Project Report

Protocol Teacher

Submitted by
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Under Supervision of:
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Acknowledgements

I am grateful to acknowledge Prof. Dave Heldenbrand and Prof. David Wagstaff for their guidance during the course of this project work. Both offering valuable information on how to improve the tool for future students to use.

My meetings with Prof. Heldenbrand helped me create the look of the Frame Builder tool. Giving suggestions on improving not only the design but also the functionality of the Frame Builder tool. Making it atheistically pleasing and user-friendly for the students that use the tool.

I would also like to extend my gratitude towards my classmates on giving me valuable information on how they would use the tool and how to improve it. Making the tool more effective and valuable for future student use.

April 2019 Abdullah Alzahrani (10782952)

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1

Introduction

Overview

This report discusses the results of the work done in development of “Protocol Teacher.” It is a part of the Undergraduate Research Project for Networking Specialization going on in Computer Science Department, Utah Valley University and aims at the development of a website designed to help students understand internet protocols and provide a visual illustration of an internet frame.

Background and Motivation

Internet frames can get complicated and hard to understand. Since students study each protocol separately, and each protocol takes time to fully understand, students find it hard to piece them together in their mind. The purpose of this project is to help them with piecing together all the information.

This can be solved by having a visualization of the protocols, it will make it easier for students to see an entire packet and where each protocol fits. Furthermore, it will also help by having the students and teacher interact with the visualization to fully understand each protocol.

Objective

The final goal of the project was to create:

1. A Frame Builder tool to help visualize and interact with each protocol. It was created to be user friendly and easy to use. The user can hover over a header field and read more information about that field. The user can also choose a protocol when hovering over the payload/data field of the header.
2. A Network Protocols page to provide more information about protocols covered in the Frame Builder tool.

Methodology

To implement the above goals, the following methodology needs to be followed:

1. Collecting research material and information about each protocol.
2. Developing the UI design of the header and header fields.
3. Coding the functionalities of the Frame Builder tool in JavaScript.
4. Working with Prof. Heldenbrand to reach the desired look of the Frame Builder tool.
5. Implementing the Network Protocols and About pages.

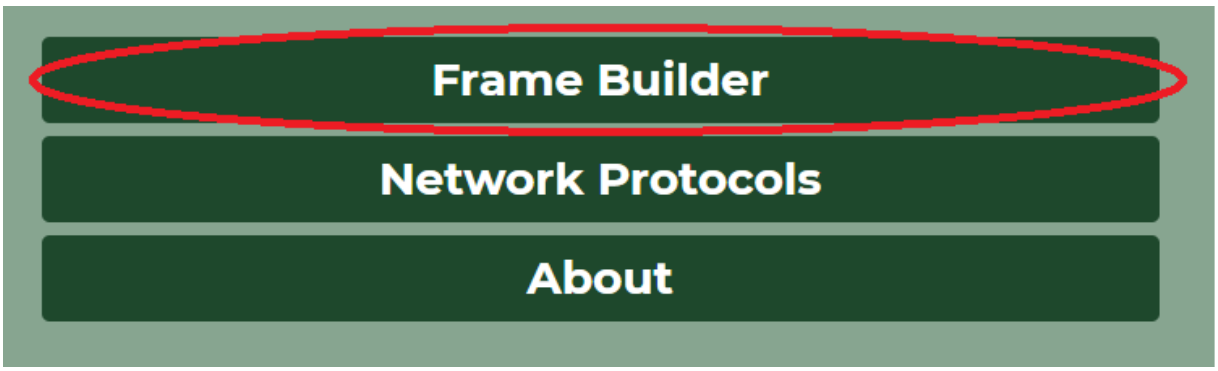
Chapter

2

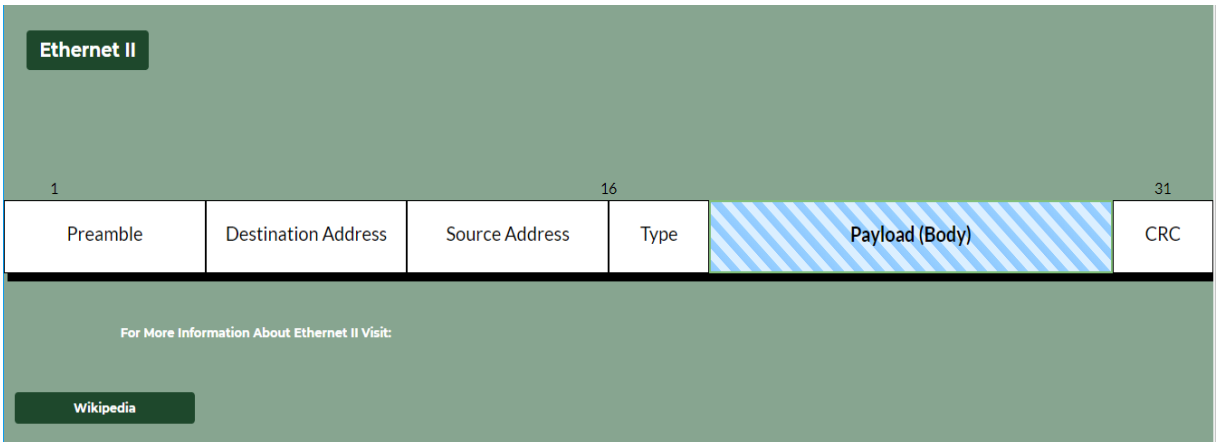
Frame Builder Tool Description

Tool Interaction

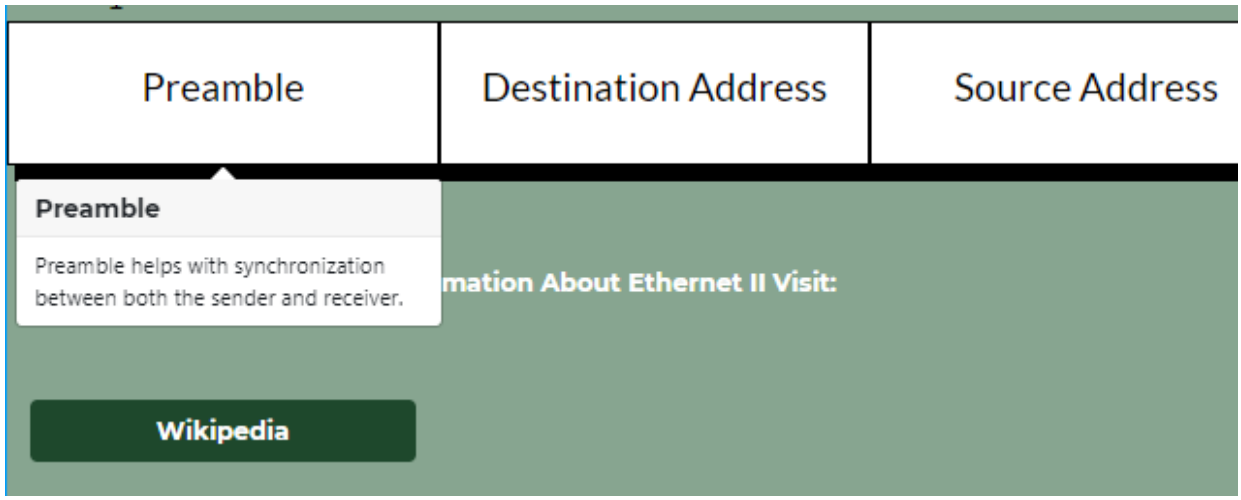
The Frame Builder tool can be accessed from the home page of the website, as shown below:



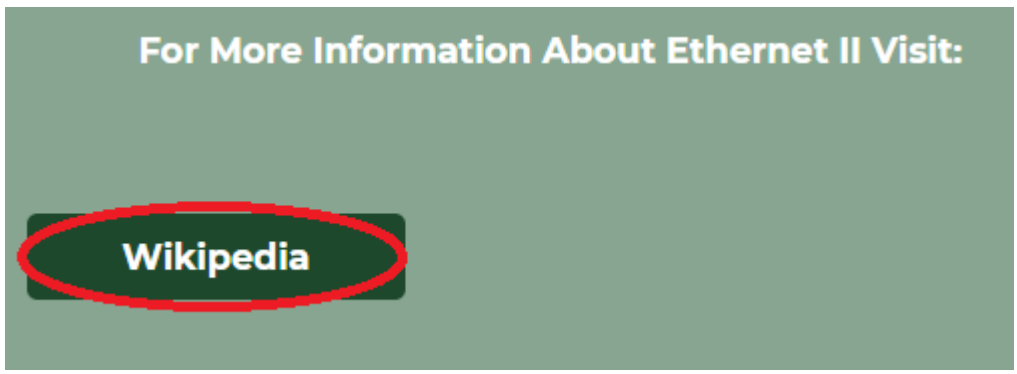
The user will then be presented by an Ethernet II header to start with, as shown below:



From here the user can hover over each header field to read more information about that specific header field. For example, the user can hover over the Preamble field of the Ethernet II header, as shown below:

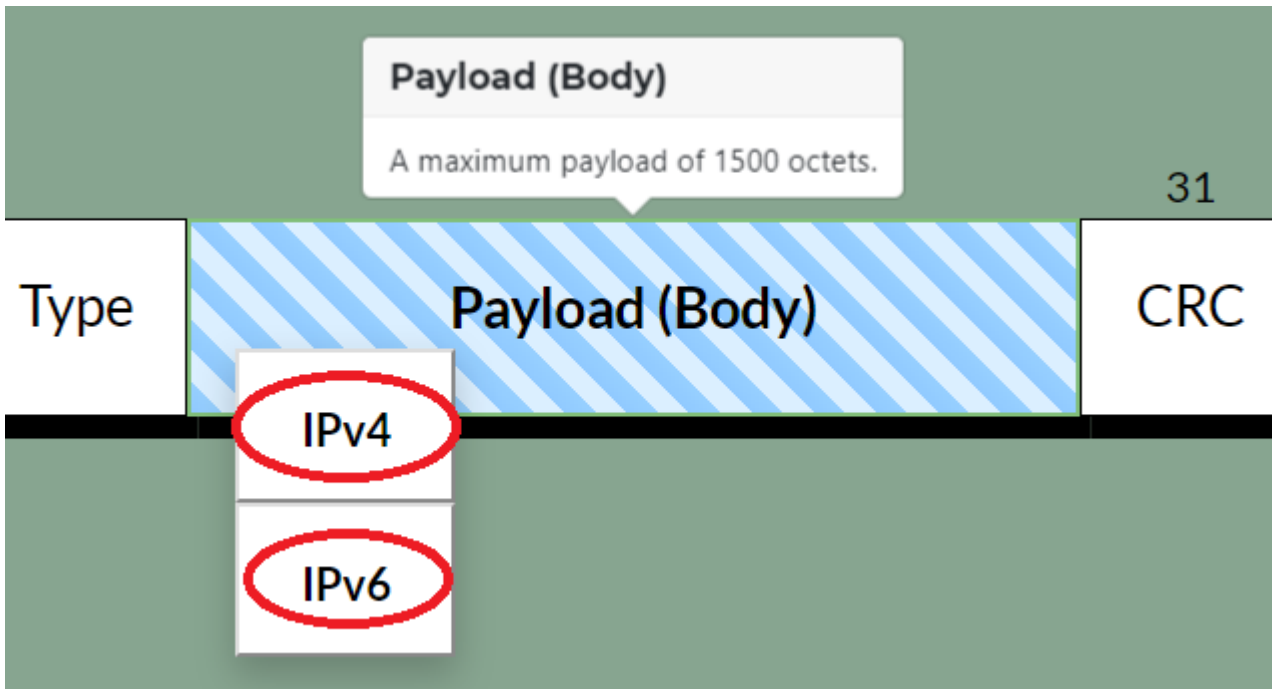


If the user wants to read more information about the protocol they can click on the Wikipedia or RFC link. For example, there is no official RFC for Ethernet II but there is a Wikipedia page that the user can visit, as shown below:



A protocol that has an official RFC would include that link as well, for example, IPv4 has both an RFC and a Wikipedia link, as shown below:

When the user hovers over the Payload field of the header they can chose what protocol is carried inside of that frame. For example, when hovering over the Payload (Body) field in the Ethernet II header, the user is provided with two options IPv4 or IPv6, as shown below:



After the user chooses what protocol frame they want carried in the Payload/Data field the protocol will be added to the stack above the table. This makes it easy for the user to track the entire frame, they then can click on any of the protocols listed in the stack, and it will be shown in the table. For example, the user chooses IPv4 then chooses TCP as its data, as shown below:

This can enable the user to make changes without starting all over again. In the above example the user can click on IPv4 then for example can choose UDP as its data instead.

Data Representation

The data for each protocol is stored in a JSON object that will be populated in the table when needed. The JSON object includes each row of the header as a value and inside each row includes; name (the name of the header field), size (the size of the box relative to other boxes), id (describes the color of the box and if it is clickable), data (the data that will be shown when hovering over the header field), placement (the placement of the hover box containing the data), and list (includes the protocols the user can choose from if available).

The stack is stored and accessed from an array named breads. Each time the user adds a protocol it is pushed in the array and shown in the stack above the header table on the page.

Links are added and populated through the links method. It takes a protocol, as its parameters, and adds the appropriate links for that protocol. Every time the user clicks on a protocol the links method is called.

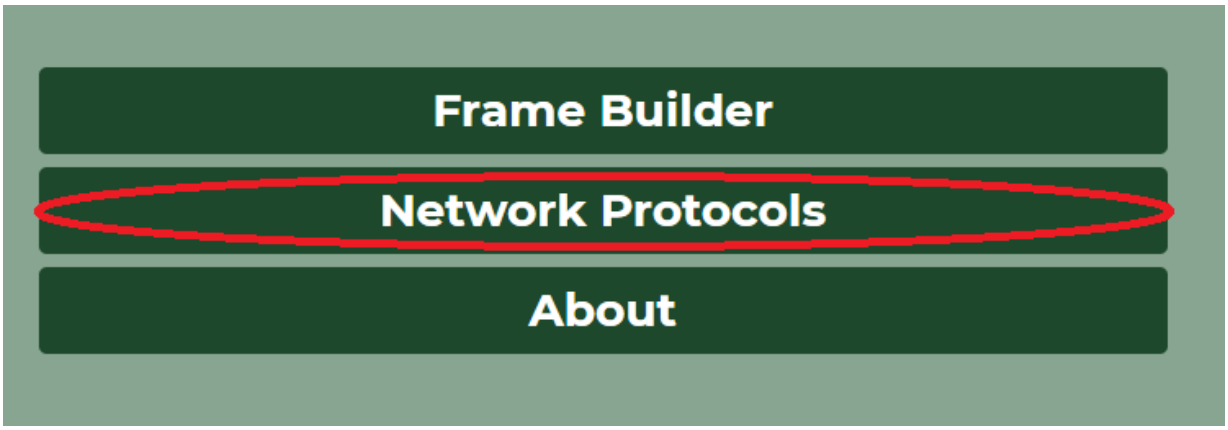
Chapter

3

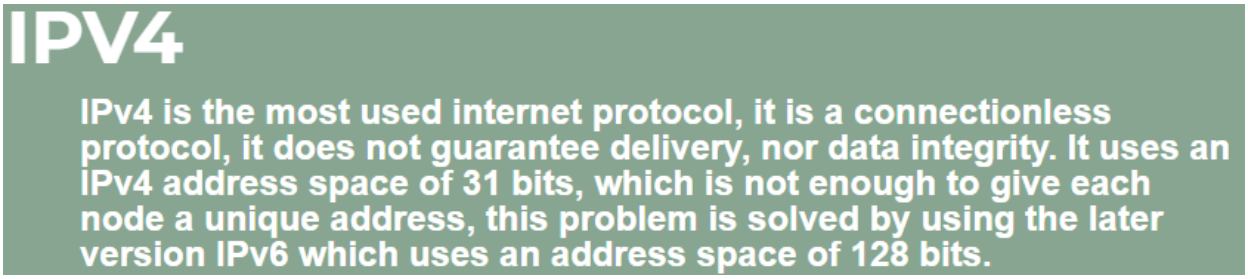
Network Protocols and About Pages Description

Network Protocols Page

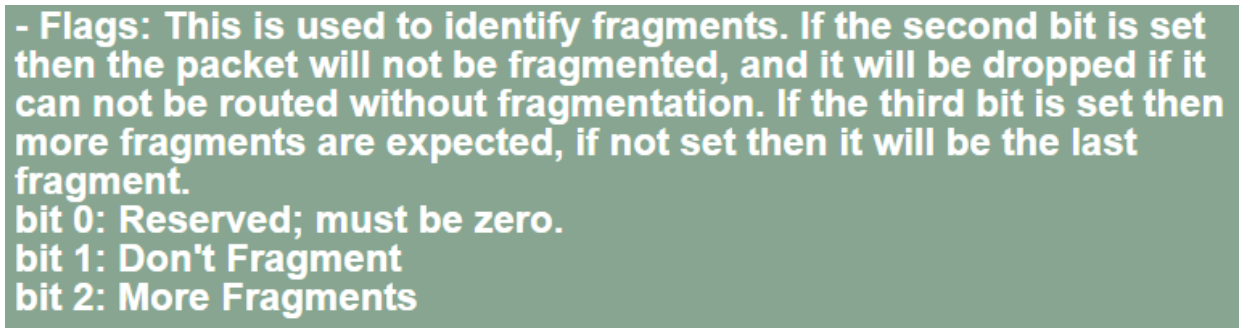
The Network Protocols page can be accessed from the home page of the website, as shown below:



It includes Information about each protocol included in the Frame Builder tool. As an example, it includes the following information about IPv4, as shown below:



It also includes more information about each header field of each protocol. It explains more than what is shown when hovering over the field in the Frame Builder tool. Using the above example, we can see more information about the Flags header field in the IPv4 header, as shown below:

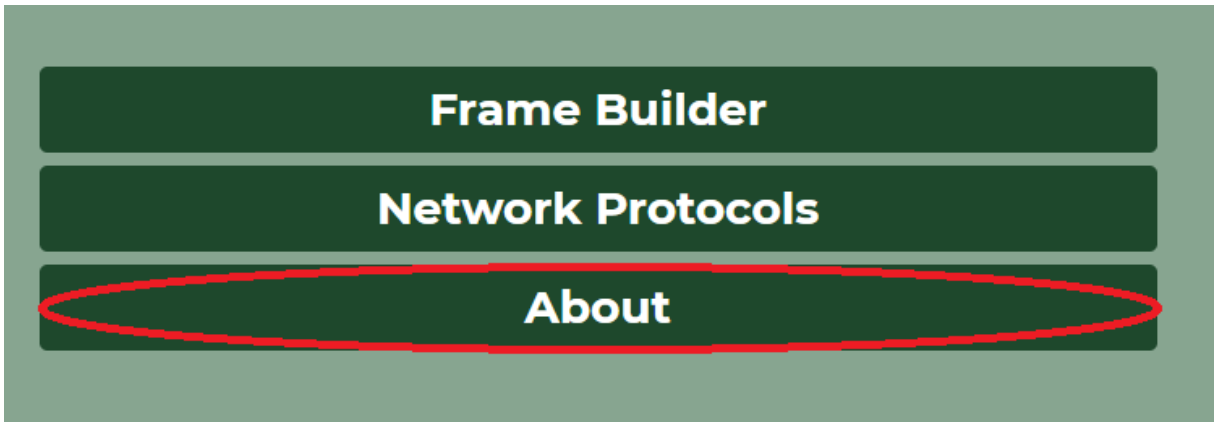


At the end of each protocol there are also links for more information about the protocol. They are the same links used in the Frame Builder tool, as shown below:

This page was designed to give more information about each protocol covered. It can be used as a review when studying protocols.

About Page

The About page can accessed from the home page of the website, as shown below:



It includes the following information:

1. A brief description of Protocol Teacher: Protocol Teacher is a website designed to help students understand internet protocols and provide a visual illustration of an internet frame.
2. Where to find the source code on GitHub.
3. The designer of the website: Designed by Abdullah Alzahrani.
4. Contact information: Contact me at protocol.teacher.uvu@gmail.com

Chapter

4

What I Have Learned

During the course of this project I learned many design skills as well as technical skills. One of the career paths I am pursuing is web design and development. This project helped me grow in both areas helping me in my career forward.

Learning the importance of designing and how to design my own web application allowed me the opportunity to learn how to choose the logo, fonts, and colors of the website. That each web page should look similar and have a similar theme. Making it easy for the user to make choices and not be overwhelmed by the design.

When researching about the protocols that were included in the website (Ethernet II, IPv4, IPv6, TCP, UDP, and ICMP). I increased my knowledge about those protocols and how they are the building blocks of what we consider as the Internet now. I am more aware of their importance and functionality and how they all fit together. There are more protocols that need to be included in the future to make the tool better and help more people too.

While creating the Frame Builder tool I learned a lot about the Bootstrap Grid System and how to utilize it to make the header look similar to what we were shown in class. Then using JavaScript to tie everything together and have the tool work smoothly. Creating the appropriate methods and JSON object structure.

Overall, I learned a lot from this project. I am proud that I can put it into my portfolio and continue working on it after graduating. This project taught me how to be self-sufficient and creative when solving problems. I look forward to seeing how I use the skills I learned during this project in the future and see how the tool progresses.

Chapter

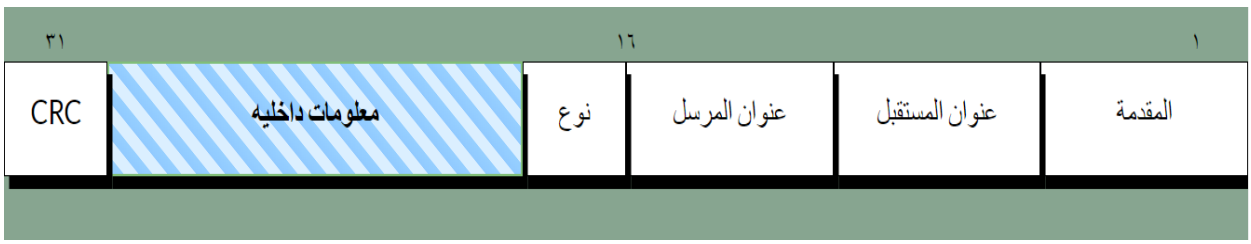
5

Future Work

- **Arabic Version**

After searching the web for information about protocols in Arabic it became apparent that there is not enough information and for some protocols there was none entirely. Work has begun on creating an Arabic version of Protocol Teacher. There are some challenges facing the conversion from English to Arabic, the main challenge is finding appropriate translations of header fields. The second challenge is that the Arabic language is written from left to right, unlike the English language.

Here is an unfinished implementation of an Ethernet II header in Arabic.



As seen above, instead of having the CRC field at the end of the header it is placed at the front since everything is read from left to write. My goal is to hopefully finish this implementation soon so more people can use this tool. As an Arabic speaker myself, I am motivated to finish implementing the Arabic version.

- **Server-Side Implementation**

  Another feature that can be implemented is to have a server that handles requests from the client. It can be as simple as requesting a JSON object of a protocol. It can be more complicated by having the server build the table, then send it off to the client, and the server would keep track of the protocol stack as well.

- **Database**

  Once we have created a server, creating a database is the next natural step. The database can hold all the protocols and feed it to the client when requested. This would take some load off the client so it does not have to load all the data every time the website is used.

- **More Protocols**

  The final step is to include more protocols. We already have a model to represent a header in a JSON object, the same model can be used to create any protocol header. There can also be an admin page that allows users with permission to enter new protocol, delete, or change current protocols.

Appendix A

Project Journal

Week 1 (Feb. 1)

Approximately 3 hours where spent to review and get the information needed from the CS 2690 & CS 4610 Lectures Slides.

Approximately 2 hours where spent to review and get the information needed from the book, Douglas Comer. Internetworking with TCP/IP, Vol. I. 5th Edition.

Approximately 2 hours where spent to review and get the information needed from the book, Computer Networks - A Systems Approach by L. Peterson and B. Davie 5th Edition.

Week 2 (Feb. 8)

Approximately 2.5 hours where spent to create the wireframes as a proof of concept and visualization of how the website would look.

Approximately 3 hours where spent to create the home page and get the color code and style for the website to be used.

Week 3 (Feb. 15)

Approximately 2 hours where spent to create the CSS implementation for how the boxes look.

Approximately 1.5 hours was spent to try and use Bootstrap flex as a tool to show the entire header, but it did not turn the way I wanted.

Approximately 4 hours was spent to learn and configure Bootstrap Grid system to show the entire header, the sizes of the boxes worked much better than flex especially when resizing the browser window size. All the testing was done for a fake header.

Week 4 (Feb. 22)

Approximately 3 hours where spent to create the functionality of choosing the next protocol in JavaScript and having the table load the next header.

Approximately 2 hours where spent to create Ethernet II and have all the header fields be the correct size according to the header samples from the books and lecture slides.

Approximately 1 hour was spent to create a simple stack on top of the header table that works and is clickable.

Week 5 (Mar. 1)

Approximately 2 hours where spent to fix some issues with popovers, after loading a new protocol header a glitch makes the popover from the previous header stay on the side of the screen.

Approximately 1 hour was spent to change how the Payload/Data box looks and some minor font changes.

Approximately 2 hours was spent to create the IPv4 header the correct way according to the book and lecture slides.

Week 6 (Mar. 8)

Approximately 3 hours where spent create the TCP header the correct way according to the book and lecture slides.

Approximately 2 hours where spent create the UDP header the correct way according to the book and lecture slides.

Approximately 2 hours where spent to fix other bugs with window resizing, and retracing the stack and deleting headers.

Week 7 (Mar. 15)

Approximately 3 hours where spent create the IPv6 header the correct way according to the book and lecture slides.

Approximately 2 hours where spent create the ICMP header the correct way according to the book and lecture slides.

Approximately 1 hour was spent to change how the Payload/Data box looks and some minor font changes.

Week 8 (Mar. 22)

Approximately 1 hour was spent for minor font and style changes.

Approximately 2 hours where spent create Network Protocols page.

Week 9 (Mar. 29)

Approximately 6 hours where spent to change from using static HTML for each protocol table to creating the JSON object structure and having it populate in HTML.

Week 10 (Apr. 5)

Approximately 3 hours where spent converting the website to Arabic and making an Arabic version of Ethernet II header.

Approximately 3 hours where spent to review all the information about each header field for each protocol to have them shorter in the Frame Builder tool, but longer in the Network Protocols page.

Week 11 (Apr. 12)

Approximately 5 hours where spent on finishing the Frame Builder tool description and future work for the final report.

Approximately 2 hours where spent to implement the links and have the appropriate links for each protocol.

Approximately 1 hour was spent change how the stack looks on top of the header table. Adding a button and arrows.

Week 12 (Apr. 19)

Approximately 5 hours where spent to create the slide show and prepare for the presentation.

Approximately 1 hour where spent to fix bugs with resizing in the Network Protocols page.

Approximately 1 hour was spent on testing.

Week 13 (Apr. 26)

Approximately 30 minutes where spent to create the About page.

Approximately 30 minutes where spent to create the GitHub repository and email.
It can be found here: https://github.com/Protocol-Teacher/Prorocol-Teacher

Approximately 5 hours where spent on finishing the Final Report and proof reading it.

Appendix B

Original Project Proposal

TO: Professor David Wagstaff
FROM: Abdullah Alzahrani
DATE: January 31, 2019
SUBJECT: **Proposal for an Educational Website on Internet Frames**

Here is the proposal for the educational website project on internet frames.

Proposed Title—The name of the website will be "Protocol Teacher."

Proposed Delivery Date—End of Spring, 2019 Semester.

Brief Description—Protocol Teacher is a website designed to help students understand internet protocols and provide a visual illustration of an internet frame.

Detailed Description—Internet frames can get complicated and hard to understand. Since students study each protocol separately, and each protocol takes time to fully understand, students find it hard to piece them together in their mind. The purpose of this project is to help them with piecing together all the information. The website, Protocol Teacher, will have two main parts. The first part is a frame building tool that lets the student or teacher build a frame and choose the appropriate protocols they need. For example, they can choose an Ethernet frame carrying an IPv4 frame carrying a TCP frame, etc. The second part of the website is a simple description of each protocol covered in the frame building tool, what is TCP for example.

Applicable Tools Needed—This project relays on research and programming.

1. CS 2690 & CS 4610 Lectures Slides
2. Douglas Comer. Internetworking with TCP/IP, Vol. I. 5th Edition
3. Computer Networks - A Systems Approach by L. Peterson and B. Davie 5th Edition
4. Visual Studio Code v1.30.2
5. Website Hosting Server

Proposed Deliverables—Deliverables will include: source code; wireframes; progress reports; final project report; oral presentation; weekly work log detailing what work was done.

Timeline—Below is the timeline I propose for completing the project

Feb. 1 Project design, phase 1 (review of literature, acquisition of project resources)

Feb. 8	Project design, phase 1 (Wireframes)
Feb. 15	Project design, phase 2 (Ethernet Frame & IP Structure)
Feb. 22	Project design, phase 2 (develop design specification)
Mar. 1	Project execution (Ethernet)
Mar. 8	Project execution (IPv4)
Mar. 15	Project execution (TCP)
Mar. 22	Project execution (UDP)
Mar. 29	Project execution (Application Layer)
Apr. 5	Write research report
Apr. 12	Write research report and develop oral presentation
Apr. 19	30-minute oral presentation of project results
Apr. 26	Testing
Apr. 29	Submit project deliverables to faculty adviser

I am looking forward to gathering the information needed and programming the website, making it easier for students to understand internet protocols.

Appendix C

Wireframes