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Intro to Networks and their Applications

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In The Design Philosophy of the DARPA Internet Protocols by David D. Clark, he describes how the first internet protocol suite was designed and who needed it. Beyond just that Clark discusses the different levels of goals for the internet as well as a hierarchy of issues that he wanted to ensure the internet protocols considered based on the need of that time. The top-level goal was to never lose connection unless there was no physical connection between two endpoints. Looking further in depth, the article mentions the ways in which they took preventative measures to make sure data did not get lost. The methods they came up with were to either use a "fate-sharing" technique or replication. We then learn that fate sharing is far more advantageous than replication due to protection against immediate errors as well actually engineering the feature. While the fate-sharing technique is advantageous in some aspect, it also challenges the most important second level goal for the internet architecture, which is survivability. The types of service were second on the hierarchy of goals for the architecture of the internet. The requirements for the services are what distinguished what type they would need, TCP was thought to be the handler for any type of service if it was general enough, but we soon learned it cannot be the jack-of-all trades provider, due to services such as XNET and the real time delivery of digitized speech. Because of this realization, TCP and IP separated into two entities. Tying the ideas back to the original intended user, the military, there needed to be a wide variety of network technologies that were in line with the internet structure. The only way to ensure all the technologies had reliable communication was to make a minimum set of assumptions for packet transportation. Beyond the three main goals, the goals lower in the hierarchy are distributed management, cost effectiveness, host attachment, and accountability. Because the 4 goals were not as important in the creation of the internet architecture, we see today what could have been changed to balance the pros and cons for the users, implementors, and programmers. The architecture and implementation of the internet did not have just one design, it was made so that it can take in a variety of designs. The issue with design is that it is difficult to provide implementors the correct guidance and the simulators do not have the ability to consider multiple implementations, so the testing is quite difficult. Datagrams are a critical component to the architecture of the internet and act as a building block. Overall, the architecture of the internet was a huge success but looking in retrospect we can see different aspects of it that could have been more important in the design but can be of more significance in the future for further integrations

Beginning this reading I was very surprised to know that the first iteration of the internet architecture was used for military. I also did not know there was a hierarchy of goals for the internet. My knowledge was very surface level (besides the content we learned in class) and using some of that knowledge from class I was able to make connections and hypothesize why they valued some goals higher than others.

My thoughts on the fundamental goal were jumbled and I had to reread the section multiple times to understand what it meant. I did not know the term ‘multiplexed’ along with what the ARPANET was. My lack of knowledge provided me reason to research these terms and investigate them further so that I was able to make sense of the paper. I learned that ARPANET was the first public packet-switched computer network but only worked with that specific transmission media. The architecture was not done yet, there were different media networks being built and the network architecture had to be prepared to incorporate and utilize them. The difference between circuit and packet switching was a topic I dove further into because I wanted to get a visual representation of the two and what made them different. I learned circuit switching was geared towards the communications network as it finds a proper route to get from one endpoint to the other and does not cut off until communication is done. Whereas packet switching allows us to break up the data and find routes for each packet to be transmitted as efficiently as possible and then reconstructed in the proper order when it gets to the receiver. Gateways were also a term I have heard in networks but never thought of looking further into. I now know a gateway is just a way to join two dissimilar systems, using this research it helped me contextualize the term when reading it in Clark’s paper.

It was very interesting to see how the hierarchy of goals were played out in the designing of the internet especially seeing how the internet has grown now, we can learn from past mistakes, adjust according to our needs, and become far more efficient. At first when I saw that survivability was the highest priority second level goal, it did not really strike me as all that important today because there are so many workarounds in today’s internet but when I thought back to when the internet protocols were first being made, there were not as many safety nets or structure around the internet where if one thing goes down we can just route the data through a different path. While there were different paths of data transmission thanks to packet-switching it was nowhere near what it is today so after digesting more of the article, it made sense as to why this was the decision. I also learned why although seemingly more secure, replication is not as advantageous as fate-sharing when discussing survivability.

As for the less prominent goals of the internet I was fascinated with how even though there are multiple management centers they still allow gateways to communicate with each other and that “various organizations which manage the gateways are not necessarily the same organizations that manage networks the networks to which the gateways are attached.” It always seemed to me that the internet was ruled by one governing body but come to find out that a multitude of organizations run different segments of the internet and communicate with other organizations, and it happens so seamlessly. My final takeaway from this article is just how complex each aspect of the internet is, it seems like the designers and the engineers must change their way of thinking for each integration and weigh the pros and cons of how they should design the internet protocol based on the purpose it serves. Clark even mentions, “However, we still strongly feel the need to give the implementor guidance. We continue to struggle with this problem today.” The architecture of the internet is so variable and has only grown further in its complexity.

David Clark begins his talk at Google with talking about the content of the book and how it relates to requirements and the perception that people had on this content. Many people believed that learning about the requirements of the internet were uninteresting but Clark rebuttals the statement by claiming that if you really sit back and think, it is an interesting question of what kind of requirements it takes to design the internet. The talk continues with a timeline starting from the 1970's discussing just how little was known about the internet to then hearing about TCPs, debugging code, and writing specs. On to the 1990's where the hierarchies of the internet started to be made. The 90's were also quite particular for Clark because this is when he noticed that the internet was not purely technological and that he was going to have to get involved with economics as well as politics. The durability of the internet was another question in contention in the designing of the internet to which we find out there are conflicting theories, specifically 27 that are covered in the book. Clark also mentions how people ask, "why did you not think of security first?" The answer to the question is that it was thought of, but just in an incorrect way. From Clark's perspective of the internet, it is hard to nail down security because there are so many applications built on top of the network of packets being delivered and there is no such thing as perfect security for every app as we continue to create. The Band-Aid solution we have now is cryptography which does not solve all the security problems. Clark elaborates further on security by explaining the CIA triad (Confidentiality, Integrity, &, Availability) and how adding crypto to the elements will not work. The final statements of Clark were about deliberate design choices of the internet as well as why the idea of packet identifiers will not work today.

The first idea that stood out to me after watching the video was the story of Clark going to the largest ISP during that time and the CTO declining Clark's idea of implementing DiffServ in the network, this was particularly important to me because this related to how Clark mentions that the internet is not all technological and there are major economic implications that take place. Being well-versed is something that is a must, there is no growth or success in a technological company, they must have economists, political scientists, and lawyers. One of the most prominent quotes from the talk is, "Whenever we look at dysfunction, for example the failure of quality of service in the internet, it's not because it doesn't work technically… it's because it didn't work economically" It seems as software developers we are stuck on the idea that our project or startup code is the issue when in reality it is the fact that it does not fit in with the current economic climate.

Telephone companies predate the internet, and during the early stages of the internet they stressed adding management tools, or else it would not be manageable in the long run, unfortunately it was not high enough on the hierarchy, so it was not added. This bring on the question of network durability, while I reasoned from Clark's words that flexibility and adaptability were the most plausible means of durability, I soon realized there were far more ideas that proved to be durable for the internet such as the state of stability of the internet on the platform layer because it creates a cycle of survival for the innovators forcing the internet to stay afloat

The final takeaway from David Clark's talk at Google deals with security. Although I understood there were a vast number of applications built on top of the internet, I was under the impression that there was a one-size-fits-all baseline for security measures on the internet. Clark discusses how there are different objectives for security measures depending on each app. The different types of attacks that Clark broke down into four parts was something I was also unaware of. The attacks are third-party interference, attacking from a connection, broken mechanisms of the internet, and denial of service. The routing of traffic through a seemingly safe place vulnerability that was documented in 1983 is incredible that they knew that was a weak spot and it proved to be right. An even more interesting take is that the insecurity has not been fixed because of the debates on the requirement where the issue stems from and since the internet really does not have someone in charge, who is going to fix these issues?

Overall, the way that Clark describes the internet is a series of balances and tradeoffs. Designers made decisions for specific applications that had advantageous purposes for one app but created a security risk in another app. It is interesting to see the project that Clark is working on at MIT about making more methodical decisions to help the application designers. The issue will be everlasting because we are continually innovating and upgrading so these tradeoffs will continue to appear.