A Novel Method for Minimizing Data Overheads in Store and Forward Networks

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ABSTRACT: *Minimizing data overheads in packet networks is an essential performance promotion issue. One of the past solutions was to select a single optimum packet size that minimizes the combined data overhead factor resulting from both operational and blank padding requirements. Such a packet size is associated with the characteristics of the random streams of messages applied to the network. This paper provides a different method that lead to improved minimization of the overheads. The method is based on selecting multiple packet sizes, with each being concerned with minimizing data overheads of messages falling within a certain range of length. The performance of the method was studied using computer simulation. The results obtained illustrate that in comparison with the old method, the new method can reduce the combined data overhead factor by approximately 25%. Future use of the method would provide more efficient data flow through packet networks.*

Keywords: Minimizing, Optimum, Performance, Overheads, Blank Padding

Received: 18 July 2013, Revised 28 August 2013, Accepted 31 August 2013

1. Introduction

In packet networks, messages are sent to store-and-forward switches, where they are stored, subdivided into packets, and subsequently sent toward their final destination. Data overheads in such networks have been divided into two types: Operational and blank padding overheads. Reducing the proportion of total overheads relative to data in data communications is of significant importance as it promotes throughput; and this has been considered by [1].

Selecting one packet to minimize overheads for one particular traffic pattern has been considered in [2]. There are other methods for reducing overheads, and these concentrate on finding ways to reduce the size of packet headers, while maintaining their required data flow function [3, 4].

In this paper we provide a new method, based on selecting multiple optimum packet sizes, for further reduction of the total overheads. Section 2 of the paper presents the theoretical base of the method. In section 3 the method is investigated using computer simulation. The results obtained are introduced and discussed in section 4. Finally section 5 concludes the work and provides future directions.

2. Theoretical Analysis

Overheads are data that are not part of the user data, but which are needed for managing data flow through networks. They are used for a wide variety of purposes, such as circuit monitoring, channel separation, addressing, error control, priority indication, and congestion management. Although overheads are essential to the integrity of data storage and transmission, they occupy a space on the expense of user data. Therefore minimizing data overheads is an important issue in data communication. In the following the two types of overhead factors associated with both headers and blank padding [2], are described. The new method that provides further reduction of their total is then presented, followed by the investigation approach.

2.1 Operational Overhead factor (F_h)

F_h is the overhead factor required at each packet header. It can be calculated using

$$F_h = \frac{\sum_{i-1}^{N} (H[i] + b[i]) ... K}{\sum_{i-1}^{N} (H[i] + a[i]) ... P}$$

Table 1 describes the equation variables.

2.2 Blankpadding Overhead Factor (F_b)

F_b is the overhead bits to be added at the last packet per message. It can be calculated using

$$F_b = \frac{\sum_{i-1}^{N} (1 - a[i]) . P}{\sum_{i-1}^{N} (H[i] + a[i]) . P}$$

All equation variables are described in Table 1.

2.3 Overhead Factor (F_t)

F_t is the total of overhead bits = $F_h + F_b$.

Simulation variables are described in Table 1.

N	Number of messages.
***M* [*i*]**	Size of message [*i*] [bits].
M	Average message size [bits].
P	Fixed packet size [bits].
K	Operation overheads per packet [bits].
(1 – *a* [*i*]) . *P*	Blank padding overhead per message [bits], where: $a[i] < 1$.
***H* [*i*]**	Number of packets in message [*i*].
***b* [*i*]**	Factor ‘0’ or ‘1’ (for fraction).
F	The overheads factor = Overheads / Information.

Table 1. Simulation variables

2.4 The New Method

A previous method used computer simulation to choose a single packet size that lead to minimizing the combined overhead factor of a stream of messages with different random lengths related to a specific range. The new method divides the range into a number of ranges, and finds one optimum packet size that minimizes the combined overhead factor for each range, resulting in a multiple optimum packet sizes instead of only one. This provides further reduction of the combined overhead factor of the total stream, as proved in the investigation below.

2.5 Investigation Approach

Figure 1 illustrates the general approach used to investigate the method using computer simulation.

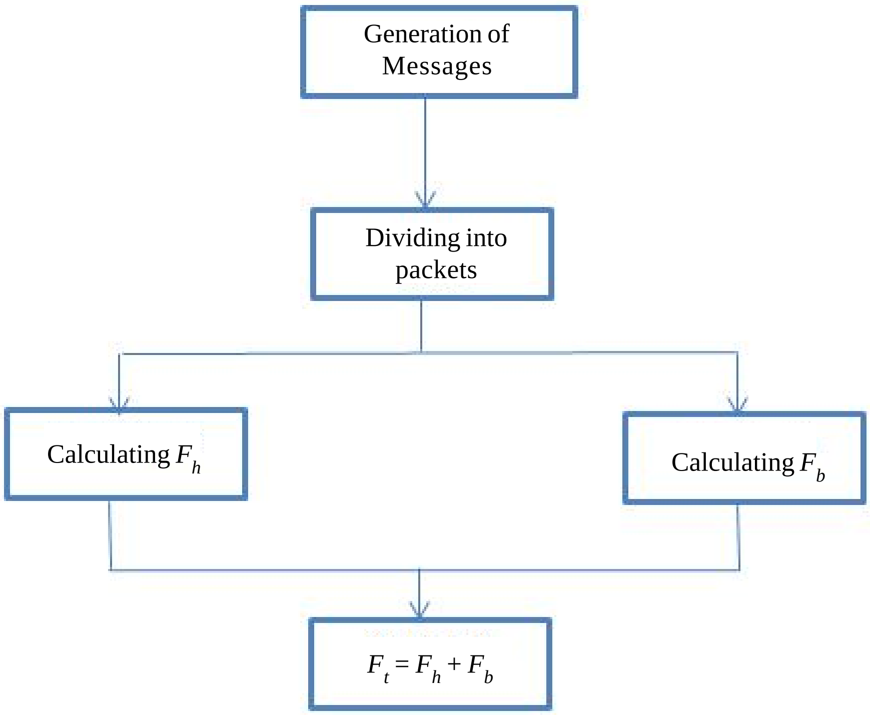

Figure 1. Simulation steps

N	10000 [200 per range].
x	No. of ranges = 5
$M[i]$	1000 :100000
M	20000
P	300: 5000: P += 100
K	200

Table 2. Simulation inputs

3. Investigation

3.1 Statement

To calculate the optimum packet length for different ranges of message lengths.

3.2 Parameters

The parameters that we used in our paper is listed in the table 2.

4. Simulation Results

Values 1, 3, 5, 7, and 9: represent different ranges of messages. Optimum packet size is calculated for each range using simulation. These calculated packet lengths are assigned to the input messages according to their lengths in the different cases.

Packet Size (Simulation)	Total Overheads	Throughput (%)	Overheads (%)
1	33639000	83.0446	16.9554
3	27855000	85.9604	14.0396
5	26490000	86.6481	13.3519
7	25898000	86.9468	13.0532
9	25620000	87.0865	12.9135

Table 3. Simulation outputs comparison

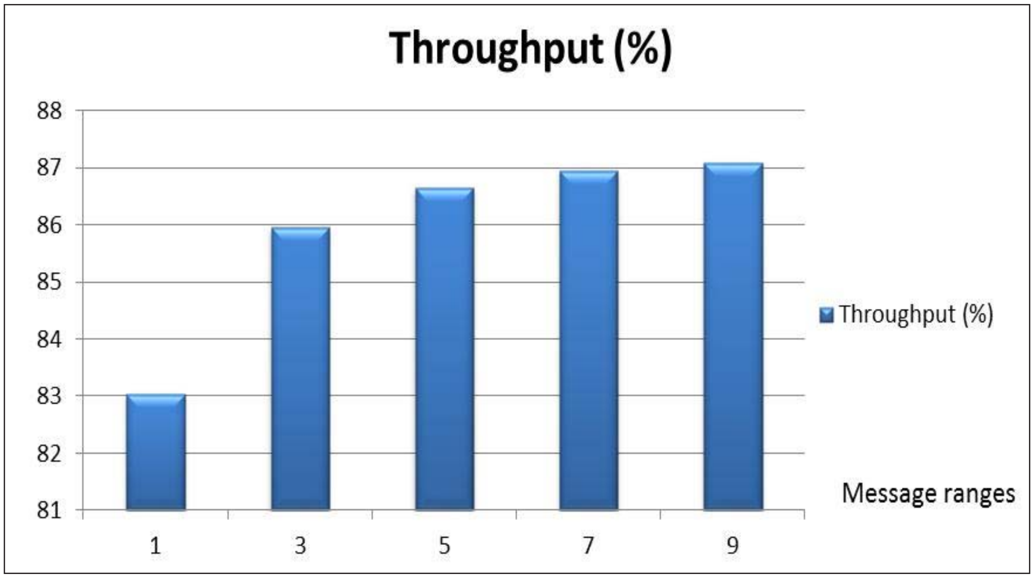

Figure 2. Simulated "*Cumulative improvement of throughput vs ranges of message*"

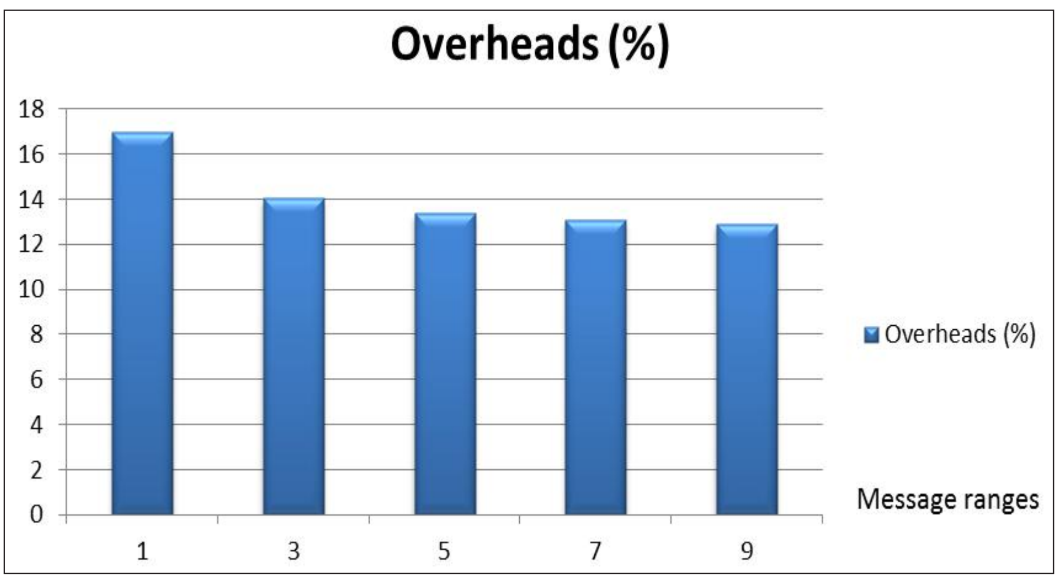

Figure 3. Simulated "*cumulative improvement of overheads vs ranges of message*"

From the simulation result we found that:

1. Using multi ranges with different packet lengths is better than using single packet size only.

2. The more the ranges the better the throughput as shown in the figure 3.

3. The 9 ranges throughput is approximately 4.0419 % better than single packet size one.

5. Conclusion

This paper has presented a novel method for reducing the combined data overheads in packet networks handling streams of random message lengths. Instead of choosing a single optimum packet size for this reduction, as given in previous work, the paper recommended choosing multiple optimum packet sizes associated with different message length ranges within the stream. Computer simulation investigations have proved that the new method leads to substantial reduction in the combined overhead factor. For example, dividing a stream into five ranges with an optimum packet size for each range has reduced the overhead factor by around 25 % in comparison with a single packet size for the whole stream.

6. Acknowledgment

We are grateful to the Research Centre (RC), College of Computer and Information Sciences (CCIS), for extending us all support during this research work. We are also thankful to all those who contributed in any form to make this research successful.

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