

1. Summary of the Paper

The paper End-to-End Arguments in System Design was published by the CS Lab at MIT in 1981. It was at a critical time when the data communication network was becoming an important part of the computer system. The paper discusses precisely the determination of the functional boundary demarcation of this data communication network from the other components of the computer system. The paper points out that there are many underlying implementations of functions such as error check, retransmission and encryption, and decryption functions that are actually redundant in the underlying network implementation. For example. If an error occurs on the endpoint or during transmission from the endpoint to the network underlay that is not detectable by the network's underlying error checking mechanism, it still needs to be re-implemented on the endpoint. When feedback is requested, it is more clearly seen that the message sent by the network underlay to the endpoint is useless, and the issue of concern to the endpoint is not whether the message has reached the other endpoint, but the feedback action made by the other endpoint to the message.

2. Critical Review

In the face of today's complex Internet environment and various application requirements that contradict the end-to-end argument, whether we should abandon the end-to-end argument and return to the path of centralized services, or continue to adhere to it and ignore the development trend of the Internet, requires a rethinking of the end-to-end argument. On the one hand, the significance of the end-to-end argument should be affirmed:

- (1) Flexibility, when there are new services to be deployed, it is obviously much easier to make changes to the endpoint than to the core part of the network.
- (2) Openness, by having the endpoint provide application services, any capable user or company is free to deploy new services, which encourages innovation and promotes the development of the Internet.
- (3) Reliability, with the endpoint maintaining the state of end-to-end communications while keeping the backbone network as simple and generic as possible.

On the other hand, since the current Internet architecture was basically shaped around the 1980s, while the Internet application boom triggered by web technologies started in the 1990s, this inevitably led to a misalignment between the situation considered in the design and the specific application environment. In terms of the end-to-end argument, it was originally proposed around those needs that could only be met by the correct implementation at the endpoint, and if some needs could only be met by services implemented in the backbone network, then the end-to-end argument did not apply.

Today's Internet is no longer end-to-end transparent. The backbone network is no longer limited to purely forwarding packets. The current Internet environment is dangerous, and the Internet we all rely on faces many significant challenges. The more we rely on the Internet, the more dangerous we will find, and the end-to-end argument of the Internet must be focused on solving the current challenges, and some changes need to be made in time.

- Improve the endpoint to meet can be part of the demand. Such as spam filtering can be handled at both ends of the server-side or client-side, malicious programs can be controlled through the client's firewall, etc.

- Arrange some proprietary services in the core of the network, and transfer some software involving security needs (such as PayPal, Gmail, etc.) to be carried out in that service, combined with the current end-to-end communication. And other software without similar needs remains in the end-to-end communication.

- Legal constraints to improve self-restraint. Fulfilling your responsibilities will reduce the appearance of malicious messages.

- Conditional trust. No longer trusting users unconditionally, the network itself needs to implement security features.

- Openness, but the need to increase the control of network services.

The end-to-end argument of the Internet is gradually transitioning to a set of mutually cooperative principles - the Internet is no longer a blanket end-to-end argument of best-effort services regardless of user behavior, and a new network-centric model can be gradually established in the middle of the network. If the bottom layer is designed to provide more functionality than is necessary for the core business, as in the hourglass model, and if the layer cannot be "completely and correctly implemented, then consider designing for such functionality in other layers. The most important benefit of end-to-end arguments is that they preserve the flexibility and versatility of the Internet, allowing applications to be added without requiring changes to the backbone network deployment.

The success of the Internet is a direct result of its core design philosophy, so changes to the core design philosophy must be made very carefully and only minor changes can be made while keeping the Internet alive and active. As for whether the end-to-end argument will survive, it is too early to make predictions. All we can do now is drive some specific results. The flexibility and openness promoted by the end-to-end argument will continue to be important in guiding future network development, and this flexibility should be preserved. It is unlikely that future network development will be limited to the architectural ideas of the end-to-end argument, but it is also unlikely that such doctrinal guidance will be completely abandoned.