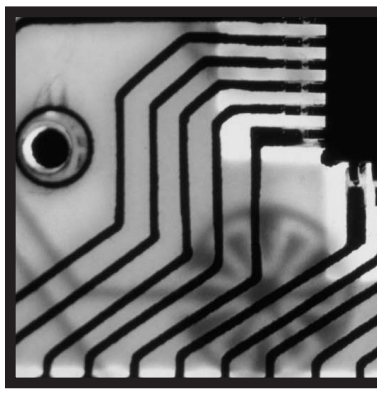
Network Economics & Public Policy

a primer

By Lawrence J. White

Networks. They're all around us. They encompass the Old Economy – roads, rail, pipelines, the dumb old telephone system – and the New Economy – computers and software, the Internet, the smart new telephone system.

They are also a continuing source of policy headaches. But this is nothing new: turnpikes, canals and the banking system were all political flashpoints for our young Republic. By the late-19th and early-20th centuries, attention had turned to railroads and the nascent telephone system. The regulation of telephone, rail, trucking and airline networks have been prominent issues for the last three decades. And, oh yes, there's the small matter of Microsoft, the largest software company in the world and the target of the high-



est profile antitrust lawsuit in decades.

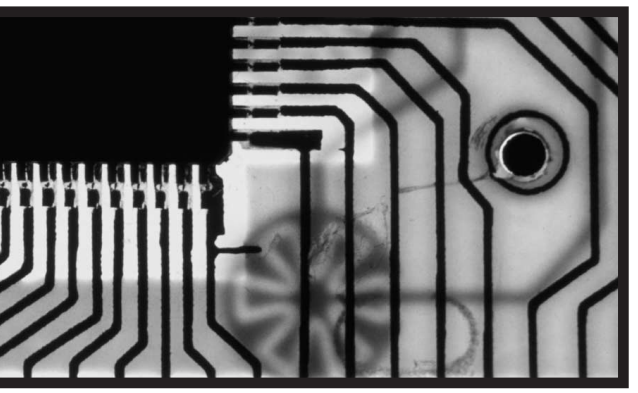
But what exactly are networks, and why do they receive so much attention? Herewith, a cheat sheet.

SO, WHAT IS A NETWORK, ANYWAY?

This is one of those questions to which experts are inclined to answer, "If you don't know already, it's too complicated to explain." Let me instead offer an illustration.

Figure 1 shows a "star" network. Points A, B, C, etc., and point S are the nodes; the lines between them are the links. Simple, yes, but not a bad schematic of a telephone system. Nodes A through F represent telephone network users, while links are the wires that connect them and node S is the central switch that routes the calls. Figure 1 is also a decent approximation of the network that characterizes the Old Economy Postal Service and the New Economy FedEx. And it is a good representation of the hub-and-spoke network of a post-deregulation airline – think of O'Hare or Atlanta as node S.

Figure 1 illustrates some crucial features. First, for a network to be useful, the users must be effectively connected by the links. In network-speak, the links and users must be compatible. Second, in this style of network, the central node is crucial, since all interactions must go through it. In a telephone system, this node would be the central facility that switches calls among the users. Third, networks often exhibit positive "externalities" – that is, the value of a network increases when an additional user joins; equivalently, the value of the whole is greater than the sum of its parts.



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Such externalities have important implications. The mantra of microeconomics – that in an efficient ordering of things, market prices should equal the marginal cost of production – doesn't necessarily hold. After all, the value added by putting one more line on the phone network exceeds the value accruing to the new user.

Note, too, that markets with network characteristics may be unstable and subject to tipping: even modest advantages for one competing network may snowball and allow it to dominate rivals – a winner-take-all effect. Being first in a market may provide this modest advantage, so there may be considerable jockeying to obtain such a position.

Lest one assume that bigger is always better, note that extra network users can have negative consequences for other members – for example, the extra user may add to congestion delays (highways) or static (the radio spectrum), degrading the experiences of the others. Still, it appears that many networks have the ability to expand crucial links or nodes at little cost, implying that the advantages of size overshadow the disadvantages.

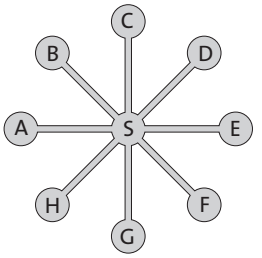
NOW FOR SOME JARGON...

To add a little complication (and a lot of sophistication) to the network example, consider Figure 2, with its two star networks linked by a trunk. This could represent:

- Two local telephone networks with a long-distance connection.
- A pair of railroad marshaling and switching yards with a long-haul line between them.

- An electricity network, with the left-hand star representing a collection of power-generation units, the right-hand star representing electricity users, and high-voltage transmission lines linking them.
- A credit card network, with card-accepting merchants on the left, cardholders on the right, and a credit card system between.

FIGURE 1
A STAR NETWORK



Although all these networks can be represented in the abstract by Figure 2, one interesting difference separates the first two from the others. For the telephone and railroad networks, a peripheral node (user) anywhere in the figure is potentially interested in communicating with any other node. Thus, the positive network externalities from additional users of the network are direct. These are *two-way networks.*

By contrast, for the electricity and credit card networks, the peripheral nodes on one side of the diagram are only interested in transactions with nodes on the other side of the diagram. The presence of an added electricity (or credit card) user provides no direct benefit for other users. However, if there are economies of scale in this arrangement for delivering electricity, then more users will mean lower per-unit costs for all users. For credit cards, a similar effect will operate: with more cardholders, more merchants will want to join the network – which widens the variety of outlets at which holders can use their cards. But the beneficial effects in both instances are indirect, operating through economies of scale in links and nodes, rather than through direct externalities. These are *one-way networks.*

Finally, consider networks of software applications for personal computers and their users. There are no physical or electrical links between users and software firms. But there are links among the PCs' operating systems, which run the software. These arrangements have come to be described as virtual networks, with characteristics quite similar to those of one-way networks. An extra user may provide little direct benefit to other users. But an extra user will mean a larger market for software developers, which will encourage more software variety, which in turn encourages more users.

In the framework of Figure 2, the left-hand nodes are the applications-software developers of a virtual network, the right-hand nodes are the users, and a PC operating system is the link between the two clusters. Note that the software, operating system and users' computers all have to be compatible. This virtual network concept has wide applicability to many software/hardware situations such as videotapes and VCRs, recorded music (tapes and CDs) and their hardware.

SO, WHAT'S THE PROBLEM?

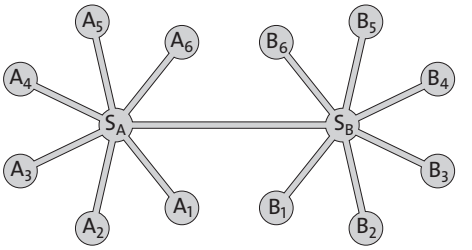
The centrality of networks to modern economic life offers one clue to why they feature prominently in our political life. Governments, after all, respond to the pressures of

LARRY WHITE, a professor of economics at New York University's Stern School of Business, has served in senior positions in three presidential administrations.

their constituents, who tend to feel strongly about networks. But the features of networks described above would create problems even for a purely private system not susceptible to constituent pressures.

- The positive-externality feature of networks implies that privately priced networks may remain smaller than the underlying benefits would warrant. This may argue for well-focused subsidies even for a privatized Postal Service.
- With larger networks offering greater variety, network sizes may well be unstable. Tipping and winner-take-all dominance may arise, creating market power. Think Microsoft's Windows operating systems for PCs. And with software, the low cost of serving another customer may encourage tipping. In the middle of Microsoft's browser wars with Netscape, both sides were giving away their browsers. Unhappy rivals may claim that such pricing is predatory and file antitrust suits.
- If early-product strategies play an important role in tipping, then superior products that are late in appearing or that experience an early strategic stumble may lose out. Competition among networks may not necessarily yield the best outcomes. Just ask enthusiasts of Sony's Betamax video recording system or of Apple's Macintosh computers.
- Since compatibility is important, the question of who owns the standards becomes crucial. If the standard is open and owned by no one – e.g., the width (gauge) of railroad tracks or the design of a telephone jack – then rivals are not automatically precluded from connecting to the network and offering competing services. If, instead, a standard is proprietary (e.g., the copyright on the essential features of Microsoft Windows), then the owner of the standard effectively controls access to the network and has the potential for exercising market power.
- Those who bought hardware and software compatible only with a losing network will find themselves orphaned and often facing unexpected losses. In essence, purchases of network-compatible hardware and software are risky investments in the future success of the chosen network.
- For networks that require a central node, as in Figures 1 and 2, the node is likely to serve as a bottleneck for transactions, thereby conveying market power to the owner. For example, the Baby Bells' control of their central switches is clearly the source of their market power.
- Investments needed to build a new network may be very large. Thus, competitive entry may be deterred and market power strengthened. For example, replicating all of the pieces of a local telephone network or a railroad system today would be unthinkable.
- To the extent that networks are not owned collectively – e.g., the road system – decisions about the maintenance and expansion of the network become political decisions instead of economic ones.

FIGURE 2
A MORE COMPLICATED NETWORK



It is easy to exaggerate the difficulties that

networks pose, and policy wonks with an interventionist bent are prone to do so. Remember that gasoline powered cars did supplant carriages in spite of the problem of finding fuel. CDs have replaced vinyl records, even though very few CD players were around at the creation. Still, it is clear that the competitive process in the context of networks is considerably more complicated than, say, competition among hairdressers, haberdashers, or (the favorite of economics texts) wheat farmers.

FOUR NETWORK TALES

Theory is dry and often not illuminating. Consider these concrete illustrations of how public policy has become extensively involved in shaping network industries – sometimes for the better, sometimes not.

Telephones

From Alexander Graham Bell's invention of the telephone in 1876 until the early 1980s, the story of the network was largely the story of AT&T. Bell's initial patents protected the Bell System from competition for 17 years while it expanded its infant local telephone networks. After the patents expired in the 1890s, rival telephone networks appeared. But AT&T's innovation in long-distance technology in the early 20th century gave it a substantial edge. And by refusing to interconnect its long-distance service with rival local telephone networks – in essence, by unilaterally creating long-distance incompatibility – AT&T greatly reduced the value of rivals' networks to their customers. This made it possible for AT&T to out-compete them or to induce them to sell out to AT&T.

Despite a 1913 agreement with the Department of Justice intended to slow absorptions, AT&T continued to expand its ownership of local systems. By the 1920s, the company provided about 80 percent of local service and virtually all long-distance service. The remainder of local service was split among hundreds of small local companies along with a few larger ones, notably GTE. Western Electric, AT&T's manufacturing subsidiary, supplied most of AT&T's telephone equipment.

State regulation of local phone service began at the turn of the century and blanketed the country by 1920. Federal regulation of interstate long distance acquired strength in 1934, with the passage of the Federal Communications Act and the creation of the Federal Communications Commission.

The regulatory agencies set prices for telephone services to various categories of users. Generally, they favored local users over long-distance users, household users over business users, rural users over urban users, low-volume users over high-volume users, and basic services over luxury services and equipment.

Competition in long-distance service began modestly in the late 1950s, with MCI receiving permission from the FCC to offer microwave service for business lines between St. Louis and Chicago. Despite the FCC's general protectionist attitude toward AT&T, other companies such as Sprint began offering similar services. And by the early 1970s, even residential long-distance service was being offered by non-AT&T companies. Similarly, restrictions on competition in the provision of equipment were gradually eased, starting in the 1950s.

The FCC was torn between a recognition of the benefits of competition and the realization that competition could upset the patterns of cross-subsidies described above since competitive entrants were likely to skim the cream from high-margin services. The states saw this conflict even more clearly, and were

quite hostile to competition that shuffled the burden of costs among consumers.

By 1974, the Department of Justice had concluded that competition could work in long-distance service and equipment sales.

MICHAEL DARTER/PHOTONICA

But as long as AT&T owned the local telephone companies, it was likely to inhibit and distort competition in those areas. Such distortions could occur in at least two ways. First, AT&T's local service companies bought their equipment from Western Electric. AT&T could thus add to the apparent costs of the regulated entities by having them pay too much for equipment and recover those costs through higher rates. Meanwhile, its subsidiary, Western Electric, would earn higher unregulated profits. The same distorted incentives would apply to costs allocated between regulated monopoly local service and unregulated long distance.

Second, long-distance providers could access their users only by traversing AT&T's local switches at both ends of a long-distance call. Local regulation would presumably prevent AT&T from charging monopoly prices for access. Nevertheless, AT&T would be able to impede long-distance competition and efficiency by degrading the quality of its long-distance rivals' offerings through subtler interference. This would allow AT&T to expand its long-distance market share, or to raise its prices, or both.

The Justice Department's remedy was to ask for the divorce of AT&T's regulated local service from its equipment and long-distance subsidiaries. When Judge Harold Greene indicated that the government was likely to prevail, AT&T quickly moved to settle. As of January 1, 1984, the former unified Bell System was separated into seven separate Baby Bells (since reduced to four by mergers) and a long-distance and equipment company – today's AT&T.

By the late 1980s, the Baby Bells were petitioning Judge Greene for permission to offer long-distance services. They took their pleas to Congress, which eventually granted permission in the Telecommunications Act of 1996. But only in late 1999 did the first of the local service companies, Bell Atlantic, receive permission to offer long distance –

and only to residents of New York state.

Cable television

Cable television networks began as vehicles for improving reception for viewers in remote areas. But in the 1960s, their owners realized that microwave and satellites could be used to import television signals from distant markets. Their initial efforts were opposed by the owners of local stations, who feared the diversion of viewers (and advertising revenues). Broadcasters took their opposition to the FCC, which responded by restricting signal imports in the cause of supporting localism in TV broadcasting. Only in the late 1970s did the FCC move away from this protectionist stance and allow cable to become the wide-ranging source of content that it is today.

Ironically, as satellite-based direct-to-viewer broadcasting became practical in the 1980s, the owners of cable systems lobbied to hobble satellite distribution as they had been hobbled by local broadcasters. Indeed, satellite distribution was substantially freed only last year.

The franchising and rate regulation of cable was initially a local affair. But in the early 1980s, Congress had heard enough horror stories of municipal abuse to convince it to pass legislation that effectively prevented local rate regulation. Hearing a new set of horror stories in the early 1990s, Congress passed legislation that reauthorized local rate regulation. And reversing course yet again, the Telecommunications Act of 1996 scheduled a phaseout of local regulation.

This last action was motivated in part by the hope that cable systems would become competitors to local telephone systems in the provision of both telephone service and Internet access. This has proceeded slowly, at least partly because cable systems are one-way networks. By contrast, telephone networks are two-way, and the Internet is a mixture of two-way (e-mail) and one-way (the World Wide Web). Two-way networks require considerably more switching capabilities at their central nodes.

Nevertheless, the greater capability of a cable connection to transmit large amounts of information to a user indicates the potential value of such conversions for Internet access. AT&T's purchase of a cable company, TCI, in 1999, and AOL's prospective purchase of Time Warner Inc. both represent aspirations to convert cable systems into these more sophisticated networks.

The Internet

Created in the late 1960s as a backup communications network for defense purposes, the Internet had evolved into a global networking system with open (nonproprietary) standards by the 1990s. E-mail and Web browsing, supported by increasingly sophisticated software, have been the mainstay services delivered by the network.

Access to service has remained open and competitive. Many Internet service providers offer access and little else; others (like AOL) attach proprietary content. Users have wide choices, and they pay for what they get (as well as getting what they pay for).

There have been few complaints of exclusion. AOL's recent effort to make its instant-messaging e-mail a proprietary service restricted to subscribers is one of the few exceptions. However, if AOL were to develop into the dominant provider of access, it might be in a position to enter into exclusive arrangements with leading Web site content providers – thereby putting rivals at a disadvantage. This is an antitrust issue waiting to happen.

If cable TV systems become important

means of access to the Internet, then Internet service providers' access to users through those cable systems may become an important issue. AOL was quite concerned about cable access when AT&T (which is also an Internet service provider) bought TCI. AOL's purchase of Time Warner, with its extensive cable systems, will provide AOL with assured cable access and a bargaining chip for negotiating with AT&T. Just how other Internet service providers fare remains to be seen. Thus far, the FCC has taken a wait-and-see stance on the access issue, and any antitrust actions would be premature.

The information-highway metaphor for the Internet is more apt than is generally realized. Because individual users do not pay directly for use, there is no pricing mechanism to deal with congestion problems or to offer differential speed. Similarly, the overall financing mechanism for the Internet backbone network itself leaves open the question as to whether sufficient capacity will be available in the right places at the right times.

Microsoft and PC operating systems

Microsoft was founded in 1975 as a small software company. It received a phenomenally fortunate opportunity in 1980, when IBM asked it to provide the operating system software for IBM's forthcoming PC.

Most PC manufacturers assumed that IBM was likely to achieve the same dominance in PCs as it had two decades earlier in mainframe computers. By choosing the same operating system and microprocessor for their own PCs, these other manufacturers could promise their customers that (a) applications software written for IBM's PCs would work on theirs as well (indirect network externalities), and (b) files produced on one company's PCs would be compatible with another company's PCs.

Though IBM's PCs never attained the dominance of its mainframes, IBM made Microsoft's operating systems (first MS-DOS and then versions of Windows) the industry standard. And the indirect network externalities proved powerful, as more Microsoft-based PC users inspired more software applications, which in turn attracted even more users.

In the early 1990s, the Federal Trade Commission and then the Justice Department investigated Microsoft. Justice was especially suspicious of two practices. First, Microsoft signed contracts with some PC manufacturers that required them to pay Microsoft a fee for every operating system installed on the company's PCs, regardless of whether that system was Microsoft's. This arrangement made it difficult for the developer of another operating system to induce a major PC manufacturer to install its system on even a fraction of the manufacturer's PC output since the manufacturer would essentially have to pay twice to use the second operating system. Microsoft's contracts extended for as long as five years, again making entry by rivals difficult.

Second, Microsoft allowed applications software developers to have access to early versions of new operating systems (such as Windows) but then insisted that the developers not collaborate with other producers of operating systems for up to three years. Again, this made entry by the latter more difficult.

In 1994, Microsoft signed a consent decree in which it agreed that PC manufacturers would have to pay only for Microsoft operating systems that were installed, and that the contracts would last for only one year. It also agreed that its arrangements with applications software developers would not preclude them from working with other operating systems producers, as long as proprietary infor-

mation was not revealed.

Nonetheless, in May 1998 the Justice Department filed an antitrust suit against Microsoft, this time alleging that Microsoft had illegally tied its Explorer browser to its Windows 95 and Windows 98 operating systems. Justice argued that Microsoft had an overwhelming market share in PC operating system software which, thanks to network effects, could not be easily challenged. Microsoft had recognized that, when combined with the Java programming language developed by Sun Microsystems, the Netscape Navigator Web browser could usurp Windows' role and thus represented a challenge to the Windows monopoly. So, according to the government, Microsoft responded with a variety of actions that constituted illegal efforts to weaken Netscape.

The judge agreed, finding Microsoft guilty of antitrust law violations. But just how or when the case will be resolved is still unclear.

THE BOTTOM LINE

Some general lessons, as well as a few specifics:

- The nature of networks makes judgments about efficiency pricing more difficult than for industries that are not on networks. There is no assurance that a network monopolist will price its products in a socially efficient manner. But the history of regulatory intervention is hardly an advertisement for bigger government.
- The deregulation of network industries (airlines, railroads, interstate trucking, interstate bus transportation, natural-gas pipelines, long-distance telephone, cable TV, banking), has been a resounding success. Rates of both productivity and innovation have risen substantially. But these successes are no reason to drop the ball on antitrust scrutiny – which unfortunately has been the government's inclination in the cases of both railroads and airlines.
- The principle applied in the antitrust suit against AT&T – that the competitive portions of a network should be separated from the regulated monopoly portions – is valid and should be applied elsewhere. The electricity network, where generation is competitive and local distribution is a natural monopoly, is a good place to start.
- The monopoly problems created by central-switch networks are real and may not give way to market-based solutions. But since regulation itself is inherently flawed, sparing use is recommended.
- Regulatory requirements for universal service ought to be avoided. They are antithetical to efficient pricing, and ultimately to competition. Where a good case for positive network externalities or other reasons for an extended network can be made, targeted subsidies are more appropriate.
- Antitrust law has an important role to play in network industries, old and new. In addition to separating competitive from monopoly components, antitrust law can prevent mergers that unduly raise seller or buyer concentration, prevent entry barriers from being artificially raised, and deter dominant firms from raising rivals' costs. Further, if regulation of network industries is no longer to be the norm, then the obligations of the dominant firm to accommodate rivals' needs to use the networks should be clarified.
- Government-owned networks like the Postal Service and local transportation systems should be subjected to competition just as readily as other network industries are. Again, pleas for universal service in such systems should be met, when appropriate, with properly targeted subsidies – not with restrictions on competition.