Bytewalla IV
Implementation of Delay Tolerant Networks on the Android platform

Thesis Plan v1.3

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## Revision History

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### Abbreviations used in this document

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<th>Description</th>
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<tr>
<td>NordSecMob</td>
<td>Master’s Programme in Security and Mobile Computing</td>
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<tr>
<td>KTH</td>
<td>Kungliga Tekniska Högskola</td>
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<tr>
<td>NTNU</td>
<td>Norwegian University of Science and Technology</td>
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<tr>
<td>DTN</td>
<td>Delay-Tolerant Network</td>
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<tr>
<td>PRoPHET</td>
<td>Probabilistic Routing Protocol using History of Encounters and Transitivity</td>
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<tr>
<td>SSA</td>
<td>Sentinel Surveillance Application</td>
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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 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.
Motivation

The main functionalities have been implemented in Bytewalla 1 and 3 while Bytewalla has been focusing the security aspects.

However, there is room for improvement in optimizing DTN and application interoperability. Hence this thesis aims to make DTN networks more efficient and easier to manage and build or port applications on them.

We hope that it will be improve DTN’s penetration into real-world cases as people would then get more control on DTN services.
Goals

Overarching goals

One of the overarching goals of this thesis is to optimize DTN networks regarding the delivery rate and delays. This will be achieved with the help of the existing specifications as well as with new functionalities.

Also, the output of this work should help developer porting and developing applications for DTN, as the challenged networks have very different requirements and capacities compared to standard networks such as Internet.

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. This includes measuring the improvements on the DTN network, comparison with the previous Bytewalla system and comments in the results.

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 (Related Work)

- Implementation according to the verification report and specifications, as described below.

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 application. At least one of the above queuing policy should be implemented.

Service Layer
The objective here is to set up “service layers” which will be responsible for optimizing the DTN network.

As the figure 2 shows, the streams will be going through proxies before and after going through the DTN. The service layers basically act as proxies between the Bundles protocol and common application protocols. This way, it will help implementing some optimization techniques such as:

- **Protocol Spoofing**
  
  In case of chatty protocols (e.g. FTP, IMAP or key-exchange mechanism [6]), it takes the client a tremendous amount of time to process all the consecutive requests, as the delay is already big for a single request in challenged networks. Hence, it would be very useful to modify the protocol such that several requests may be bundled into one request, semantically performing the same operation. This feature would also greatly improve applications interoperability. Existing applications designed for Internet would only have to communicate with the service layer, which will handle the transmission of the request to its final destination through DTN.

The service layer will be tested with at least one kind of service which is already implemented and running over Internet.

Management
Management tools would help getting feedbacks from the DTN network (through the Bundle Status Reports mechanism) and managing the network by defining priorities and firewall rules.

The Bytewalla 3 application already includes the Bundle Status Reports mechanism; however there is no way for the administrator to have access to these reports and take actions based on them. Also, administrators may want to deal with the priorities and add rules according to the situation and DTN environment.
Deliverables

Generic Deliverables
- Master’s Thesis Project Website
- Thesis Plan
- Thesis Draft
- Final Thesis Presentation
- Final Thesis Report

Master’s Thesis Project Specific Deliverables
- Verification Report of Bytewalla 3
- Android Bytewalla Application Source code with queuing mechanism
- DTN Management Application (PHP, Python)
- Service Layer (Python)
  - Protocol Spoofing
  - Optional: Additional Optimization Techniques such as compression
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 ByteWall 3 will be used as well as part on this thesis.

Here is their configuration as given by ByteWall 3 [7]:

<table>
<thead>
<tr>
<th>Specification</th>
<th>Requirements</th>
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<tbody>
<tr>
<td>CPU</td>
<td>2.26-GH Core Duo p8400</td>
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<tr>
<td>Hard Disk</td>
<td>300 GB or more</td>
</tr>
<tr>
<td>Network Interface</td>
<td>Wi-Fi compatible with IEEE802.11 b/g</td>
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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

Activity Breakdown

<table>
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<th>Activity Breakdown</th>
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<td>1-2 (Feb 14th-25th)</td>
<td>• Review of previous Bytewalla projects.</td>
<td>• Thesis plan</td>
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<td>• Literature Study: DTN, Bundle Protocol, PRoPHET etc.</td>
<td>• Thesis Website</td>
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<td>• Thesis topic definition.</td>
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<tr>
<td>3-6 (Feb 28th-March 11th)</td>
<td>• Testing and verifying Bytewalla system.</td>
<td>• Bytewalla verification report</td>
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<tr>
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<td>• Continue literature study.</td>
<td>• New objectives / Updated thesis plan</td>
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<td>7-15 (March 14th-May 27th)</td>
<td>• Implementation of queuing mechanism</td>
<td>• Bytewalla application with queuing mechanism</td>
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<td>• Implementation of the service layer (protocol spoofing, caching)</td>
<td>• Service layer</td>
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<td>• Implementation of the management tool</td>
<td>• Management tool</td>
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<td>16-18 (May 30th-June 17th)</td>
<td>• Implementation analysis and Conclusion</td>
<td>Final thesis draft</td>
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<tr>
<td>19-20 (June 20th-30th)</td>
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<td>• Thesis presentation</td>
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Gantt Diagram
Issues

Objectives
One of the main objectives—the Bundle Status Reports—had to be cancelled.

It wasn’t really stated whether this had been implemented as part of Bytewalla, but after deep testing of the Bytewalla application, I noticed it was included in the Bytewalla application and working exactly as defined in the Bundles Protocol specifications [8]. However, it will be used anyway as part of the management system.

System Setup

Hardware
The HTC Wildfires 2.1 phones have a manufacturer issue which makes them unable to received UDP broadcast. It wasn’t easy to figure out where the problem was coming from but it is confirmed by other people having the same issue: http://code.google.com/p/android/issues/detail?id=8407.

Installation
Some parts of the installation guides from Bytewalla 1 and 3 are sometimes unclear or incorrect. Also, guides were edited by two different groups, depending on the component.

Source Code
The Bytewalla application source code wasn’t available until the middle of the second week.

Supervisors availability
It was hardly possible to agree on objectives before mid-March because of their occupations. But from this time, it is all fine.
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
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Norwegian University of Science and Technology (NTNU)

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


Resume

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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 Computer Science
University de Franche-Comté
Besançon, France
August 2006-June 2008

PROFESSIONAL EXPERIENCE
Master’s Thesis
Royal Institute of Technology
Stockholm, Sweden
Implementation of Delay Tolerant Networks on the Android platform.
February 2011-June 2011

Technical Manager
Royal Institute of Technology
Stockholm, Sweden
Developing an "instant-task" (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://adelha.hognerud.net
August 2010-January 2011

Freelance
Independent
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 2006-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, Process-Algebra, Design Patterns
Network: DHCP, MPLS, TCP/IP, DNS, RIP, OSPF, BGP, NAT, SNMP
System: Windows, Android, Linux
Language: English (Fluent), French (Naive), Norwegian/Swedish (Beginner)