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## **Design the Internet Part Two**

The article highlights key decisions driving the internet's success. Two crucial choices are adopting packet-switched networks and establishing robust security protocols, particularly from the 1970s. Packet-switching optimizes resource use and scalability, while security measures ensure data confidentiality and user trust, fostering widespread internet adoption.

Firstly, choosing a packet-switched network over a circuit-switched one was a really important decision mentioned in the article. This choice played a big role in making the internet successful because it made better use of network resources. In a packet-switched network, data is divided into small packets that travel independently through the network. This means resources are only used when data is being sent, unlike in a circuit-switched network where they're reserved for the whole connection. Because of this, packet-switched networks can handle more traffic and deal with network problems better.

This decision was smart and well-planned because, at that time, circuit-switched networks were the most common and widely used. It was quite innovative to consider using packet-switched networks, like ARPANET(Advanced Research Projects Agency Network). However, it turned out to be a wise move. Even though packet-switched networks weren't widely used outside of programs like ARPANET, choosing this technology laid the foundation for the internet's success. It allowed for scalability, flexibility, and efficient use of resources, which were crucial for accommodating the internet's rapid growth and changing needs.

Secondly, Another crucial decision highlighted in the article is the establishment of robust security protocols, particularly considering those developed in the 1970s. These measures, including encryption and authentication mechanisms, ensure the confidentiality of data and verify user identities. By prioritizing security from the outset, the internet has mitigated cybersecurity threats and fostered trust among users, facilitating its widespread adoption and evolution into a cornerstone of modern communication and commerce.

Furthermore, the article focuses on the rationale behind the decisions, addressing the "why" rather than the "how", by distilling the Internet's essential simplicity. It emphasizes the fundamental design choices of the Internet from first principles without delving into all ensuing complications. The first "why" that provides additional insight into the development of the internet is why its designers chose to utilize a service model supporting "best-effort" packet

delivery instead of a network with infrastructure guaranteeing specific bounds on latency, bandwidth, and reliability. This choice stems from the "best-effort" service model imposing minimum requirements on the infrastructure, enabling rapid Internet growth, and on the application's network requirements, allowing them to be designed to adapt to various performance levels, thereby reducing their requirements.

The second "why" that offers additional insight into the decisions made by the Internet's architects revolves around the strategic selection and implementation of routing protocols. Understanding why certain routing algorithms were chosen over others sheds light on the underlying principles guiding the development of the Internet's infrastructure. The intricate balance between efficiency, scalability, and resilience in routing protocols is crucial for maintaining the stability and functionality of the network. By exploring the motivations behind the adoption of protocols like link-state and distance-vector routing, we gain a deeper appreciation for the challenges faced by network designers in ensuring reliable packet delivery while adapting to dynamic network conditions. This comprehension enables us to grasp the rationale behind the design choices that have shaped the Internet's evolution, providing valuable insights into its robustness and adaptability.

The aim of this article is to present the Internet as a collection of simple design concepts, rather than to get lost in the often overwhelming and convoluted details that often give the impression of a complex and daunting architecture.

The term "extraction" aptly describes the approach taken in this article, as it seeks to elucidate the central ideas underlying this complex architecture, as implementation details may overshadow its beauty. The necessity for explaining the key concepts of this sophisticated architecture arises from its perception, as the article itself states that many in the computer science community believe the Internet to be “merely a collection of complicated protocols, not a conceptually simple and brilliantly daring design.” Therefore, by stripping away the intricate protocols and algorithms we are able to see and understand the fundamental design concepts and essential building blocks more clearly.

Introducing the Internet as a set of key design choices — namely, a service model, a four-layer architecture, and three crucial mechanisms (routing, reliability, and resolution) — not only simplifies its underlying concept but also directs the reader's focus towards comprehending the rationale behind these choices. Understanding these key principles and methods allows the readers to envision the basic technical designs which make up today's Internet, without having to master its complexity. Considering the fact that its creation took place more than four decades ago, the article highlights the extraordinary foresight that guided the team of engineers, which aims to make the readers appreciate the design itself and its simplicity more.

According to this paper, the Internet's essential simplicity served as the catalyst for its rapid expansion and widespread adoption. By minimizing the requirements, this simplicity allows for the organic growth of the Internet and the seamless integration of new, more technologically advanced devices and applications, as fewer requirements result in fewer constraints.

When it comes to discussing the history of the Internet, there are several names and previous architectures that come to mind, with ARPANET standing out as a crucial predecessor. ARPANET started out with only four host computers, based on the idea of the computer network concept and packet switching theory. Soon, after the addition of more computers the first Host-to-Host protocol, called the Network Control Protocol (NCP) was implemented in ARPANET. Later, the idea of open-architecture networking that enables communication of multiple independent networks emerged, which required a new protocol that is able to reliably send messages outside the ARPANET network. Thus, the TCP/IP communication protocol was born, which is still the foundational protocol of the Internet. TCP was based on only four ground rules of Robert Kahn. Eventually, the interconnections of networks like these lead to the creation of the Internet. (Leiner, B.M. et al, 1999) However complex today's Internet has become, these main design principles, architecture and core protocols remained the same. These simple, but essential concepts are the key to its robustness, and survivability.

The research article by McCauley, Shenker and Varghese (2023) focuses on the essential simplicity of the Internet's design by focusing on the underlying principles rather than the intricate protocols. While our aim in the first assignment was to dive deep into the design of the internet rather than thinking it too much on a concrete level, we overlooked various points. However, comparing our own design of the internet with the real internet design outlined in the research article (McCauley et al. 2023), several key learnings emerge, and we can see the strengths and weaknesses of our own design.

After introducing us to the article by McCauley, Shenker and Varghese (2023), we quickly realized that our design was notably simpler than the actual complex design of the real internet. Our own design focuses on basic functionalities, such as direct connections, like user-to-user sharing. The real Internet design, as revealed in the article (McCauley et al. 2023), is much more complex, incorporating multiple layers, protocols, and mechanisms to ensure functionality, scalability, and resilience. The real internet has multi-layer architecture, “the four-layer Internet architecture”, including the physical layer, network layer, internetworking layer, transport layer, and a fifth layer responsible for end-user applications, the application layer (McCauley et al. 2023). Each layer is responsible for specific functions and employs various protocols to advance communication. Our design assumes seamless connectivity between users, unlike the real internet, which, for instance, incorporates technologies such as Ethernet and fiber optics at the

physical layer. In other words, our design lacked multiple layers, which could enhance the strength, scalability, and interoperability across diverse networks and applications.

Our design overlooks the importance of routing algorithms and protocol choices in ensuring efficient data transmission. The article (McCauley et al. 2023) highlights the critical role of routing protocols, such as Border Gateway Protocol (BGP), routing in maintaining connectivity and avoiding loops in the real Internet. It would be suitable to add some similar protocols to ensure that the packet truly reaches its destination efficiently. Avoiding routing loops enhances the reliability of the internet.

Moreover, our design does not delve deeply into mechanisms for handling packet loss, ensuring data integrity, and mitigating security threats, even though we do have recognized the need for encryption for example. However, unlike our assignment, the research paper (McCauley et al. 2023) underscores the importance of reliability mechanisms such as Transmission Control Protocol (TCP), which includes features to help the mitigation of internet network challenges, and security protocols. These mechanisms and protocols ensure safeguarding of data transmission and protecting against various threats such as distributed denial-of-service (DDoS) attacks mentioned in the paper (McCauley et al. 2023).

We quickly discuss future proofing, but the article by McCauley et al. (2023) considers more deeply the challenges faced by the real Internet. These are for instance the lack of evolvability due to the widespread implementation of IP and the emergence of large private networks, highlighting the need for continuous evolution and innovation. Assuming failure as a normal principle could be added to our design. It means incorporating the principle of assuming failure as the normal case into the design philosophy, which involves designing network protocols and mechanisms to handle failures efficiently and gracefully. This could include designing routing algorithms and transport protocols that treat failure as a common occurrence and can adapt dynamically to maintain network connectivity and reliability.

Another topic we did not discuss in our assignment is the involvement of the community and collaboration of various stakeholders. Adopting a community-driven approach to network design and governance encourages participation of stakeholders from diverse backgrounds, which would enhance the architecture, protocols, and standards of the network. This would be similar to the early Internet's approach of rough consensus and running code inspired by the article by McCauley et al. (2023). This involves encouraging collaboration and participation from diverse stakeholders in the design and evolution of the network architecture, protocols, and standards.

Overall, comparing my own design with the real Internet design reveals the complexities, challenges, and multifaceted considerations involved in building and maintaining a global communication infrastructure. It underscores the importance of comprehensive understanding,

Careful planning, and ongoing innovation in creating and sustaining such critical systems. Our design included many of the main design choices the real internet has, but lacked deeper analysis and details and could have decomposed functionalities into logical layers and smaller tasks.

## References

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