CS 494/594 Internetworking Protocols: Homework 1 (Winter 2022) Portland State University

**Due Date: 1/18/2022, 11:59 pm PST, ONLINE**

Name (please print): **Parth Parashar** Circle One: 494 ***594***

Instructions:

594 Students:

The papers:

Please embed your homework answers in the space provided below. Submit a PDF on Canvas.

Please DO NOT email your homework to the instructor or TA.

Do not slip your homework in the instructor’s mailbox or under her office door.

*Late submissions are not accepted for this homework. Your homework score for your final grade will be the mean of your top 4 HW scores (out of 5 HWs).*

Please review the following papers in addition to submitting the homework. Please see the links provided on the course page on John Ousterhout’s Guidelines for Paper Reviews, as well as some excellent sample reviews.

* “The Design Philosophy of the DARPA Internet Protocols”, David Clark, ACM SIGCOMM 1988.
* "End-to-end arguments in system design", Saltzer, Reed and Clark, ACM TOCS, 1984.
* “The Internet Governance Ecosystem”, Vint Cerf, CACM, April 2014.

**Review of "The Design Philosophy of the DARPA Internet Protocols", David Clark, ACM SIGCOMM 1988.**

This paper aims to clarify the design goals and considerations that went into building the TCP / IP protocol suite. The paper highlights the tradeoffs made and tries to assess the impact of these design decisions on the future evolution of TCP/IP as it is increasingly deployed in the internet. The author does not only stop in describing the existing Internet protocols, but also shows the imperfect parts of the Internet architecture and the goals that current protocols haven't reached yet. I was particularly interested in the explanations of how the relative priority of the different goals affected the protocols.

The internet protocol was very effective in meeting its original set of priorities, but was not designed to meet the priorities of today. If designed today the internet protocol would assign much different weights to the set of goals when defining. Some of the goals that were lower in importance when the internet was created were less effectively met and have now become serious shortcomings.

The paper barely addresses alternatives that were considered. I would like to know which design decisions were strongly contested. It does not explore the protocols that might have resulted from different goal prioritization. New types of networks and technologies are connected to the Internet without reengineering of the protocols, the Internet generally functions well in the face of failure, and new types of services are   
delivered without changes to the underlying protocols. However, the protocols do not lend themselves to lower priority goals such as resource accounting, and I would have liked more about alternatives that address these goals.

The author did make some suggestions of flow monitoring or soft state, but says very little to back this up. He says it may well permit us to reach our goals, but offers no reassurance, and leaves it open as a type of exploration, not a solution. The author also does not give a convincing explanation as to why packet switching was chosen. It merely compares with circuit switching and uses remote login as an application to justify the choice of packet switching. The reasoning could have been more sound.

One possible drawback with the design as presented, is the fact that these design goals might not hold in today's Internet which is far more inhomogeneous in terms of actual network components as well as types of service required for content and management. The goals of a protocol suite would probably place more emphasis for instance on accountability and ease of management. Also glaring, is the omission of the network security aspect and the behavior of the network in the presence of malicious entities either at the ends or the core of the network. This seems like a critical necessity in today's internet and it would seem that a protocol suite with security as a design goal would prove quite different from the current TCP/IP design.

System researchers and builders should recognize that in ever changing environment of the internet priorities often change. It is not the ability to immediately satisfy all priorities, but rather the ability to adapt to meet the priorities of tomorrow. It was a large step to move from networks which had been traditionally circuit switched to the packet switched internet. The use of datagrams allows much more flexibility in dealing with unlike systems than continuous streams would allow. It is also important to realize that sessions can still be used in the datagram model by creating a virtual circuit. The issue of survivability that was once so important to the military is pretty much non-existent due to the extreme redundancy built into the topology of the internet today. Much more important today is the issue of performance. Performance was not a large issue when the internet was created, but could now be considered the most important issue. TCP/IP has adapted to fit the current day needs, but it is evident by the ordering of priorities when created that the protocol was not designed for the present day internet.

**Review of the "End-to-end arguments in system design", Saltzer, Reed and Clark, ACM TOCS, 1984.**

This paper is a presentation of the end-to-end argument in relation to system designs. In short, the end-to-end argument proposes that, "a function should not be provided in the lower level of the system unless it can be completely and correctly implemented at that level". The paper argues the pros and cons (mostly the pros) of this argument and provides examples supporting this design principle.

The strengths of the paper:

Formalizes the end-to-end design principle, that has already been widely in use at the time of publishing, but not well documented.

The design principle presented in this paper is general enough to be applied to areas other than communications network.

It provides detailed examples in diverse areas of system design, such as security, message suppression, delivery acknowledgement, and crash and error recovery.

Sole Weakness:

While the entire paper is very well written and provides a strong argument in favor of the end-to-end design principle, it does not provide any quantifiable proof in support. There are no facts or figures that demonstrate that putting functionality at a lower layer is more costly or only good for performance. It only vaguely addresses the other approach to move functionality into the lower layers. Instead, it appeals to the reader’s common sense to accept their argument.

Overall this is a very well thought out and well written paper. While it does not put forward new ideas, it does a good job of consolidating the existing thought process behind adopting this approach. Is this approach the correct one? Looking at the current state of the Internet, it seems the answer is yes. Specifically if you look at how the foundation of the Internet is organized, specifically the TCP/IP stack, the advantages of this approach are immediately obvious.

**The Internet Governance Ecosystem**

**By Vinton G. Cerf**

Summary:

Internet is a network of interconnected computer networks. Since it deals with a system that is diverse, evolving, and dynamic has a huge scope for development. This paper lists out the various agencies that have been formed in the recent years in order to manage the usage of Internet in the academic and private-sector organizations by executing the necessary function.

What the author is trying to accomplish:

The author discusses the timeline of organizations along with their motives. By indicating their developments, he shows a hope for future evolution in the domain of Internet. In the early stages, Internet was a research project sponsored by the U.S. Department of Defense's Advanced Research Projects Agency. However, with the involvement of other organizations like NASA and NSF, its study expanded gradually. In the mid of 1980’s, the US government Internet policy had undergone a few changes in its formation, at the end of which it was folded into the President’s Committee of Advisors on Science and Technology. Over a period of time, many agencies were formed which concentrated on the research and development and the operational functions of Internet networks. In 2003, the White House formed the Internet Corporation for Assigned Names and Numbers (ICANN) which was responsible to take care of the Internet’s critical space. Internet was then developed by allocating the Internet address space to root zone of top-level domains and registering the key parameters of Internet protocols specified by IETF. The focus then shifted to the identification of public policy issues and the understanding of roles of governments. The Internet Governance group had its first meeting in 2006 and they group meet every year. Currently, ICANN President Chehade set up four advisory panels in efforts to understand better the implementation and operation of Internet. ICANN suggested forming Affirmations of Commitments (AOCs) in order to identify each one’s responsibility and work in the direction towards their implementation.

Interesting things learned:

The author presents the various developments made over the past few years in the Internet domain. It lists out the organizations and their roles. By talking about the recent innovations made, the author creates a hope in the reader’s mind as to where there can be a development in the field of Internet.

Critical Elements:

The paper is grammatically strong and highly informative. The author presented his paper in a very organized fashion by discussing about various agencies in the order of their year of formation.

1. **(20 points) Packet Switching Vs. Circuit Switching**

**Consider an Internet audio chat application which transmits data at a fixed rate of 320 kbps (e.g., the sender generates anywhere 320,000 bits of data every second). Also, when such an application starts, it will stay on for an hour. Is this application more suited to run over a packet- switched network, or a circuit-switched network? Briefly explain your answer.**

Ans) According to the problem provided, the application will run best on circuit switched networks.

According to the circuit switched networks, there should be a physical connection between two nodes for establishing any communication between them.

Also, according to the concept of packet switching, there does not need to be a physical connection between nodes.

So, in our internet audio chat application, we will prefer circuit switching. There are other factors to this as well. These are: -

1. Circuit switching is preferred because according to the question, the packets take a long time to reach to the other node. Hence, circuit switching will be preferred.
2. Since there are many packets to be transferred over a long period of time, circuit switched networks are preferred.
3. Circuit switched networks are preferred for our application because there is less delay in switching
4. Quality of communication is better in case of circuit switched networks which makes it good for our application
5. In circuit switching, it is easier to maintain the order of the packets which is not possible in case of packet switching making circuit switched networks ideal for our application.
6. **(20 points) Internet Design**

In his SIGCOMM 1988 paper, David Clark describes the design goals that guided the development of the Internet protocols. Can you describe a positive artifact that is a result of the priority accorded to different design goals at the inception? Can you describe a negative artifact that is a result of the priority accorded to different design goals at the inception? How could this problem be addressed?

Answer:- The author in the research paper has talked about how the United States government has introduced internet protocol to make a set of protocols for the use of internet within the government organisations as well as the corporate environments.

This architecture developed by DARPA focused more on building effective techniques on the multiplexing utilization of the existing interconnecting networks to be used on circuit switched networks.

When DARPA was building the internet protocols, they were focusing more on the accountability of the protocols and the internet for better packet travel between the two nodes. This was important at that point of time because it had to be used for military and other government organisations’ communication.

But this also meant that there was less focus on the survivability. This is understandable because it was deemed as a short-term plan. This also meant that data transfer should be done in a cost-effective measure. All the transient features had to be masked.

But with the advent and growing popularity of the internet with time, survivability also became very important. But at the time when internet protocol was being developed, the only thing that was important was accountability and not survivability.

1. (20 points) Network Delays
2. (10 points) Suppose two hosts, *Jupiter* and *Pluto*, are separated by 4.5 x 103 km and are connected by a direct link of rate *R = 10 Mbps*. Suppose the propagation speed over the link is *2.5*

*× 108* m/s. Consider sending a file of 10000 Mbytes from *Jupiter* to *Pluto*. Suppose the file is sent

continuously as one large message. What is the maximum number of bits that will be in the link at any given time? Note: *1 Mbps = 1,000,000 bps* & *1 Mbyte = (1024)*2 *bytes*.

1. (10 points) Consider a router buffer preceding an outbound link. In this problem, you will use Little’s formula, a famous formula from queueing theory. Let *N* denote the average number of packets in the buffer plus the packet being transmitted. Let a denote the rate of packets arriving at the link. Let *d* denote the average total delay (i.e., the queueing delay plus the transmission delay) experienced by a packet. Little’s formula is *N = A × d.* Suppose that on average, the buffer contains *20* packets, and the average packet queueing delay is *20* milliseconds. The link’s transmission rate is *200 packets/sec.*

Using Little’s formula, compute the average packet arrival rate, assuming there is no packet loss.

Text, letter

Description automatically generated

1. (20 points) Network Tools: traceroute

The program traceroute allows you to find out the path (i.e., a sequence of routers) that a packet will follow to a specific destination. The routers along the path are often identified by name. Use traceroute to find the number of hops from your host computer to the following destinations. (Attach your trace route printouts to the end of this homework).

|  |  |
| --- | --- |
| **Destination** | **Number of Hops** |
| **A Consumer Internet Company** | 11 hops |
| **A Government Agency** | 15 hops |
| **A Site in Europe** | 10 hops |
| **A Site in Australia** | 14 hops |

**A Consumer Internet Company**

Text

Description automatically generated with medium confidence

**A Government Agency**

Text

Description automatically generated

**A Site in Europe**

Text

Description automatically generated

A site in Australia

Text

Description automatically generated

**5)Wireshark Labs: Getting Started**

ANS)

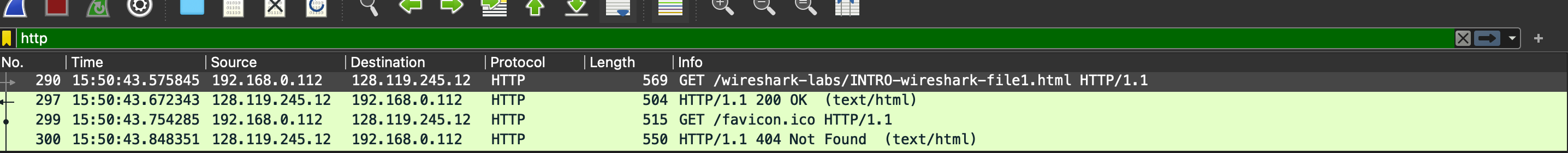
1) Three Protocols are:

-HTTP

-TCP

-DNS

2)



The time taken between HTTP Get and HTTP OK message is= 0.96

3)We can see from the above image that the internet address <http://gaia.cs.umass.edu> is 128.119.242.12 and the IP address of my computer is 192.168.0.112.

4) GET message

Text

Description automatically generated

5) OK message

Text

Description automatically generated