Effect of Using Header Compression Method in Point to Point Protocol in Communication System

Rasha T. Hameed*

Abstract

Most of the header information remains constant over the life-time of the connection. For PPP connection many fields are constant and others change with small values. To initiate compression of the headers of a packet stream, a full header is transmitted over the link. The compressor and decompressor store most fields of this full header as reference. The reference consists of the fields of the headers whose values are constant and thus need not be sent over the link at all, or change little between consecutive headers so that it uses fewer bits to send the difference from the previous value compared to sending the absolute value.

To improve interactive response time and to decrease the header overhead on the system we used the method of Compressing Protocol Headers in Point-to-Point Protocol (PPP). The simulated communication protocols have been tested between two PCs and measuring the time delay, throughput and utilization.

Keywords: (PPP) Point to Point Protocol, (UDP) user datagram protocol,(IP) Internet Protocol,(LCP) Link Control Protocol,(NCP) Network Control Protocol,(FCS) Frame Check Sequence,(MRU) Maximum Receive Unit.

تأثير استخدام طريقة ضغط العنوان الرأسي في بروتوكول PPP في نظام الاتصالات

الخلاصة

أغلب العناوين الرأسية للمعلومات تبقى ثابتة أثناء فترة الاتصال.مثلا البروتوكول PPP تبقى الكثير من الحقول ثابتة وهناك بعضها يتغير بقيم صغيرة . للبدء بضغط العناوين الرأسية لحزمة البيانات المرسلة سوف ترسل الحزمة مع كامل العنوان الرأسي. سوف يعمل الضاغط ومفك الضغط بخزن نسخة من العنوان الرأسي الكامل وتعتبر هذه النسخة كمصدر للاعتماد عليها. نسخة المصدر تحتوي على الحقول التي تكون قيمها ثابتة ولاتحتاج الى إرسال مرة أخرى أو تتغير بقيم قليلة بين العناوين الرأسية المتتالية والتي يستعمل قيم قليلة لإرسال الفرق بين القيم السابقة اذا ما قارنت مع إرسال القيم المطلقة. لتَحسين وقتِ الرَدِّ التفاعلي ولتقليل الحمل على النظام تم استعمال طريقة لضغط العناوين الرأسية للبروتوكول PPP . تمت عملية النمذجة للأتصال بأختبارحاسوبين شخصيين وقياس زمن التأخيرَ والطاقة الإنتاجية والاستخدام.

* AL Yarmouk University College / Dept.of Computer Technology Engineering.

1. Introduction

The Point-to-Point Protocol (PPP) originally emerged as an encapsulation Protocol for transporting IP traffic over point -to-point links.PPP also provides a standard method for transporting multi-protocol datagrams over point- to-point links. The Point-to-Point Protocol is designed for simple links, which transport packets between two peers. These links provide full-duplex simulations bidirectional operation, and are assumed to deliver packet in order. It is intended that PPP provides a common solution for easy connection of a wide variety of hosts, bridges and routers.

PPP include an extensible option negotiation mechanism, which is able to negotiate a rich assortment of configuration parameters and provides additional management function.[1,9] The PPP is comprised of three main components:

1. A method for encapsulating multi-protocol datagrams.
2. A Link Control Protocol (LCP), for establishing, configuring, and testing the data-link connection.
3. A family of Network Control Protocol (NCP) for establishing and configuring different network –layer protocol.[1,2]

2. PPP Main Components

a)Encapsulation

The PPP encapsulation provides for multiplexing of different network-layer protocol simultaneously over the same link. The PPP encapsulation has been carefully designed to retain compatibility with most commonly used supporting hardware.[9]

b)Link Control Protocol

In order to be sufficiently versatile to be portable to a wide variety of environments, PPP provides a Link Control Protocol (LCP).The LCP is used to automatically agree upon the encapsulation format options, handle varying limits on sizes of packets, detect a looped-back link and other common misconfiguration errors, and terminate the link. Other optional facilities provided are authentication of the identity of its peer on the link, and determination when a link is functioning properly and when it is failing.[3,4]

c)Network Control Protocol

Point-to-Point link tend to exacerbate many problems with the current family of network. For instance, assignment and management of IP addresses, which is problem even in LAN environments, is especially difficult over circuit-switched point-to-point link. These problems are handled by a family of Network Control Protocols (NCPs), each manages the specific needs required by their respective network-layer protocol.[3]

3. PPP frame format

The PPP frame structure is shown in figure (1) below. The fields are transmitted from left to right. All the fields length in octets.[4]

1	1	1	Variable	2	1
Flag 01111110	Address 11111111	Control 00000011	PPP encapsulated packet	FCS	Flag 01111110

Fig. (1) PPP frame format

- **Flag field and FCS field**

Each frame begins and ends with a flag of binary sequence 01111110 (hexadecimal 0x7e).Also the FCS field contains a 16-bit or 32-bit cyclic redundancy check for error detection.

- **Address field**

The address field is a single octet, which contains the binary sequence 11111111 (hexadecimal 0xff), the all stations address.

- **Control field**

The Control field is a single octet, which contains the binary sequence 00000011(hexadecimal 0x03).

- **PPP encapsulated packet**

The PPP encapsulated packet field contains all the packets used by the PPP, which are the LCP, NCPs and Network Layer Protocol packets.[5,6]

3.1 PPP Encapsulation

The PPP encapsulation is used to disambiguate multiprotocol datagrams.This encapsulation requires the framing to indicate the beginning and the end of the encapsulation as shown in figure (2) below. [4,9]

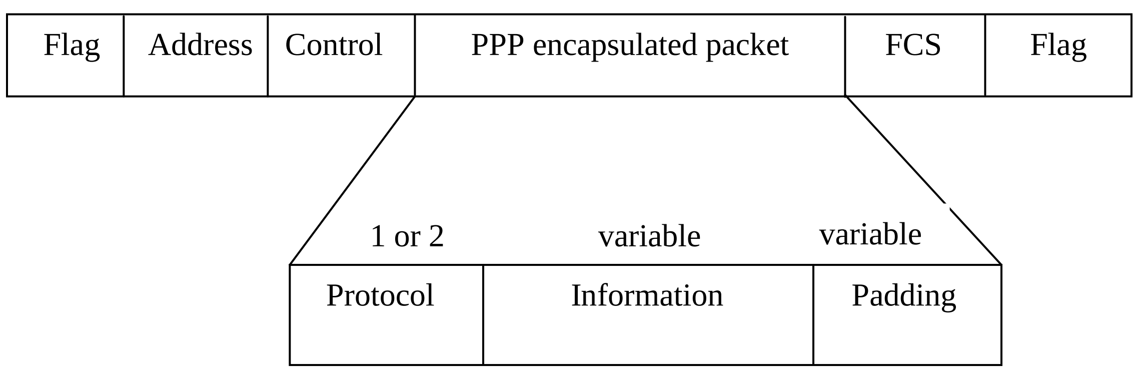

Fig. (2) PPP encapsulation format

- **Protocol field**

The protocol field two octets, and its value identifies the datagram encapsulated in the information field of the packet.

- **Information field**

The information field is zero or more octets. The information field contains the datagram for the protocol specified in the protocol field. The maximum length for the information field is termed the Maximum Receive Unit (MRU).[8,7]

- **Padding**

On transmission, the information field may be padded with an arbitrary number of octets up to the MRU.

Van Jacobson [5] has been used a method to improve TCP/IP performance over low speed (300 to 19,200 bps) serial links and compression TCP header, IP header over serial communication between many computers. Stephen Pink and Mikael Engan [6] used new header compression schemes for UDP/IP and TCP/IP protocols. They show how to reduce the size of UDP/IP headers by an order of magnitude, down to five bytes. Jason Jeffords and Lou Berger [7] used MPLS/IP header compression over TCP, each end of the link must agree on the use of compression and on the associated set of configuration options. TCP supports the negotiation of link parameters for network layer protocols via a family of network control protocols.

The purpose of the present work is to design and simulate the two computers communication system which uses a header compression of PPP. The communication between two computers are used the RS-232 cable and used USB 2.0 cable for send and receive data then testing the performance of the implemented system in terms of delay, throughput, and efficiency.

4. Proposed Protocol Design

The simulation of the software system between two computers depending on using header compression method in Point-to-point protocols.

The communication system consists of five layers (Physical, Data Link, Network, Transport, and Application). The Physical layer uses the RS-232-c or USB to connect the computers. In the Data Link layer uses PPP frame to carry data from upper or down layer. Network layered uses the IP (Internet Protocol) which have unique address of the host to deliver the data to specific host. Transport layer uses the Transmission Control Protocol (TCP) which is responsible for making and maintain the connection and sending/receiving data. Finally, the application layer which is used as interface with user. The Data Link Layer will be used the headers compression methods to reduce the overhead on the system. Figure (3) shows the algorithm that used in communication system. The Figure (4) shows the main subroutine of the communication system with PPP header compression.

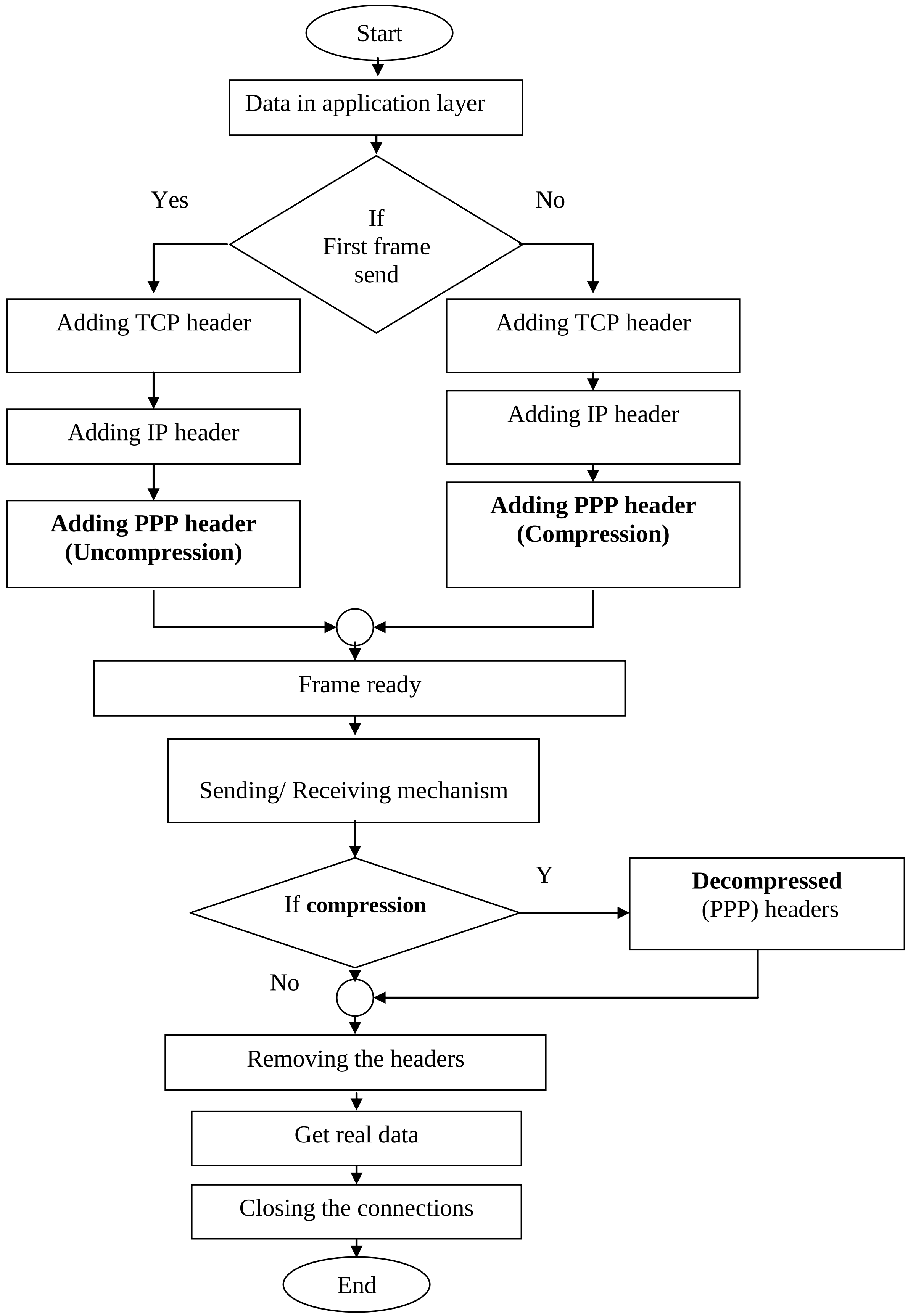

Fig. (3) The flow chart of communication system.

5. Results and Discussion

The system that work in real time it need high speed for communication and the time delay is very small, and need to calculate the utilization and throughput to ensure that the system is efficient for real time communication.

5.1 Time Delay Calculations

Time delay is calculated as the interval of the time required for a message ready for transmission to be sent from sender station until its successful reception at the receiver station.[8]

- For an uncompressed header frame

The overhead added by the transport layer is 20 byte. The overhead added by the network layer is 20 byte. Also the overhead added by the data link layer approaches to 8 byte. Hence, the total overhead added by these layers will reach 48 byte.

$$\text{Delay} = (\text{information length}+48) \times 11/\text{bit rate} \quad (1)$$

- For compressed header frame:

The compression headers added by the transport layer is 20 bytes, and by the network layer is 20 bytes, and by the data link layer approaches to 4 bytes. Hence, the total overhead added by these layers reaches 44 bytes.

$$\text{Delay} = (\text{information length}+44) \times 11/\text{bit rate} \quad (2)$$

The values of the time delay were reduced by using the compression header than that by using uncompression header and this is due to reduce in size of header with information transmission Moreover the calculated values of the time delay as shown in figures (5,6) by using USB 2.0 was less than that by using RS-232. The time delay values were decreased by using the USB 2.0 since the transmission speed was very high than that in the case of using the RS-232-c.

5.2 Throughput Calculations

The throughput rate is the average rate of transfer of the actual error-free bits of user data not counting overhead bits. [8] Information throughput rate can be defined as:

$$\text{Throughput Rate (TR)} = \text{Number of information bits/Total time} \quad (3)$$

Figures (7,8) show that the calculated throughput values were higher by using the header compression than that by using the header uncompression with all the speed of transmission used. The increase in the throughput was mainly due to decrease in the header overhead. In addition to that using the USB 2.0 as a physical media increase the throughput values compared to that using the RS-232-c due to the high speed transmission data.

5.3 Utilization Calculations

- For the uncompressed headers:[2]

$$\text{Utilization} = \text{Message Length (byte)} \times 8 / ((\text{Message length (byte)} + 48) \times 11) \quad (4)$$

In these frames the physical layer adds three bites (start bit, stop bit, and parity bit).

11= 8 (for one byte) + 3 *(start bit, stop bit, and parity bit).

- For the compressed headers:[2]

$$\text{Utilization} = \text{Message Length (byte)} \times 8 / ((\text{Message length (byte)} + 44) \times 11) \quad (5)$$

From figure (9) the calculated utilization valued were increased with increasing the information length. Also the utilization values were higher by using the compression header than that by using the uncompression header because the header overhead was reduced.

6. Conclusions

- Using the compression header method in the developed protocol improve the throughput, reliability, robustness and the speed of the protocol. The use of the USB 2.0 cable gives the system high speed (in compression to the RS-232-c cable) for sending-receiving data.
- Using the PPP layer in the developed protocol protected all the transferred messages by applying the error detection mechanism (CRC).

References

1. Dennis J. Gaushell and Henry T. Darungton,"Supervisory Control and Data Acquisition", Proceeding of IEEE, Vol.7, No.12, December 1987.
2. Bassil.AL-Mahdawi: “Region-To-Region Communication for SCADA System using PPP protocol”, M.SC. Thesis, University of technology, 2005.
3. Bahrouz A.Forouzan: "Data Communications and Networking", McGraw-Hill Higher Education, second Editions 2000.
4. Douglas E. Comer, David L. Stevens: "Internetworking with TCP/IP", Vol.II, Design, Implementation, and Internals (1998, Prentice Hall, ISBN: 0139738436).
5. Van Jacobson, "TCP/IP Compression for Low-Speed Serial Links", report No.1144, February 1990.
6. Stephen Pink and Mikael Engan, ″Low-loss TCP/IP Header Compression for Wireless Networks″, Center for Distance Spanning Technology (CDT), Sweden,Ph.D. Thesis, 2000.
7. Jason Jeffords and Lou Berger, "MPLS/IP Header Compression over TCP Lou.", Network Working Group Internet, report 2004.

8. Ashwaq A.AL-Janabi, "Implementation of Region-To-Region Communications Protocols", M.SC. Thesis, University of Baghdad, 2000.

9.W.Simpson. The Point-to-Point Protocol(PPP),Request for Comments 1661,The Internet Engineering Task Force (IETF),July 1994.

```
Start ( )
    {
    Read data in application layer.
        IF (first frame send) THEN
        Added TCP header.
        Added IP header.
        Added PPP header.
    ELSE
        Added TCP header.
        Added IP header.
        Added PPP header Compression.
    ENDIF
        Ready frame to send.
     }
TCP MECHANISM ( )
    {
    Send TCP packet.
    Receive TCP packet.
    }
COMPRESSION ( )
    {
    IF (compression frame) THEN
        Decompressed PPP header.
        ELSE
        Removed the headers of all
        protocols.
        Get the real data
 Close ( )
```

Figure (4): The main subroutine of the communication system with PPP header compression.

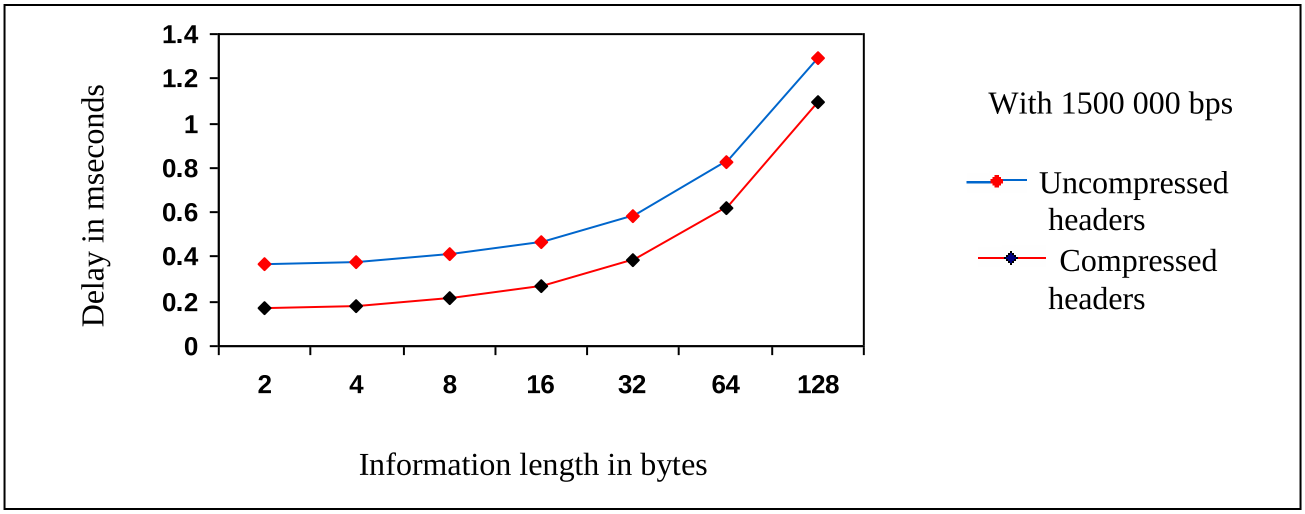

Figure (5): The relation between data information and round trip delay for both uncompressed and compressed headers using USB 2.0 cable.

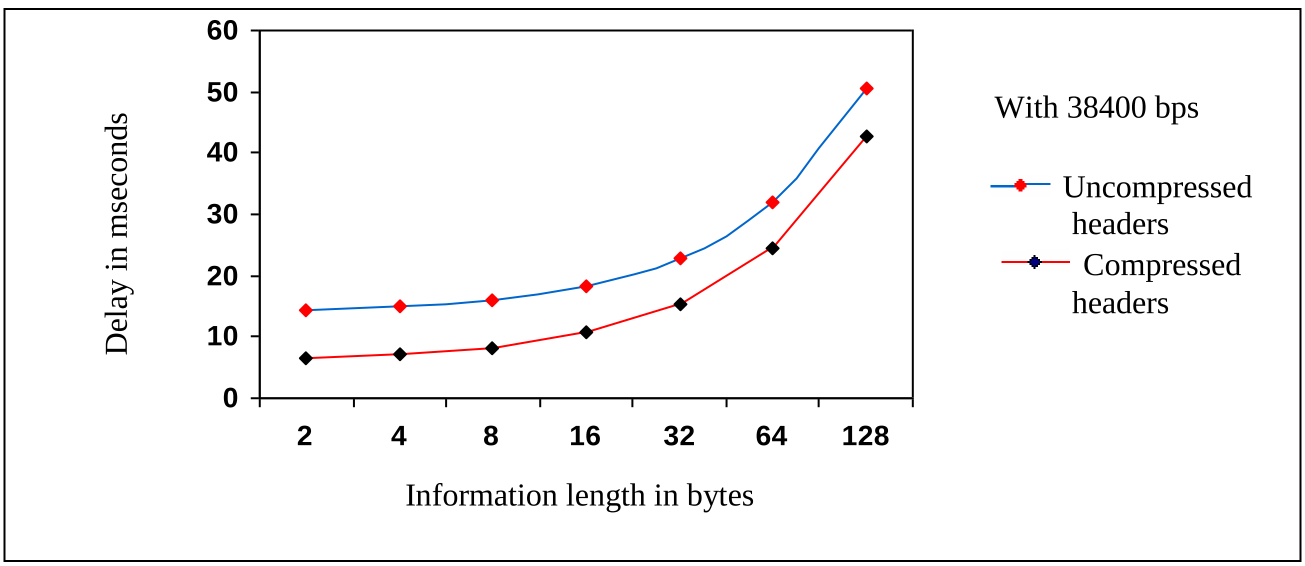

Figure (6): The relation between data information and round trip delay for both uncompressed and compressed headers using RS-232-C cable.

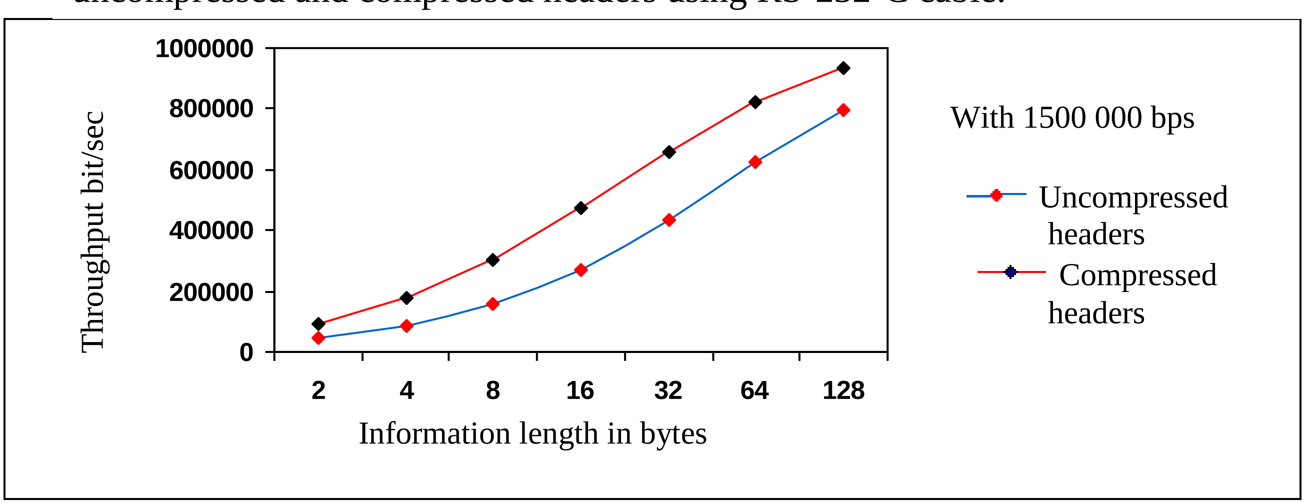

Figure (7): The relation between information length and throughput for both

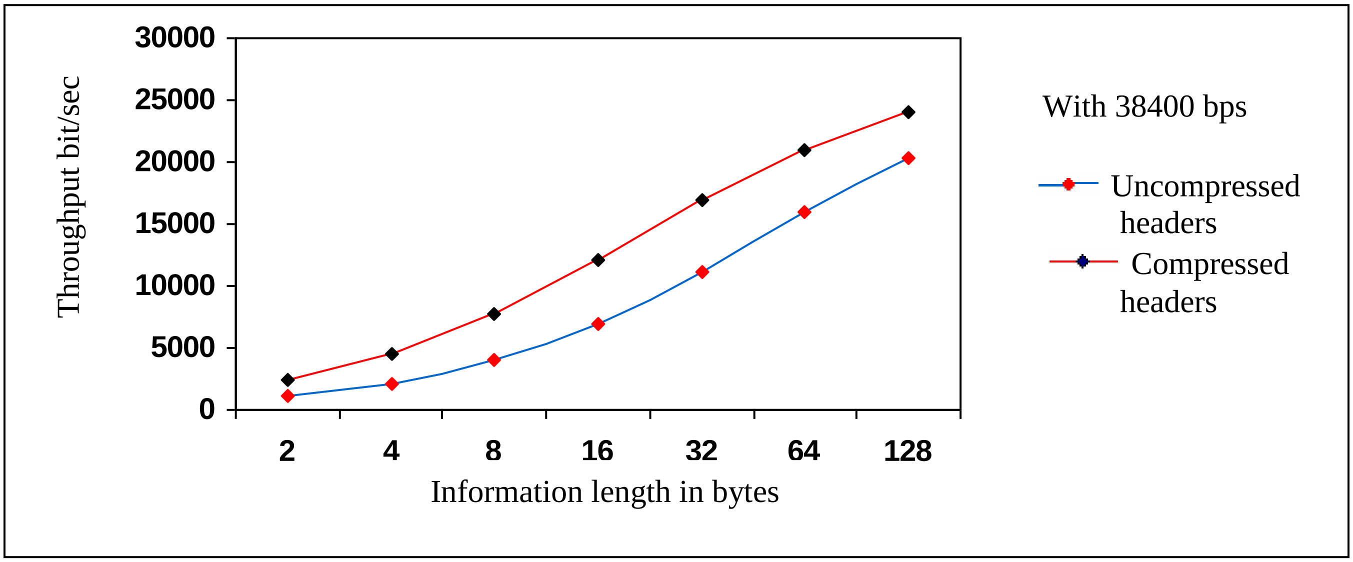

Figure (8): The relation between information length and throughput for both uncompressed and compressed headers using RS-232-C cable.

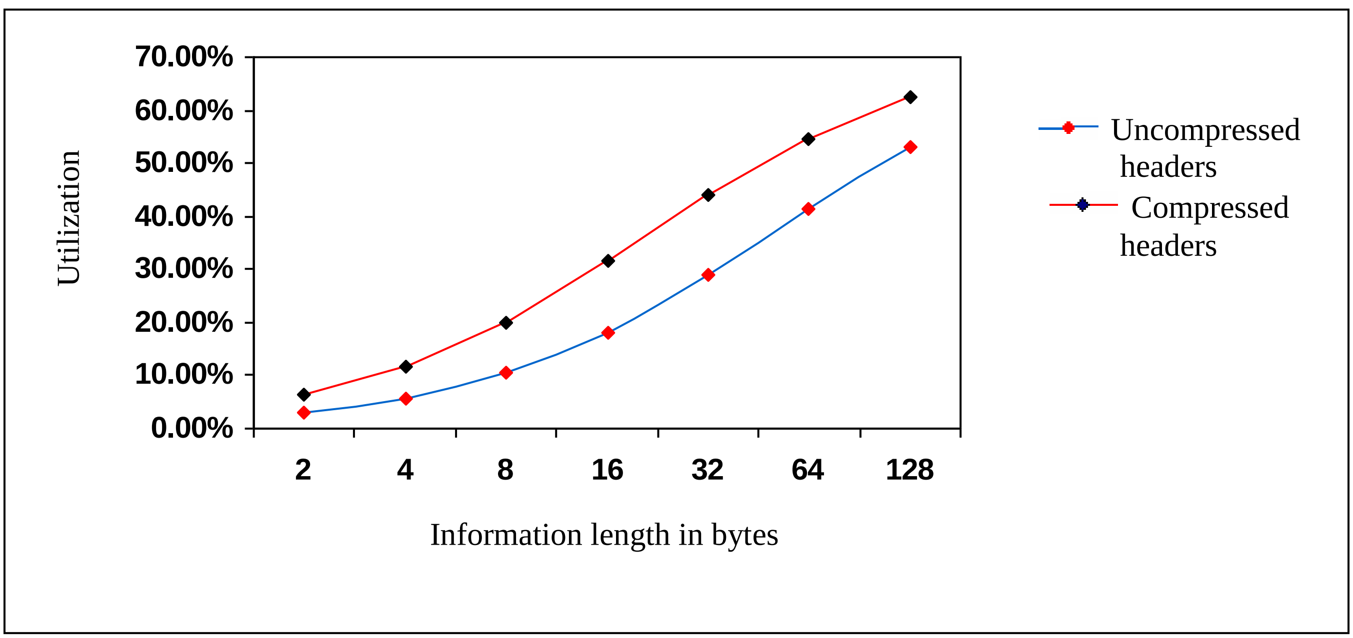

Figure (9): The relation between information length and utilization for both uncompressed and compressed headers.