INTERNET COMPUTING AS A UTILITY

AN INVITED COMMENTARY BY THOMAS M. CHEN

In modern societies a few basic services, such as water, electricity, mail, roads, and telephony, are considered vital to the quality of life. Governments typically invest heavily in these utilities because they are essential to sustain economic productivity as well as daily life. Hence, the extent of the public infrastructure for these utilities is often seen as a measure of a society's industry. As the global economy becomes increasingly dependent on information and telecommunications, a natural question may be: should Internet computing be a utility?

The vision: Internet computing could be provisioned as a utility in a manner similar to existing utilities. First, Internet access could be universal, meaning that access is ubiquitous and convenient. Just as electric outlets can be found in every public and private facility today, wired and wireless Internet access points could become commonplace in residences and public locations. Today, Internet access is limited to businesses and a fraction of private homes, although access points are starting to appear in public locations such as airports and cafes.

Second, Internet access could be simple and affordable. Electric appliances can work by simply plugging them into any power outlet. Internet access points could be standardized to allow simple connection by anyone through any access point without the need for complicated setup procedures. Furthermore, access must be possible without the need for expensive computer equipment. Today, less expensive alternatives are available (e.g., cell phones, PDAs, Internet appliances) but have not become nearly as affordable as telephone sets.

Third, Internet computing as a utility is essentially a carrier between service providers and consumers. By analogy, other utilities carry water, electricity, or mail; in all cases, the transported commodity can serve a variety of uses by the consumer. This generality enhances the necessity of these utilities. Likewise, Internet computing would have limited appeal if it had only e-mail or Web browsing (the two most popular uses of the Internet today). By connecting a consumer to any service provider through the Internet, a far broader spectrum of communications and network-based computing services is possible. Today, peer-to-peer (P2P) file sharing, multimedia streaming, and network-hosted applications are examples of newly emerging services; other yet unimagined network computing services are likely to be invented in the future. The value of an Internet computing utility is to enable access to the collective communications/computing services at any time from anywhere.

AN INTERNET COMPUTING UTILITY WOULD HAVE TO BE ORIENTED AROUND THE COMMON PERSON AND DAILY NEEDS

The infrastructure: Similar to all utilities, an Internet computing utility would involve an investment in an extensive infrastructure consisting of the network, access equipment, middleware, and service providers. Fortunately, much of the infrastructure already exists or is in the process of development. For example, the Internet infrastructure today consists of many high-speed national backbone networks throughout the world interconnecting major businesses and many residences. By constructing more access networks, Internet access could be extended to virtually all residences and public facilities. For convenience, access networks should consist of Internet access points and public access terminals (which are already appearing, e.g., in airports).

Middleware is needed to mediate between consumers and service providers. A consumer should be able to access the Internet anywhere and conveniently find a desired service (and be billed for its use), without exposure to the complexities of the underlying system. The middleware is challenging due to the heterogeneity of both service providers and Internet access devices. For example, a consumer might access the Internet by any type of device ranging from a PC to a simple telephone. The desired service might be any communication or computing application but should be adapted to the particular user and access device. Although there are various activities developing middleware and service interworking functions for the network, this field is not yet sufficiently mature to support a universal Internet computing utility.

Finally, the value of the utility depends on the variety of service providers. For an architectural model, service providers might be considered analogous to power generators in the power grid. The power grid consists of a vast distribution system of local, regional, and national power generators. For Internet computing, we might envision an elaborate array of private and public service providers. Public services might consist of supercomputer centers, servers, storage networks, and network-hosted applications maintained by the state and offered on a per-use basis to the general public. In addition, private service providers may offer specialized, value-added, or competitive services. For certain applications, consumers may have the role of a service provider at the same time, for example, peer-to-peer file sharing or donation of unused CPU cycles to a distributed computing application.

The role of government: Obviously, expansion of the Internet is continuing into businesses, residences, and public areas, driven by market forces. The Internet may evolve in the direction toward a utility "naturally" by market forces, but the government has a history of support starting from funding of the original ARPANET. The government might possibly accelerate the evolution process in a number of ways: expanding public access networks, establishing pricing incentives for consumers, and regulating to ensure compatibility between all architectural elements (access devices, networks, middleware, service providers).

Another traditional role of the government is basic R&D funding, which is being carried out in all areas of information technologies that could support an Internet computing utility. A notable example is "computing grids," which are supercomputers, computers, storage devices, and instruments interconnected by high-speed networks and coordinated by middleware to carry out large-scale resource sharing and distributed computing. Experimental grids include Information Power Grid (NASA), Legion (University of Virginia), Globus (Argonne National Laboratory and University of Southern California), DataGrid (European Union), Particle Physics Data Grid (U.S. Department of Energy), and Grid Physics Network (U.S. National Science Foundation). However, these grids are currently designed for scientific computing. An Internet computing utility would have to be oriented around the common person and daily needs.