hognerud.net

OBJECTIVE

Any position as software engineer. Preferably related to web, mobile or network.

EDUCATION / INTERNATIONAL EXPERIENCE

Master's Programme in Security and Mobile Computing (NordSecMob)	Royal Institute of Technology Stockholm, Sweden	August 2010-June 2011
	Norwegian University of Science and Technology Trondheim, Norway	August 2009-August 2010
Exchange Student	University of Iowa Iowa City, USA	August 2008-May 2009
Bachelor in Conputer Science	University de Franche-Comté Besançon, France	August 2006-June 2008

PROFESSIONAL EXPERIENCE

Master's Thesis — Royal Institute of Technology, Stockholm, Sweden — February 2011-June 2011

Implementation of Delay Tolerant Networks on the Android platform.

Technical Manager — Royal Institute of Technology, Stockholm, Sweden — August 2010-January 2011

Developing an "instant-talk" (VoIP) application on the Android platform, with a team of 8 people. Project includes: defining specifications, product development, communication around the project and validation from the project owner. More details at http://nebula.hognerud.net
From February 2011: Continuation of the project with subset of original team for a Swedish start-up.

Freelance — Independant, Telecommuting — July 2007-January 2008, And March 2010-...

Subcontracting for Web-Agencies. Developing a new project for small businesses (to be released).

Research Assistant — University of Iowa, Iowa City, USA — January 2009-May 2009

Contributed to a project whose goal was to automate the detection of malicious script using malicious scripts features. My objective was to automate samples recolting, filtering, and analysis with Weka (Weka is a collection of machine learning algorithms for data mining tasks).

SKILLS SUMMARY

Coding: Java, Python, C(++)
Web Techs: PHP, (X)HTML, XML, CSS, Web Services, Web Semantics
Database: SQL, MySQL
Engineering/Project: Scrum, GIT, SVN, SDL, UML, ASN-1, ProcessAlgebra, Design Patterns
Network: DHCP, MPLS, TCP/IP, DNS, RIP, OSPF, BGP, NAT, SNMP
Security: Web App. Security, Software Security, Fuzzing, Viruses/Rootkits, Cryptography
System: Windows, Android, Linux
Language: English (Fluent), French (Native), Norwegian/Swedish (Beginner)