[[1]](#footnote-1)

Distribution of Packets

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*Abstract*— The networking paper will mainly be answering how packets are distributed over the internet to redistribution centers. It will also describe the process of how they are distributed. To explain this, we will be giving an in depth guide to how information is distributed over the internet from start to finish. We will explicate the basics by explaining topics like, Packets, The Open Systems Interconnection (OSI) Model, Internet Service Provider (ISP), and Network Domains.

*Index Terms*— Internet Service Provider, wrapper, packet, receiver, sender, network, data link, physical, protocol, control, transmission, Open Systems Interconnection, Simple Mail Transfer Protocol

# INTRODUCTION

## JUSTIFICATION

One of the things that most people have taken for granted in more modern times is also a foreign concept to most of the world. Most people have no background knowledge in either the execution or the setup of this modern marvel. But it arguably might be the most important creation the human race has ever witnessed to this day. It serves many purposes. It can interconnect the human race all across the world, or even make all of the knowledge publically and readily available to anyone at the movement of a finger. I am sure that if it is not obvious by now it will be bluntly visible in a second; this globally used phenomenon is the Internet. When it comes to the Internet, most of the public have little to no knowledge or interest in how it’s possible to connect with someone located half way across the world. Or maybe how it is possible to simply go google how to do almost anything and gain an in depth guide of its procedure. Most people do not have an indication of how their computer or smart phone works besides the ability to operate simple commands that allow easy access to the internet or type a paper. Mainly this paper will go over what happens behind the scenes on the computer and beyond both home and personal networks. This presentation will be about how packets leave the router to obtain and reach their final destination. It will then explain the process of how it travels back and forth to complete the journey of sending data. It will also describe ISP (Internet Service Providers) and its effects on the management of internet traffic and its several hundred thousand customers. All of these are important to know for a few simple reasons. Some of these reasons are that it will be more easily understood as to why Internet traffic times can be slowed or why it takes longer to download certain files. All variables must be considered such as depending on where the files are located can depend on the set protocol that is applied. Being able to more easily understand the user’s local network and how it works is the reasoning behind the importance of this topic.

## BACKGROUND KNOWLEDGE

OVERVIEW

Now before going into the details, we will explain very basically the process that goes into sending information back and forth over the internet. We will also present an example. First when you send an email to someone, the information is transformed into packets on the computer and then sent out into the network. But before the packets are sent out, a first packet is sent to the receiver. This helps inform the receiving computer that the sending computer is now ready to send the rest of the packets. This information is used to ask if the receive computer is ready to accept them. As soon as the receiver has sent a packet back, confirming that they are ready, the sending computer will start sending packets out to their ISP. The receiver will then redistribute the packets out through paths that maximize transfer times to the receiver. As the packets are being obtained, the receiving computer marks off the packets it is expecting. If any packets are dropped or not received, the receiving computer will direct a packet to the sending computer asking for those dropped packets to be resent. Once the receiver has acknowledged that of the lost packets have been gathered, the receiver will forward a packet. This packet tells the sender that the receiver has collected the entire file. This concludes the basic ideas and processes behind information transferring.

PACKETS

Now a good question to be asking is how exactly does the internet send and receive information? To start to grasp this we need to know exactly, what does it send first? The internet at the most simplistic building block is merely just a series of packets.

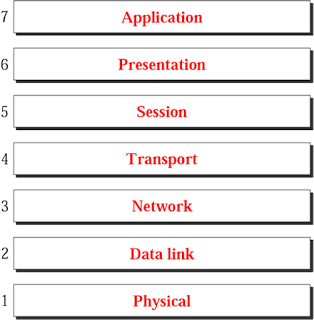
“**Packets** are parts of a file that range between 1,000 and 1,500 bytes. Packets have headers and footers that tell computers what's in the packet and how the information fits with other packets to create an entire file.” [1]

Instead of the information being sent as one large file to be displayed on the user’s computer screen, the information is split up into millions of pieces and sent to a computer. This computer’s infrastructure gathers the sent data and then properly reassembles it on the other side. The Packet is properly wrapped in a header and footer. These two entities together are called the wrapper, and they contain data regarding the information for the entire transfer process. This information within the wrapper consists of the type of data that is in the packet, how it fits together with the other packets, where the data came from, and where the data is intended to be received. [3]

Ultimately this aids in the overall reassembly in the correct process. With the data from the wrapper, protocols are able to properly reassemble the file in a form that the computer can comprehend. For example, the wrapper informs the receiver how many packets that it should expect. This is helpful because in the case that a packet is dropped, the receiver can know it has not obtained the specified amount described by the wrapper. The receiver can then ask the sender to resend the packets before confirming that it has received the designated amount. Also, the wrapper will properly inform the ISP how the files will be sent, what port number on the router the packets should be sent through, and when the packets are consumed by the receiver. This is all dependent on the protocol that is being used to send it.

OSI MODEL

“The OSI (Open Systems Interconnection) model is a reference tool for understanding data communications between any two networked systems.”[4] It divides up communications into seven processes.



[4]

Each layer supports each other and without one the whole stack would not function properly. The layers that will be focused on mainly throughout the paper are the third, the Network layer, the second, the Data link layer, and the first, the Physical layer. The leading reason for only focusing on these three layers is because everything after the Network layer only concerns devices within network rather than anything outside the network.

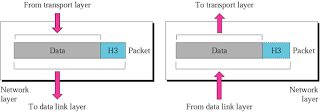
We will start from layer three and go down OSI stack. Layer three is the Network Layer and it’s primary focus is to create logical paths. These paths are known as virtual circuits. Routing and forwarding are some of the functions of the Network layer. Specifically it handles addressing the packet to where it is going to go, connecting networks together, error handling, controlling traffic so that it does not become congested or delayed and also packet sequencing. Packet sequencing assigns a number to the packets so that they may be reassembled by the receiver, in an efficient manner, when they are finally all received. [4]

The main functions of the Network layer are:  
“1. Translates logical network address and names to their physical address (e.g. computername ==> MAC address).

2. Responsible for addressing, determining routes for sending and managing network problems such as packet switching, data congestion and routing.

3. If router can’t send data frame as large as the source computer sends, the network layer compensates by breaking the data into smaller units. At the receiving end, the network layer reassembles the data.” [4]

Network Layer



[4]

Layer two is the Data Link layer and its main purpose is to handle data transfer between the network layer and the physical layer. It is also responsible for preparing the data to be sent out. Layer two is where all the organization of packets takes place and the process of assembling them happen. The Data link layer adds the wrapper to the packet. It completes this action so that the packet can be both properly identified and taken care of when it reaches either a redistributor or the intended receiver. This layer also segments upper layer datagrams into frames that the can be handled by physical hardware. It organizes and sorts out these frames for the physical layer before handing it over. Lastly, the Data link layer controls all communication for the physical layer. It monitors this by handling data frames and frame traffic control. Frame traffic control will slow down the traffic of frames that pour into a system. If more time is needed to process, frame sequencing will commence and the packets will be properly organized and accounted for. Then the frame acknowledgements, of the second layer, takes in account all of the available packets. After accountability, it handles all of the errors that occur in the transfer of the packets and solves the problems that arose. Some problems that may arise are in the possibility of a duplicate frame existing or missing packets. The basic main functions of the Data link layer are:  
“1. COMMUNICATION with the Network layer above.

2. SEGMENTATION of upper layer datagrams (also called packets) into frames in sizes that can be handled by the communications hardware.

3. BIT ORDERING. The data link layer organizes the pattern of data bits into frames before transmission. The frame formatting issues such as stop and start bits, bit order, parity and other functions are handled here. Management of big-endian / little-endian issues are also managed at this layer.

4. COMMUNICATION with the Physical layer below

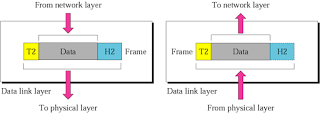
a. Handles data frames between the Network and Physical layers.

b. Frame traffic control: tells the transmitting node to "back-off" when no frame buffers are available.

c. Frame sequencing: transmits/receives frames sequentially.

d. Frame acknowledgment: provides/expects frame acknowledgments. Detects and recovers from errors that occur in the physical layer by retransmitting non-acknowledged frames and handling duplicate frame receipt.”  [4]

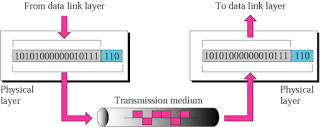
Data Link Layer



[4]

Lastly, we have the Physical layer. The Physical layer is in charge of grabbing the data translated from the Data Link layer and transmitting it over a physical wire. It performs a fragmentation of data into frames, so that it can be submitted when conducted with electricity, through a wire. It can then re assemble these frames back into data link Protocol Data Units. Ultimately the first layer is in charge of both transmissions to the physical media as well as receiving from the physical media. [4]

Physical Diagram



[4]

With all three of these layers explained in detail, it will be easier to expound on how files are transmitted and how traffic is controlled.

# PROBLEM STATEMENT

Now that a good base of knowledge has been laid down we can now start talking about the questions at hand. How exactly does information get routed over the internet and how are the paths chosen to most rapidly send the packets to their receivers?

# PROBLEM APPROACH

Several aspects go into solving and figuring out this question.

First is what is the full and in depth path that packets must take to reach its final destination as well as the entire document?

Second is how do ISP shape their internet traffic to better suit the traffic that they have circulation at that moment?

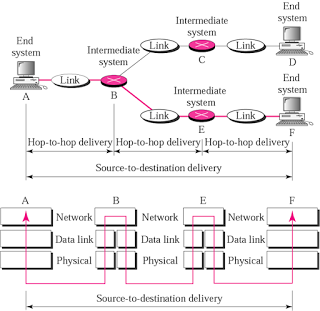
The full path of a packet will now be explained in greater depth than previously mentioned. It starts out with a user sending a requesting packet to another system for a file. After a confirmation has been sent back to the sender, the sender starts sending packets to the receiver. These packets will first go through the Network Layer where it will be given a proper address. Then the packet will be stamped with its final destination and will be sent to the closest node. The process for this node is decided by the Network layer applied functionally by the ISP. The ISP takes into consideration how much traffic is going through the potential node as well as file types and the priorities of the file. For example, a live video file packet will have a higher priority than a Simple Mail Transfer Protocol (SMTP) packet. The reason for this is because the live video file will be choppy if its packets are not flowing in at a steady rate. A SMTP file can wait because it does not matter how fast it gets there as long as all of packets eventually make it to the receiver so they can be fully assembled. This is called Traffic Shaping or packet shaping. It is also known as Quality of Service (QOS). ISP’s also use this information to limit the bandwidth of users that pay by a limited amount of bandwidth. Some things taken into consideration when picking the next node for the packet to be transferred to is,

1. Distance

2. Priority of file

3. Sender of the file

With the route picked out. The Network Layer will then make sure all the packets are of a transferable size. Now that the packet has been given a proper address and approved for sending, it then goes to the Data Link Layer. The Data Link Layer can take the data it received and add the wrapper. As explained before, this wrapper is what will tell the next node exactly where it needs to go and what type of file it is and what packet number it is. The Data Link Layer of the sender is in charge of making sure that the packets can be reassembled by the Data Link layer of the receiver. After the packet is properly assembled with the wrapper, it is sent through the physical layer where it is turned into bits that can be transported over physical cable and taken to the proper node. When the node receives the electrical currents the physical layer translates them into Protocol Data Units. That allows the Data link layer to know how to properly decipher the wrapper and show the Network layer the final destination of the packet. The Network Layer will now decide which node to transfer the packet to next depending on the final destination. Each node that is visited by the packet will be resent through that node layers again. This will repeat until it is close enough to be transported to the receiver. The receiver then will process the packets. The Receiver then will tally up any packets not received and asks the sender to resend them. After all packets are received the receiver will then reassemble them at the network level and close the connection with the sender. The file will now be fully available to the receiving system.



IV. REFERENCES

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1. [↑](#footnote-ref-1)