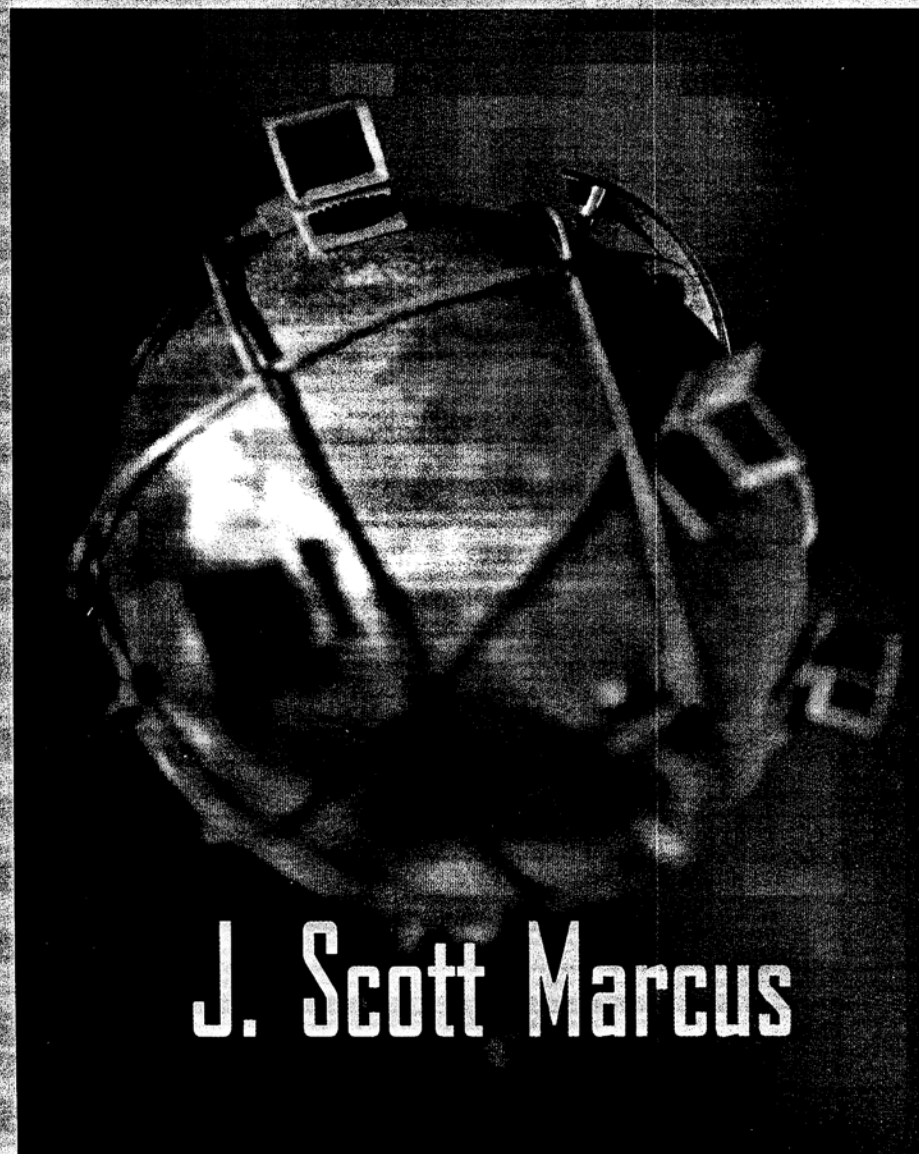**Exhibit S**

Designing
Wide Area Networks
and Internetworks

A Practical Guide

J. Scott Marcus

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14 The Public Internet: Unique Design Considerations

Much of our discussion up to this point has focused on design for private intranets and enterprise internetworks. How do things change when we design for the global, public Internet? How might the design of the public Internet interact with design considerations for enterprise internetworks?

The first six sections of this chapter deal with the overall design of the Internet, explaining how that system has evolved over time. They will be of particular interest to anyone designing for an *Internet service provider,* particularly for anyone designing a network for a *backbone ISP,* but they have other applications as well. For instance, understanding the structure of the Internet helps a business to order the most appropriate Internet access service and to position its Web servers and other sources of high traffic volume. Thus, the final section of this chapter contains helpful hints for ordering Internet access from an ISP.

14.1 Evolution of Today's Internet

Today, there is no overall central planning function for the Internet. Changes set in motion a few years ago have led to the present system. In order to understand how the system works, and how it was intended to work, it is helpful to return to the year 1993—the last point in time at which a grand vision existed for the evolution of the Internet as a whole.

Until 1995, the U.S. National Science Foundation provided the core of the Internet in the form of the NSFnet, a publicly funded backbone network. The NSFnet was restricted to carrying only traffic associated with research or education. By 1993, the NSF felt that the Internet had sufficient commercial viability to stand on its own two feet. Moreover, the NSF understood that as long as the government provided the backbone of the Internet at no cost, there could never be a broad private Internet industry. Private industry could

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not compete with a service provided at zero cost. In order to permit an industry to spring into being, the National Science Foundation would have to step aside.

The NSF initiated this transition through a public solicitation document, Solicitation 93-52, in which the NSF described a future Internet structure comprising

- *National service providers (NSPs)*, providers of Internet access operating on a national scale
- Internet service providers (ISPs), operating on a smaller scale than NSPs
- Public shared interconnection points called *network access points*, or *NAPs*
- A transit service to interconnect the regional ISPs formerly funded by the NSF
- A *very high speed backbone network service (vBNS)* to interconnect a handful of research laboratories and to serve as a testbed for new high-speed Internet services
- A *router arbiter* service, both to rationalize routing in the global Internet and to provide a central anchor point for routing research and statistics

Figure 14-1 shows a notional view of what the NSF had in mind.

On balance, the NSF was very successful in taking itself out of the innards of the global Internet without massive disruption. However, some aspects of its plan were more successful than others. It is instructive to look at the results of each element of the plan.

14.1.1 National Service Providers and Internet Service Providers

A number of NSPs and a far larger number of ISPs were already in operation at the time of Solicitation 93-52. Today, there are at least five major backbone ISPs and somewhere between six and perhaps thirty smaller backbone ISPs that could be described as NSPs. We will discuss the distinguishing hallmarks of a backbone ISP later in this chapter.

By all accounts, there are several thousand ISPs today. *Boardwatch Magazine* currently lists some 4,855 ISPs in North America.[1]

The NSF did not attempt to create NSPs and ISPs; rather, in exiting the public Internet space itself, it created the market forces that would foster the formation of NSPs and ISPs.

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1. *Boardwatch Magazine,* http://boardwatch.internet.com/isp/spring99/introduction.html, June 1999.