

# Assessing Our Internet Design

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*The article highlights a few essential design choices, a service model, a four layer architecture, and three mechanisms (routing, reliability, and resolution.) The article mentions several other crucial decisions. Describe TWO of them and explain how those choices have helped make the internet successful.*

## Modesty in Service Model

One of the main decisions that distinguished the Internet was the adoption of a modest service model that offers no guarantees regarding particular performance criteria. Rather than attempting to satisfy every potential application need, the Internet adopted a general service model that was flexible and adaptive.

Because it was not geared towards any application requirement, this decision allowed new apps to grow on the Internet, allowing the Internet to continuously evolve with time. By leveraging smart hosts and unintelligent networks, the Internet could accommodate a wide range of applications and technologies. Also, since the architecture was relatively simple, the simplicity of the service model also allowed for a rapid increase in network speeds. This strategy made it possible for the Internet to develop and grow effectively over time, according to shifting user demands and technological advancements.

## Assuming Failure is the Normal Case

Another crucial decision that let the internet flourish was the choice of assuming failure as a normal circumstance. In other words, adopting the design principle of treating failures as the common case rather than an exception. Instead of using special modes for failure recovery, almost all Internet mechanisms handle failures efficiently, such as in basic routing algorithms where route calculations are consistent whether due to link failure or periodic recalculation.

This approach has been fundamental to the Internet's scalability. As systems scale, the likelihood of component failures increases. By incorporating the assumption that failures are normal in its design, the Internet has created robust mechanisms that can gracefully handle disruptions, ensuring the ability to keep operating normally even after facing component failures or network problems, such as, link or router failures, congestion or packet losses.

This design choice has been influential not only in the Internet but has also inspired large-scale infrastructure designs, such as *tech giants'* hyperscaled infrastructure. It ensures that the Internet can continue functioning effectively even in the presence of failures, contributing to its reliability and stability on a global scale. Albeit the Internet assumes failure, there is an economic incentive, namely for ISPs, to keep services executing and connected.

*The article focuses on the rationale behind the decisions (the “why”, not “how”). Explain two examples where the “why” gave you additional insight into the internet.*

## Modularity for Autonomy

The article delved into the rationale behind the modularity of the Internet architecture. The decision to separate network infrastructure and applications into distinct layers was driven by the need for autonomy. By allowing different entities, e.g., universities, data centers, or ISPs, to deploy their technologies independently within the framework of common standards, the Internet fostered innovation and adaptability.

Understanding the "why" behind modularity provided us insight into the Internet's ability to accommodate diverse use cases and evolve over time. The decision was a strategic move to avoid a rigid, one-size-fits-all approach seen in traditional telephone networks. This insight underscores the intentional flexibility of the Internet's design, enabling it to serve as a platform for a wide array of applications, services, and network types.

## Assuming Failure is the Normal Case

The article discusses the design philosophy of treating failures as the common case rather than an exception. The rationale is that as systems scale, the probability of components failing increases. The decision to design the Internet with the assumption of frequent failures influenced its robustness and scalability.

Understanding the "why" behind this approach provided us insight into the Internet's resilience. The decision stemmed from a realistic acknowledgment that failures are inevitable in large-scale systems. This insight showed us the Internet's capacity to handle disruptions, ensuring that it remains operational and reliable even under less-than-ideal conditions. It also influenced a broader engineering mindset, evident in the development of other large-scale systems that prioritize degradation in the face of failures.

*The title of the article is interesting. Explain what the authors meant by it. (Note: there is historical background for the title which you don't have to find, but if you do, it will increase your insight.)*

## The Interest of the Title

The title of the article, "Extracting the Essential Simplicity of the Internet," suggests that the authors aimed to distill the core principles of the Internet's design.

The word "Extracting" suggests a process of isolating specific components or characteristics from the complex system that is the Internet, by extracting the essential simplicity of the Internet from its intricate network of protocols.

"Essential Simplicity" refers to the minimal fundamental components of the Internet's architecture and functionality that are essential to its operation. It requires determining the fundamental ideas and choices that support the architecture of the Internet, removing superfluous details to expose the core components that enable the network to function as intended.

By focusing on extracting the essential simplicity of the Internet, the authors seek to uncover the foundational elements that have enabled the Internet to function as a global communication platform connecting users worldwide.

The authors found that their research colleagues did not find the Internet of interest and inspiring as a research topic. According to them, most of their colleagues believe that understanding the Internet properly requires understanding all the protocols and the small details that compose the Internet.

The article's thesis states that a small set of design choices best understands the Internet. These choices lie in the Internet's fundamental concepts. Those concepts represent best-effort solutions to three simple problems: routing, reliability, and resolution.

Given this context, the article focuses on the motivation behind each design choice, illustrating both advantages and disadvantages for distinct use cases. Moreover, although the current Internet has a high degree of complexity, it is possible to conceive a new system with similar properties by extracting the simplicity present in such fundamental concepts.

*What did you learn about your own design compared with the real Internet design?*

## The Lessons Learned

After analyzing this paper, we understood that the design presented last week is relatively similar to the one of the real Internet.

It builds a stack of ideas on top of each other as problems *appear* along the way. In our design, those problems appeared in an unstructured way, sometimes needing to be clarified. However, the article introduces the three main concerns *a priori*, making it easier to follow and understand. Also, the article exposes how the best-effort approach, present in some of the Internet's services, is daring since it opens the door to uncertainty during operation.

Furthermore, our design falls short on fundamental concepts and dives into other shallower concepts. As mentioned in the article, the Internet could cope with new demands and

requirements without changing its architecture due to the cleverly designed network infrastructure and the opaqueness towards the contents determined by the application level.

In our design, we do not address problems in the network graph, such as cycle elimination, which are crucial to ensure that routing works correctly. Conversely, we discuss topics that are outside the domain of Internet operation. For instance, HTML is a document representation highly adopted in the real Internet. Nonetheless, it is just a set of arbitrary decisions on how to represent a document that can be altered without sacrificing the properties of the Internet. The same applies, even though partially, to HTTP.

Another vital lesson learned and that should be explored is precision. The design we presented may need to be more specific in some areas because it explains concepts with a simple, and clearly defined nomenclature. One instance is the need for more precise delineation of the operational approach in various mechanisms, rather than relying solely on a best-effort basis.

In conclusion, our analysis of the paper has revealed several valuable lessons regarding our design presented last week. By addressing these lessons, we can enhance the effectiveness and clarity of our design, ensuring it aligns more closely with the robustness and adaptability of the real Internet architecture.