CIRCUIT SWITCHING IN THE INTERNET

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Pablo Molinero Fernández
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I certify that I have read this dissertation and that, in my opinion, it is fully adequate in scope and quality as a dissertation for the degree of Doctor of Philosophy.

Nick McKeown
(Principal Adviser)

I certify that I have read this dissertation and that, in my opinion, it is fully adequate in scope and quality as a dissertation for the degree of Doctor of Philosophy.

Balaji Prabhakar

I certify that I have read this dissertation and that, in my opinion, it is fully adequate in scope and quality as a dissertation for the degree of Doctor of Philosophy.

Nicholas Bambos

Approved for the University Committee on Graduate Studies:

Abstract

The motivation for this thesis is our desire to build faster routers and switches to accommodate for the traffic growth in the Internet. For the past few years, Internet traffic has been doubling every year, and nothing indicates that this growth rate will slow down in the near future. The Internet forwards information through packet switching, which has so far proven to scale from the early slow phone modems to the current fast link rates. However, it is unclear whether it will continue scaling to match future optical link rates.

Fiber optics and optical switching elements have demonstrated a capacity to forward information that today looks unattainable by electronic switching elements. As a consequence, one possible way of increasing network capacity is to build all-optical packet switches. However, these switches are not possible today because packet switching requires the buffering and processing of packets, and we do not (yet) know how to perform them in optics. On the other hand, optical circuit switches do not have these constraints, and thus they are already in use. The simplicity of the forwarding path in a circuit switch makes it faster than an equivalent router, even when implemented in electronics. In this thesis, I argue that we would greatly benefit from the use of circuit switching in the core of the network, in either electronic or optical form.

Circuit switching is already used in the Internet. Since the beginning of the Internet it is widely used in the core of the network; when early Internet service providers wanted to interconnect remote sites, the only option was to lease a circuit from the long-distance telephone carrier. Chapters 2 and 3 of this thesis analyze what type of network we would build were we to start with a clean slate. After analysis, modeling and simulation, I conclude that we would be better off with a hybrid network similar to the current one.

A problem with the current circuits in the core is that they are completely decoupled of

packets in the edges. Rather than following traffic patterns in real time, circuits are usually provisioned manually, and thus they change very slowly. IP considers circuits to be static, point-to-point, layer-2 links between routers. Chapters 4 and 5 propose two evolutionary ways of integrating circuit and packet switching, so that circuits are automatically controlled by the traffic carried by IP. The first approach uses lightweight, fine circuits to carry single user flows, whereas the second multiplexes several flows onto heavyweight, coarse circuits.

> ... un primer axioma para establecer cualquier sistema educativo: Es objetivo primordial e irrenunciable mantener el sentido universal de la Ciencia y no sólo en un aspecto informativo, sino en el creativo de la investigación.

D. Luciano Fernández Penedo en “Momentos estelares de la enseñanza Española”

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