# Resource-Sharing Computer Communications Networks

This reading describes the state of networking in 1972 and it details the way in which computer communication networks were used and speculates as to how they could be used in the future. The only well developed communication network at the time was the circuit-switched telephone network. While the telephone network was useful for some computer traffic, such as messages between teletype machines, there were issues with using it for computer to computer communication. The paper pointed out that development was being done to improve this issue, with one promising idea being message-switched transmission networks.

The major development described by this reading is the Interface Message Processor (IMP). The IMP might be comparable to a modern modem and router combination; several host computers are connected to one IMP, and the IMP manages the message traffic to and from the network. Interestingly the message-switched routing algorithm used by IMPs (section 4) is similar to the low level processes that are still used today. This makes sense, we know the ARPANET and the routing algorithm used by its IMPs were the predecessors of modern networking architectures. The concerns in the ARPANET reflect modern concerns, such as network saturation and efficient buffer management.

However, there are some unique differences, such as packet size. Khan acknowledges that many of the design decisions in ARPANET were made intuitively such as the choice to cap message size at 8192 bits and packet size at 1024 bits. In section 5C he notes that the logic describes why message size should be capped at 8192 bits, but it considers whether it should be kept even smaller than that. In our networks we know that packets and messages can in fact be extremely small and still be effective and efficient.

The networking possibilities made possible through the IMPs lead directly to many questions. There were a lot of potential issues caused by the network latency. One such example is the echoing problem which causes the echoed user input to be different for remote users and local users. The reading determined that to solve this problem terminals will need their own internal processors in order to integrate the network traffic seamlessly into the user experience. It is rather entertaining how accurately this has been reflected in the modern internet where “terminals” are often their own full computational systems.

There were multiple points made in the Kahn paper that didn't align well with the state of computers today. The growth and scale of the network was one of the major points missed. It seems in the paper they focus on the concept and benefits of a shared network, but due to the technological limitations of the time there were major oversights of the benefits of a truly large scale network. On page 1400, Figure 1 shows the process of routing a message from U.C.L.A.

to M.I.T. This looks good in theory, but, there is little description of how this would scale a node per household. Clearly personal computing, where each person may own multiple machines each connected to the network, was outside the scope the author's imagination. The described was experimental, so it makes sense as to why the issue of scaling was overlooked. Another issue not considered in the paper was the duplication of files. In an existing distributed operating system, there would be minimal duplication of files. This issue is still being faced by large scale systems by companies and government agencies, in which changes to resource management are very costly and time consuming to implement due to regulations.

New possible methods of communication were also overlooked. This wasn't really seen as an issue of the time because there existed technologies and infrastructure to allow people to communicate expediently. The evolution of communication technology went from postal mail that was very slow, to telegrams for instantaneous messaging of text, to the telephone, an instant medium of hearing a real human voice in real time. Using computers to send text would have seemed like downgrade.

With the conversion of networks from analog to digital, transmission of information became cheaper, more accurate, and increasing asynchronous with multiplex lines that could have more than two connections live on one wire at a time. In combination with decreasing costs in computers made computer based communication viable.

Finally, the paper outlines potential future applications and uses for networking. Its predictions are impressively accurate. We currently use networks for file transfers, remote job processing for very large models such as weather maps, and for distributing a single program across multiple machines to create redundancy and parallel-processing. The final future application that Kahn described, distributed operating systems, essentially exist, though in a centralized form. For example, enterprise network account management systems fulfill many of Kahn's criteria. However, a fully distributed, decentralized, and homogenous operating system has yet to be made.