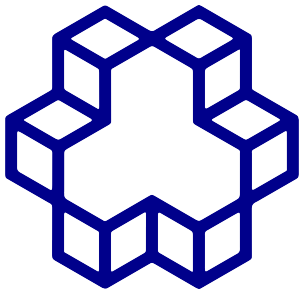

دانشگاه صنعتی خواجه نصیرالدین طوسی

K. N. TOOSI UNIVERSITY OF TECHNOLOGY

In Partial Fulfillment of the Requirements for the
Degree of
BS in Computer Engineering

Framing Techniques In Data Link Layer

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ABSTRACT

The data link layer plays a pivotal role in network communication, providing reliable data transfer across the physical medium. A core functionality of this layer is framing, which involves dividing the continuous stream of data into manageable frames for efficient transmission and error handling. This project explores various framing techniques, including character count, byte stuffing, bit stuffing, and physical layer coding violations, analyzing their mechanisms, advantages, and drawbacks. A comparative evaluation of these techniques highlights their applicability in different networking scenarios, emphasizing their impact on data integrity, synchronization, and transmission efficiency. Through simulation and case studies, this project aims to provide insights into the design and optimization of framing techniques for modern communication networks.

TABLE OF CONTENTS

LIST OF ILLUSTRATIONS

LIST OF TABLES

Number *Page*

Chapter 1

INTRODUCTION

In modern networking, the data link layer plays a critical role in ensuring reliable and efficient data communication between devices. One of its fundamental tasks is framing, the process of converting a continuous stream of bits from the physical layer into structured and manageable units called frames. Frames encapsulate data, ensuring proper synchronization, addressing, and error handling. This division simplifies the handling of data by the upper layers of the OSI model and ensures smooth communication between various points on the network.

Despite its importance, framing introduces several challenges, such as detecting frame boundaries, handling errors, synchronizing devices, and minimizing transmission overhead. Addressing these challenges requires a deep understanding of various framing techniques and their trade-offs.

This project delves into the methods and mechanisms of framing in the data link layer, focusing on their design, operation, and optimization. By exploring popular framing methods such as byte count, bit-pushing, and byte-pushing, this study aims to provide insight into their effectiveness and practical applications in diverse networking scenarios.

1.1 Project Description

The primary objective of this project is to analyze the configuration techniques used in the data link layer and to evaluate their impact on the reliability and efficiency of data transmission. Key aspects of the project include:

Understanding Framing Fundamentals

Examining how the data link layer converts packets from the network layer into frames. Analyzing the role of frames in separating and organizing data for transmission and reception.

Exploring Framing Challenges

Identifying issues such as frame boundary detection, error handling, and synchronization. Investigating the impact of framing overhead on network performance.

Evaluating Framing Methods

Studying various techniques like byte count, bit stuffing, and byte stuffing. Exploring how these methods address frame boundary detection and error control.

Designing Solutions

Proposing optimized methods to address common framing challenges, such as reducing overhead and ensuring compatibility between devices.

Practical Implementation

Simulating framing techniques to visualize their operation and evaluate their efficiency. Presenting case studies to demonstrate the application of different framing methods in real-world scenarios. By the conclusion of this project, a comprehensive understanding of framing techniques and their implications on networking performance will be established. The findings aim to assist network engineers and researchers in selecting and designing suitable framing mechanisms for specific applications.

1.2 Objective

The objective of this project is to investigate and evaluate framing techniques in the data link layer, focusing on their design, efficiency, and practical implications in modern networking. By addressing challenges such as frame boundary detection, error handling, and synchronization, the project aims to propose optimized solutions that enhance data transmission reliability and minimize overhead.

1.3 Methodology

Literature Review

Conduct an in-depth study of existing framing methods such as byte count, bit stuffing, and byte stuffing. Analyze research papers, technical documentation, and industry standards to understand the strengths and limitations of these techniques.

Problem Analysis

Identify key challenges associated with framing, including synchronization issues, framing overhead, and error detection. Define performance metrics to evaluate framing methods, such as bandwidth efficiency, error resilience, and compatibility.

Simulation and Testing

Use networking simulation tools to implement various framing techniques and observe their performance in different scenarios. Compare techniques based on

predefined metrics, emphasizing practical applications and trade-offs.

Chapter 2

FRAMING METHODS(DATA LINK LAYER)

In the Physical Layer, data transmission involves synchronized transmission of bits from the source to the destination. The data link layer packs these bits into frames. The Data Link Layer takes the packets from the Netmork Layer and encapsulates them into frames. If the frame size becomes too large, then the packet may be divided into small frames. Smaller sized frames make flow control and error control more efficient.
Then, it sends each frame bit-by-bit on the hardware. At receiver end, the data link layer picks up signals from hardware and assembles them into frames.

2.1 Problems in Framing

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Detecting start of the frame
When a frame is transmitted, every station must be able to detect it. The station detects frames by looking for a special sequence of bits that marks the beginning of the frame, i.e., SFD (Starting Frame Delimiter).

How does the station detect a frame
Every station listens to link the SFD pattern through a sequential circuit. If SFD is detected, sequential circuit alerts station. Station checks destination address to accept or reject frame.

Detecting end of frame
When to stop reading the frame.

Handling errors
Framing errors may occur due to noise or other transmission errors, which can cause a station to misinterpret the frame. Therefore, error detection and correction mechanisms, such as cyclic redundancy check (CRC), are used to ensure the integrity of the frame.

Framing overhead

Every frame has a header and a trailer that contains control information such as source and destination address, error detection code, and other protocol-related information. This overhead reduces the available bandwidth for data transmission, especially for small-sized frames.

Framing incompatibility

Different networking devices and protocols may use different framing methods, which can lead to framing incompatibility issues. For example, if a device using one framing method sends data to a device using a different framing method, the receiving device may not be able to correctly interpret the frame.

Framing synchronization

Stations must be synchronized with each other to avoid collisions and ensure reliable communication. Synchronization requires that all stations agree on the frame boundaries and timing, which can be challenging in complex networks with many devices and varying traffic loads.

Framing efficiency

Framing should be designed to minimize the amount of data overhead while maximizing the available bandwidth for data transmission. Inefficient framing methods can lead to lower network performance and higher latency.

Chapter 3

BYTE COUNT FRAMING METHOD

We had seen in previous article framing, that to send packets from sender to the receiver framing is required. But the question was how the receiver will identify the starting and ending of a frame. For receiver, starting and ending of a frame is necessary to recognize the next frames transmitted by the sender. So in this case Byte count framing method will support. The byte count framing method uses a field in the header to specify the number of bytes in the frame.

- **Data link layer at sender sends the byte count.**
- **Data link layer at receiver counts the byte count.send by sender.**
- **If there is difference between bytes counts of sender and receiver.There is error in data received.**
- **Else received data is correct.**
- **Above points are shown in diagram below.**

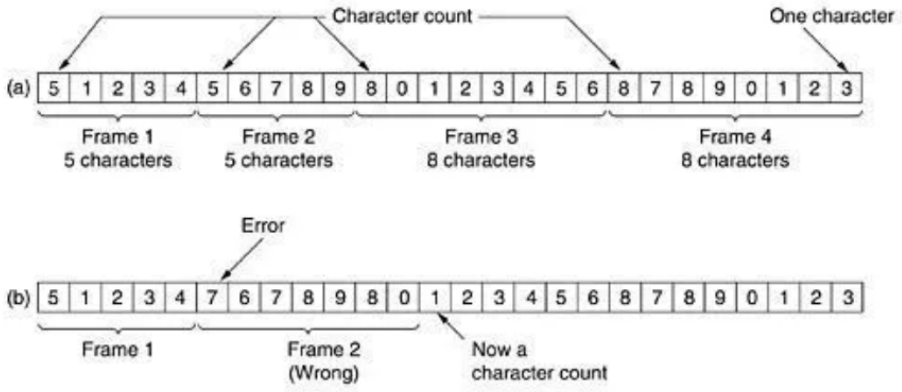

Figure 3.1: Byte count framing

Framing is function of Data Link Layer that is used to separate message from source or sender to destination or receiver or simply from all other messages to all other destinations just by adding sender address and destination address.

The destination or receiver address is simply used to represent where message or packet is to go and sender or source address is simply used to help recipient to acknowledge receipt.

Frames are generally data unit of data link layer that is transmitted or transferred among various network points. It includes complete and full addressing, protocols that are essential, and information under control.

Physical layers only just accept and transfer stream of bits without any regard to meaning or structure. Therefore it is up to data link layer to simply develop and recognize frame boundaries.

This can be achieved by attaching special types of bit patterns to start and end of the frame. If all of these bit patterns might accidentally occur in data, special care is needed to be taken to simply make sure that these bit patterns are not interpreted incorrectly or wrong as frame delimiters.

Framing is simply point-to-point connection among two computers or devices that consists or includes wire in which data is transferred as stream of bits.

However, all of these bits should be framed into discernible blocks of information.

Chapter 4

FLAG BITS WITH BIT STUFFING

The data link layer is responsible for something called Framing, which is the division of stream of bits from network layer into manageable units (called frames). Frames could be of fixed size or variable size. In variable-size framing, we need a way to define the end of the frame and the beginning of the next frame. Bit stuffing is the insertion of non information bits into data. Note that stuffed bits should not be confused with overhead bits. Overhead bits are non-data bits that are necessary for transmission (usually as part of headers, checksums etc.).

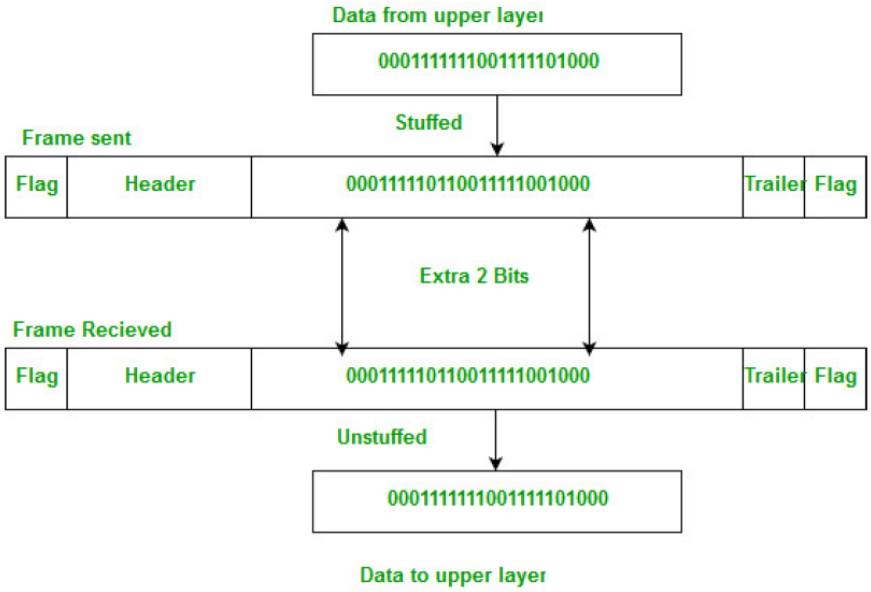

Figure 4.1: Flag Bits with Bit Stuffing

Regardless of the intended purpose, the location of the stuffed bits is transmitted to the receiving end of the data transmission, where the extra bits are extracted and sent back to their original form or bit rate. In this way, bit stuffing enables multiple channels to be synchronized, maximizing the use of available bandwidth. Alternatively, bit stuffing can be used for run-length limited coding, which limits the number of bits that that can pass without a transition. This reduces the number of consecutive bits with the same value in a data stream to ensure reliable transmission and receipt of data.

However, bit stuffing alone does not guarantee that a payload will be free of transmission errors. Instead, it simply ensures that the transmission begins and ends in the right places. For this reason, Ad hoc error detection techniques must be used to check for issues at the end of the frame and, if errors are present, resend the frame.

Bit stuffing is defined by some to include bit padding, which is the addition of bits to a transmission to make the transmission unit conform to a standard size. It is distinct from bit robbing, a type of in-band signaling.

Chapter 5

FLAG BYTES WITH BYTE STUFFING

In Data Link layer, the stream of bits from physical layer are divided into data frames. The data frames can be of fixed length or variable length. In variable – length framing, the size of each frame to be transmitted may be different. So, a pattern of bits is used as a delimiter to mark the end of one frame and the beginning of the next frame. However, if the pattern occurs in the message, then mechanisms needs to be incorporated so that this situation is avoided. So in this case Flag bytes with byte stuffing framing method will support.

- **In this method a flag byte, is used as both the starting and ending of a frame. See in the figure below.**

- **Two consecutive flag bytes indicate the end of one frame and the start of the next frame.**

- **If the receiver ever loses synchronization it can just search for two flag bytes to find the end of the current frame and the start of the next frame.**

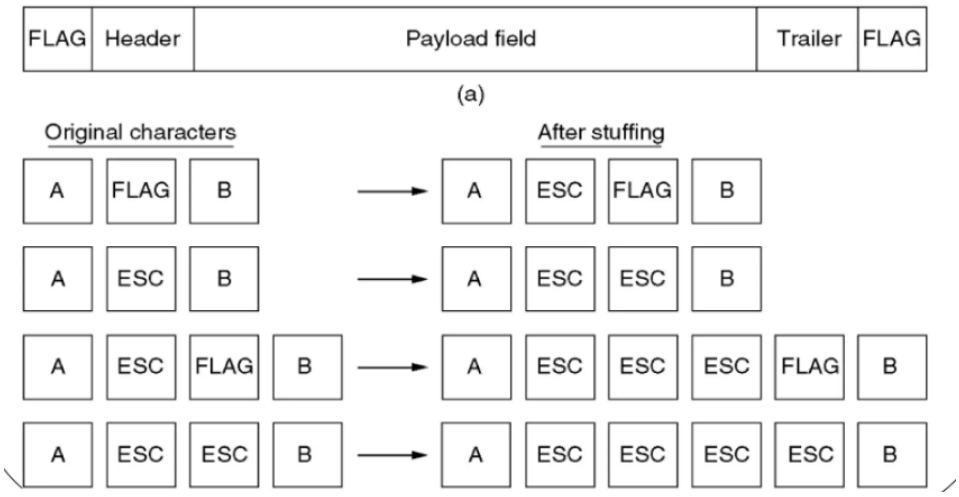

Figure 5.1: Flag Bytes with Byte Stuffing

If the pattern of the flag byte is present in the message byte, there should be a strategy so that the receiver does not consider the pattern as the end of the frame. In character – oriented protocol, the mechanism adopted is byte stuffing.
In byte stuffing, a special byte called the escape character (ESC) is stuffed before every byte in the message with the same pattern as the flag byte. If the ESC sequence is found in the message byte, then another ESC byte is stuffed before it.

Appendix A

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INDEX