# Simulation/Animation Framework for Ethernet Concepts

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***Abstract*—This report explains the creation of a tool that shows how Ethernet works. It uses animations to demonstrate how data packets move from one place to another, highlighting important concepts like delays, transmission speed, and errors. The tool is interactive and combines visualizations with calculations to make learning about Ethernet easier.**

## I. Introduction

The simulation/animation framework aims to visualize Ethernet packet dynamics, focusing on core elements such as framing, transmission flow, and performance under different conditions. The framework is designed as an interactive tool for educational purposes, allowing users to explore the impact of network configurations like bandwidth, packet size, and link length on data transfer.

## II. Ease of Use

### A. Maintaining the Integrity of the Specifications

The framework is designed to follow strict rules to keep its visualizations and calculations accurate and reliable. It is built in a way that allows different parts to work together smoothly, making it easy to update or add new features in the future. This design also helps it handle larger tasks or more complex simulations without needing big changes. Additionally, it can be easily added to different educational systems or platforms, making it useful for teaching and learning. Overall, the framework is reliable, flexible, and easy to expand or use in various settings.

### B. Units and Parameter Calculations

**Transmission Delay** refers to the time required to send a packet of data across a network. It is determined by the size of the packet and the available network bandwidth. The formula for calculating transmission delay is given by:

$$T_{\text{trans}} = \frac{\text{Packet Size (in bits)}}{\text{Bandwidth (in bits per second)}} \tag{1}$$

For example, if a packet of 1024 bytes (which is 8192 bits) is transmitted over a network with a bandwidth of 1 Mbps (1,000,000 bits per second), the transmission delay is:

$$T_{\text{trans}} = \frac{8192\,\text{bits}}{1,000,000\,\text{bits per second}} = 8 milliseconds \tag{2}$$

This calculation shows how the size of the data packet and the network bandwidth affect the transmission time.

**Propagation Delay** is the time it takes for the data to travel from the sender to the receiver, based on the distance between them and the propagation speed of the medium. The formula for propagation delay is:

$$T_{\text{prop}} = \frac{\text{Link Length (in meters)}}{\text{Propagation Speed (in meters per second)}} \tag{3}$$

For instance, if the link length is 10 km (10,000 meters) and the propagation speed is $2 \times 10^8$ meters per second, the propagation delay is:

$$T_{\text{prop}} = \frac{10,000\,\text{meters}}{2 \times 10^8\,\text{meters per second}} = 0.00005\,\text{seconds} = 50\,\mu\text{s} \tag{4}$$

**The Total Transfer time** $T_{\text{total}}$ is the sum of the transmission delay $T_{\text{trans}}$ and the propagation delay $T_{\text{prop}}$, expressed as:

$$T_{\text{total}} = T_{\text{trans}} + T_{\text{prop}} \tag{5}$$

## III. Prepare Your Paper Before Styling

In this project, we will incorporate common terms and abbreviations like CRC (Cyclic Redundancy Check) and MAC (Media Access Control) where they are relevant. These terms will help in explaining key concepts and technical components used in the system. The experiment plan consists of both frontend and backend development:

**For The Frontend**, the goal is to create a dynamic animation that shows real-time packet movement, updating as the network changes. The users will be able to adjust various settings like bandwidth, link length, and packet size, allowing for a customizable simulation of the network's behavior.

**On The Backend**, the system will handle the logic for calculating real-time delays and transmission times. To ensure smooth and seamless operation between the frontend and backend, APIs will be developed to allow for efficient communication between the two parts of the system. This approach will ensure that the network simulation is both interactive and accurate.

# CODE LINK: Simulation/Animation Framework for Ethernet Concepts

## IV. SCENARIO ANALYSIS

The system will work with several input parameters that can be adjusted for different network conditions. The available bandwidth rates are 100 kbps, 500 kbps, 1 Mbps, and 10 Mbps, allowing for different network speeds to be simulated. Link lengths can be set to 1 km, 5 km, 10 km, or 50 km, enabling users to test how distance affects packet transmission. Additionally, packet sizes can vary, with options of 64 bytes, 512 bytes, and 1024 bytes, giving flexibility to the simulation based on the size of the data being sent.

Different scenarios will be tested to observe how these parameters impact network performance. In the scenario of high bandwidth and short distance (for example, 10 Mbps bandwidth and a 1 km link), minimal delays are expected as the high speed and short distance result in quick packet transmission. In contrast, when low bandwidth is combined with long distance (such as 100 kbps bandwidth and a 50 km link), significant delays will be observed due to the limited data transfer rate and the increased time required for packets to travel across the longer link. Finally, a medium bandwidth and medium distance scenario (for example, 1 Mbps bandwidth and a 10 km link) represents an average network setup, where performance will be moderate, reflecting typical network conditions for general use.

## V. RESULTS

The system will include several visualizations to help users better understand how different factors affect network performance. One visualization will show the relationship between bandwidth and transmission delay. This graph will illustrate how higher bandwidth reduces delays, with a clear curve indicating that as bandwidth increases, the time it takes to transmit data decreases. Another visualization will focus on the link length and propagation delay. This graph will show a linear increase in delay as the distance between the two points grows, highlighting how longer links result in higher propagation delays. The final visualization will depict the relationship between packet size and total transfer time. As packet sizes increase, the total time needed to transfer the data will also increase, which will be shown as a gradual rise in the graph.

From these visualizations, several key insights can be gained. First, high bandwidth is crucial for minimizing delays, especially when dealing with larger packets. This means that for larger data transfers, using higher bandwidth can significantly reduce the overall transmission time. Additionally, propagation delay becomes more noticeable as the link length increases, meaning that long-distance links will naturally lead to higher delays due to the time it takes for the data to travel. Finally, optimizing packet size can improve network performance. By finding the right balance between packet size and transfer time, the overall system can be made more efficient, ensuring faster data transmission with fewer delays.

## VI. INDIVIDUAL CONTRIBUTIONS

- **Janvi Mangukiya:** Built the frontend with animations to show real-time data movement, ensured an interactive user experience, and helped with documentation, report writing.
- **Pratixa Bhuva:** Worked on the backend, created the logic to calculate delays, connected the frontend and backend with APIs, and helped collect data for the project.
- **Hardi Desai:** Helped gather and organize data for the project, ensured the information was accurate, worked on the backend, and ensured it functioned properly.

## VII. CONCLUSION

The framework effectively demonstrates key Ethernet concepts through real-time simulations and visualizations, offering an interactive and dynamic way to explore the principles of network communication. By enabling users to adjust parameters such as bandwidth, link length, and packet size, it illustrates how these factors influence network performance and transmission efficiency. This comprehensive approach provides users with a deeper understanding of the interplay between various parameters and their impact on overall system behavior. As a result, the framework serves as a powerful educational tool, facilitating an intuitive and practical learning experience for analyzing and optimizing network performance in diverse scenarios.

## VIII. ACKNOWLEDGMENT

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## REFERENCES

[1] IEEE Standards Association, "IEEE 802.3 Ethernet standard."
[2] M. Young, The Technical Writer's Handbook, University Science Books, 1989.
[3] William Stallings, Data and Computer Communications, 10th Edition, Pearson Education, 2014.
[4] James F. Kurose and Keith W. Ross, Computer Networking: A Top-Down Approach, 8th Edition, Pearson, 2021.
[5] K. Salah, "Simulation of Ethernet LAN performance," Journal of Network and Computer Applications, vol. 30, no. 2, 2007.