

Master Thesis Specification:  
Routing Software Improvements:  
Removal of Redundant Route Changes

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**Abstract**

This document is the specification of a Master Thesis at the department of Computer Science and Electrical Engineering, Luleå University of Technology (LuTH), Sweden by Tommy Lundemo and Kristofer Wårell. The Master Thesis work will be done at Effnet AB, Luleå. Effnet needs to improve the routing capabilities of their products, in terms of available routing protocols and efficiency of the implementations. The objective of this project is to improve an existing routing software package and deploy the result in Effnet products.

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# 1 Introduction

This document is the specification of a Master Thesis at the department of Computer Science and Electrical Engineering, Luleå University of Technology (LuTH), Sweden by Tommy Lundemo and Kristofer Wårell. Master Thesis work (30 ECTS Credits) will be performed during winter of 1999/2000 at Effnet AB, Luleå, Sweden. This paper will be approved by advisors at Effnet and examiner at LuTH.

A background for the project is described in section two. Section three contains Master Thesis objectives and a strategy to fulfill them. Activities of the project is identified and described in section four. Section five contains administrative information. Section six describes confidentiality considerations. Copyright notices and discussion about legal issues can be found in section seven.

## 2 Background

Routing is the technique of distributing *information about network topologies* between connection points in computer networks. Forwarding is the technique of distributing *data* in these networks. Both are essential and tightly coupled components when connecting distinct networks to internets. Effnet are well known for their fast forwarding technology. It is however desirable to enhance the routing capabilities of their products. The following subsections give a brief introduction to routing, a description of GateD[4] and its interaction with Effnet products.

### 2.1 Routing

There are several types of routing protocols, in this work we concentrate on the most popular ones used in Internet today. They can be categorized in the following ways.

Routing protocols are divided in two hierarchical groups, interior and exterior gateway protocols (IGP and EGP). The former are used within an Autonomous System[2] and the latter between Autonomous Systems. There are two types of algorithms used in IGP implementations; Distance Vector and Link-State. Examples are Routing Information Protocol (RIP)[3] and Open Shortest Path First (OSPF)[5], respectively. An example of an EGP is Border Gateway Protocol (BGP)[6].

There are also two techniques for distribution of data, one-to-one (unicast) and one-to-many (multicast). The protocols mentioned above are all unicast. Examples of multicast routing protocols are Distance Vector Multicast Routing Protocol (DVMRP)[7] and Protocol Independent Multicast - Sparse Mode (PIM-SM)[1].

### 2.2 GateD

GateD is a routing software package that includes most of the routing protocols used in Internet. Effnet products currently use the free distribution of GateD, which includes old implementations of some of the protocols mentioned in the

previous subsection. To achieve enhanced routing capabilities Effnet has decided to join the GateD Consortium. This gives access to the commercial distribution, which includes documentation, technical support, enhanced implementations and an extended range of protocols.

### **2.3 GateD and Effnet Products**

In the current GateD implementation all route changes are inserted in the kernel routing table. This is a problem in Effnet products, since every route change triggers a recalculation of the forwarding table. Often, these recalculations are unnecessary since the route changes do not lead to any changes in the resulting forwarding table.

## **3 Master Thesis Objectives**

This section describes the objectives of the Master Thesis. Specific goals are stated in terms of what we should produce and in terms of new knowledge. The strategy to achieve these goals is outlined.

### **3.1 Goals**

The first goal is to obtain detailed knowledge about the routing protocols we will work with (see section 4.3). Next goal is to identify weaknesses in GateD and deal with one or more of these. One known issue is kernel calls with new routes, which do not result in any change of the forwarding table. Addressing this issue is the most important improvement we will study. If time allows we will also try to identify and remove other bottlenecks, both in terms of memory consumption and code inefficiency. A general project goal is to become routing experts in some sense. If possible, it would be desirable to incorporate the improved GateD in an Effnet product.

### **3.2 Strategy**

To reach the first goal (knowledge) we will study relevant books and RFCs, deploy and analyse the GateD package. The next goal (weaknesses) require further analysis of the GateD performance and source code. By successfully fulfilling these goals the general project goal is accomplished. Further cooperation with Effnet employees and extended knowledge of existing products allows incorporation of the improved GateD.

## **4 Project Plan**

This section describes the main activities in this project, approximately in the order they will be performed. A rough estimation of the time needed for the activities is included in appendix A.

## 4.1 Installation

As a first measure hardware and software will be installed. Introduction at Effnet and practical details are taken care of. (*Completed*)

*Exit criteria:* Workstations up and running. Tools and basic software installed.

## 4.2 Specification

The project will be specified in terms of activities and their estimated durations. Project goals and plans will be established. They are all defined in this paper. (*Started*)

*Exit criteria:* This paper finished and approved by advisor and examiner.

## 4.3 Literature Study

This section includes learning about unicast and multicast routing protocols and the GateD package. Relevant RFCs will be printed and filed for further reference. This activity includes production of summaries to be included in the final report. Specifications of the routing protocols in Table 1 will be examined. Focus of the examination will be protocol functionality, in order to achieve enough knowledge to successfully configure GateD.

*Exit criteria:* None. Continuous work.

Unicast	Multicast
BGP-4	DVMRP
OSPFv2	PIM-SMv2
RIPv2	

## 4.4 Software Deployment

Installation and configuration of GateD. Basic functionality tests on a simple network topology, using the protocols mentioned in the previous section. We will achieve an understanding and make a performance evaluation of the implementations.

*Exit criteria:* There is a router running the new version of GateD. Basic tests performed successfully.

## 4.5 Code Study

Detailed study of core GateD source code, focusing on the parts handling the routing table and interaction with the OS kernel. This may include implementation of necessary test tools.

*Exit Criteria:* Thorough understanding of the studied mechanisms.

## 4.6 Implementation

Implement and verify correctness of our route change filter. Verification involves testing in small to medium sized network topologies. This activity includes

production of detailed technical documentation. *Exit criteria:* Our solution is integrated and verified as more efficient.

#### **4.7 Productification**

As a secondary goal the improved GateD should be incorporated in an Effnet product. This might be impossible due to planned changes in Effnet's general configuration API. In this case we will instead contribute in the process of designing the new configuration API.

*Exit criteria:* A prototype product or contribution to the configuration API is produced.

#### **4.8 Final Documentation**

A document describing our Master Thesis work will be produced.

*Exit criteria:* Master Thesis approved by examiner and handed in for printing.

#### **4.9 Presentations**

In the end of our project we will make a presentation at Effnet and at LuTH.

*Exit criteria:* Presentations approved.

### **5 Administrative Information**

Following sections includes practical and administrative details.

#### **5.1 Equipment**

Apart from our workstations the following hardware will be needed. One Effnet router for initial deployment and testing of GateD. When performing basic functionality tests we will need access to Effnet's test network (currently four routers). We will also investigate the possibilities to use a packet generator available at Effnet. In the later stages of the project access to a larger test network at the university is desirable.

Necessary software includes NetBSD with user applications (editors, browsers etc) and GateD.

#### **5.2 Location**

Master Thesis work will be performed at Effnet in Luleå.

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## 5.3 Contacts

Location	Name	Phone	Cellular	Email
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## 6 Confidentiality

It is Effnet's policy to continually innovate, improve technology and protect intellectual properties by patents. Therefore some parts of the thesis might be considered confidential and left out of the publically available thesis.

## 7 Copyright

Copyright and similar legal issues are regulated by employment contracts established between Effnet AB and Tommy Lundemo/Kristofer Wårell.

## References

- [1] Estrin, D et al. “*RFC 2362: Protocol Independent Multicast-Sparse Mode (PIM-SM): Protocol Specification*”; URL: <http://www.ietf.org/rfc/rfc2362.txt> (2000-02-16)
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- [6] Rekhter, Y et al. “*RFC 1771: A Border Gateway Protocol 4 (BGP-4)*”; URL: <http://www.ietf.org/rfc/rfc1771.txt> (2000-02-16)
- [7] Waitzman, D et al. “*RFC 1075: Distance Vector Multicast Routing Protocol*”; URL: <http://www.ietf.org/rfc/rfc1075.txt> (2000-02-16)

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<sup>1</sup>Examiner

<sup>2</sup>Supervisor

## A Time Plan

	Oct	Nov					Dec					Jan					Feb				Mar				Apr			
Activity \ Week	43	44	45	46	47	48	49	50	51	52	01	02	03	04	05	06	07	08	09	10	11	12	13	14	15	16	17	
Installation	->																											
Specification	->	->			->																							
Literature Study	->	->	->	->	->							->	->	->	->	->	->	->	->	->								
Software Deployment												->	->															
Code Study												->	->	->	->	->	->	->	->	->	->							
Implementation																												
Productification																												
Final Documentation																												
Presentation																												

Activity closed	-> Work performed	Planned work	Divergence
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