Telecommunications Network Elements with Market Power

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Under a recent Supreme Court decision, the FCC must find significant market power by a LEC for a network element before requiring the LEC to offer it to a rival. How is this new requirement likely to affect telecommunications regulation and what elements are likely to generate market power concerns?

On January 25, 1999, in its decision of *AT&T v. Iowa Utilities Board*,[1] the U.S. Supreme Court required a new administrative step for implementing the Telecommunications Act of 1996. To implement the use of unbundled network elements from the local exchange carrier (LEC) by new providers of local service, the Court effectively requires that the Federal Communications Commission (FCC) find that the LEC has significant market power with respect to a network element before the LEC may be required to offer it to any rival. How is this new administrative step likely to affect telecommunications regulation?

The 1996 Act requires the FCC to consider whether access to a network element is necessary and whether not having access would impair the provision of a rival's services.[2] The Court decided that the FCC erred in the test it used for the "necessary and impair" standard. The FCC had required only that the absence of the network element increase the cost or decrease the quality, to any degree, of the service that the entrant wished to offer when compared to providing it using other unbundled elements of the LEC network. The Court disagreed for two reasons.[3] First, the Court decided that the FCC must consider the alternative of providing the service without the use of the LEC network. It found that "the FCC cannot, consistent with the statute, blind itself to the availability of elements outside the incumbent's network."[4] Second, the Court found that a *de minimis* increase in cost or decrease in quality is insufficient.

The test for the "necessary and impair" standard then becomes whether the absence of the network element significantly increases the cost or decreases the quality of the service that the entrant wishes to offer when compared to providing it in any alternative manner. This effectively requires that the LEC have no significant market power with respect to this network element.[5]

In requiring this new test, the Court was concerned that rivals might be able to effectively compete with the LEC without the use of some denied network elements. As the Court noted:

Until the 1990s, local phone service was thought to be a natural monopoly. States typically granted an exclusive franchise in each local service area to a local exchange carrier (LEC), which owned, among other things, the local loops (wires connecting telephones to switches), the switches (equipment directing calls to their destinations), and the transport trunks (wires carrying calls between switches) that constitute a local exchange network. Technological advances, however, have made competition among multiple providers of local services seem possible, and Congress recently ended the longstanding regime of state-sanctioned monopolies.[6]

The Court was concerned that technological advancements may have eliminated some earlier market power.

For a different view of the same issue, consider the 1984 breakup of AT&T. At that time, only the transport facilities necessary to provide long-distance services, primarily the transport trunks that connected switches over long distances, were thought not to offer any market power naturally. The network elements necessary for the provision of long-distance services were spun off, and the transition started for these services to be provided competitively. The elements that remained in the local exchange were thought to be a natural monopoly. Would technological changes since the breakup have led to the AT&T network being separated in the same places in 1999 as in 1984?

These technological advances have clearly affected telecommunications significantly. For telecommunications, along with the advancements in the computer industry, the costs of digital technologies have dropped significantly. For heavily used transmission corridors, the capabilities of optical fiber have dramatically lowered transmission costs. The cost of switching has also fallen substantially. Outside of traditional voice services, technological change has created new telecommunications industries for data transmission, cable TV, and wireless communications. In addition, these effects have been felt unevenly across the network. Have these technological advancements increased the ability of new suppliers to effectively compete with incumbent suppliers? Have the network elements with market power changed?

Recent Technological Change

The technologies necessary to use optical fiber became mature in the 1980s. Fiber deployment was initially for long-distance transmission, but now is used for transmission throughout much of the network. Fiber is now also the medium of choice between central offices on the local level, for some feeder transmission in the local loop between the consumer and the neighboring central office, and for large telecom customers or other high-bandwidth users for transmission all the way to the customer's premises. As time passes, fiber's advantages become even stronger. The cost of manufacturing fiber, of lasers, and of the necessary digital electronics has been dropping continuously and even the fiber itself improves. As a result, fiber optic lines have been laid at a strong pace that continues today.[7]

Switches have experienced lower costs primarily because of rapid, continuous advancements in the computer industry. Costs have fallen most in those technologies employed in telecommunications that are most like those used in the computer industry. Unfortunately for the telecommunications industry, it seems that those technologies most like the computer industry's are not those that have been traditionally adopted by the telecommunications industry. Two technology alternatives seem most important in this regard.

First, telecommunications may transmit signals in an analog or a digital form. In its analog form a broadcast-like wave is sent down the wire, while in a digital form, the message is encoded as a sequence of on/off pulses. The traditional wired telecommunications network was constructed for analog transmissions, but the biggest cost savings have been in handling digitally encoded information. As telecom networks have shifted to digital technology, networks have become mixed between analog and digital signals.

Second, when transmitting a message, telecommunications operators may switch circuits, that is, open dedicated connections from one point to another, or send small digitally encoded packets, many of which would be necessary to compose a message, on non-dedicated lines. Traditional voice telecom networks have been circuit switched, and at present they are overwhelmingly so. Nevertheless, due to the tremendous growth and maturation of the Internet and the equipment supporting it, packet-switched networks will grow tremendously over the next few years.

The last few decades have also seen extremely rapid growth in telecommunications services other than voice, and these new services significantly alter the economics of the traditional network. These services may use the same traditional network constructed for voice or they may offer a substitute for it. Advancements in data transmission for facsimile transmission and the Internet, cable TV, and wireless technologies have each led to entirely new industries, which have had two important effects on the traditional network. First, the new services that these new industries offer each increase the demand for telecommunications transmission significantly. These increases will be even larger in the future. The prime example is the 50 percent annual growth rate expected for the Internet. Second, to the extent new physical facilities are constructed, these industries offer substitutes for some traditional wireline telecom services.

Data transmission has become a major telecommunications service now on par with voice. Businesses have used private lines for decades to send data between themselves. Facsimile transmission has been prominent since the late 1970s. The Internet (net), which started as a private network to connect research institutions, seems to be overtaking all. Each of these data services is best offered over a packet-switched, digital network. Internet messages, in particular, usually pass over a data network largely separate today from the voice network, though translations between digital and analog signals and between transmission protocols are made when necessary.

The net has several advantages. Its digital, packet-switched architecture efficiently uses the resources of the telecommunications network, much more so than the traditional circuit-switched network. The packet-switched network is roughly an order of magnitude more efficient at transporting information. Further, it is experiencing rapidly declining costs over time as the technologies most heavily used by the net are just those experiencing the greatest cost reductions from technological change. And, demand growth for services provided over the net has been tremendous over a sustained period.

Inevitably, the net will soon offer a high-quality substitute for voice, as well as for data transmission, but for general use it is not yet a perfect substitute. At present, sending voice over the net sometimes faces quality problems during peak periods because of the net's "best efforts" transmission. Not all packets may arrive in real time, as is needed for voice transmission. This is not a technical problem since users can establish priorities for all packets that put those providing real-time services at the head of the queue. This is an economic problem, as charges necessary for at least the highest-priority packets to implement the system require significant transaction costs and adjustments to existing economic relationships between the multiple operators of the interconnected facilities making up the total network. As the economic advantages of using the net over the traditional network broaden, this problem is expected to be overcome.[8] The net also is just in its infancy in developing the capability for offering enhanced services, such as call forwarding or 911.

Cable television, another relatively new telecommunications service, this one offered over coaxial cable, was implemented initially in the 1960s to provide better TV reception in rural areas that ordinary broadcast did not serve well. With technological advances that significantly increased the capacity of the coaxial cables used to feed the signals into each household, cable TV penetration grew tremendously from the 1980s in the U.S., and somewhat later in other countries. Penetration varies a great deal in different countries, but it can be widespread. In the United States, for example, 98 percent of households are now passed by cable.

Wireless cellular telephone services started in the 1980s, and they have had a strong growth rate ever since. As demand has grown, new radio spectrum has been allocated for its use to accommodate its strong growth. Wireless services started with analog signals and have shifted, though not entirely at this time, to digital signals. The primary attraction of this technology for most customers is that it provides telecommunications for the mobile user, whatever their mode of transport.

Components of a Telecommunications Network

To better understand the effect of these technological advancements, and the resulting new economics of the various vertically-related elements of the telecommunications network, consider the components of a telecommunications network that may be used in placing a telephone call.[9] Once a message has left the customer's premises, an intermediate destination is the neighboring wire center or central office, which is the location of the first switch that the call passes through. The route from the customer's premises to the wire center is known as the local loop.

The local loop itself is made up of several different components. For the typical customer, the local loop starts with the network interface device (NID) that connects wiring in the customer's premises with the provider's facilities. A twisted-pair of copper cable, along with its supporting infrastructure, then connects the NID to a block terminal in a segment called the drop. The drop is either buried directly in the ground or carried in the air, supported by telephone poles. At the block terminal, which services several housing units either at a ground pedestal or attached to a pole, each drop is spliced into a distribution copper cable composed of multiple twisted pairs.

This distribution cable then moves toward and eventually connects with the serving area interface (SAI), while lines are spliced into it from other distribution cables en route. Distribution cable is either buried (in trenches or plowed directly into the ground), placed underground (strung through conduit such as plastic pipe, which is buried in the ground), or carried in the air (connected to utility poles). In more urban areas, drops and distribution cable may be located within a high-rise building. The drop and distribution cable may carry either an analog or a digital signal, though the preponderance is still analog. Within these cables, each customer has one or more pairs of lines dedicated to its own use, whether or not they are in use. For a wireline network providing only basic local voice services, drop and distribution lines are copper, but higher bandwidth services, say to businesses, might use optical fiber.

At the SAI, signals are aggregated and transferred to feeder cable where lines are used as needed. Signals in feeder cable may be either analog or digital. If analog, open circuits are cross-connected to copper feeder cables, a bundle of many twisted pairs sized to anticipate the largest number of open circuits necessary to handle this area. If digital, the distribution carrier connects with a remote terminal, which converts the signal to digital form, if necessary, and multiplexes it with other digital signals before sending it to an optical fiber feeder cable. Feeder cable, whether copper or optical fiber, transmits the signals from the SAI to the switch at the wire center. Feeder cable is buried, underground, or aerial, and the structures supporting it (i.e., trenches, conduits, or poles) may be shared with other telecom providers, cable television providers, or electric utilities. Feeder lines may be either copper or optical fiber depending upon engineering constraints (optical fiber can transport signals further than copper), the economics of using each medium, and whether they serve high-bandwidth customers. Due to capacity limitations of an SAI or the design of the distribution cable, multiple SAIs usually feed the same wire center.

A wire center normally contains at least one end-office switch. The end office provides dial tone and connections to other switches. The wire center may also contain a tandem switch-an intermediate switch connecting a number of end offices that operates something like an airline's hub. Physical facilities include a building, power and air conditioning systems, the switches, and the necessary entrances for feeder and interoffice cable.

Interoffice transmission is predominantly provided over optical fiber, and it increasingly uses a fiber optic ring architecture. The ring architecture allows at least two paths for a signal, which increases the reliability of the network.

In addition, a signaling network, which sits astride the main network, determines and establishes call routing and provides access to call-related databases necessary for, among other things, billing, collection, and advanced intelligent network services. Facilities for the signaling network are often located within a central office or alongside interoffice transmission cable. Operating the network also requires operations support systems necessary for ordering, provisioning, maintenance, and repair (primarily software), plus operator services and directory assistance. An operator tandem is often located within a wire center.

New Economics of Various Network Elements

As might be expected, the technological advancements discussed above, primarily those that provide the relative cost advantages of optical fiber, digital packet switching, and the new technologies for the Internet, cable TV, and wireless, affect different components of the network unevenly. The greatest economic effects appear in heavily-used transmission corridors, in switches, and for wireless customers. The smallest effects are in the local loop, especially between the customer's premises and the SAI.

The economics of heavily-used transmission corridors have changed significantly with these technological advances. It can be argued that interoffice transmission, even without optical fiber, has rarely been a natural monopoly. Since multiple routes are highly desirable for reliability anyway (to maintain service in the event of failure in one line), if each wire center were connected to two neighboring wire centers, multiple routes appear quite naturally. The incremental cost of sending signals on these multiple routes would vary little with distance. Multiple carriers could provide transmission with little, if any, increase in cost.

Nevertheless, the conclusion becomes much stronger with the introduction of optical fiber. First, optical fiber can transmit signals over longer distances without boosts than can copper cable, so that now more routes are available that can efficiently provide transmission between any two central offices. Second, the dramatic increase in demand for telecommunications services, largely due to the increase for data services, requires new transmission facilities. Since existing facilities remain useful and can remain in place, new facilities can be constructed by new carriers, and, consequently, multiple, independent carriers can efficiently provide service even on the same routes. Incumbents laying fiber on their own right of way or new entrants laying fiber in rights of way also used by pipelines, railroads, or electric utilities all face virtually the same costs. As a result, except in unusual circumstances, transmission in heavily-used corridors is not a natural monopoly. This includes not only long-distance transport, as has been long recognized, but also local transmission between central offices.

Heavily-used transmission corridors also include local loops to high-bandwidth customers. High-bandwidth, video-laden digital services, including cable TV, video on the Internet, or high-bandwidth data services require either an optical fiber or a coaxial cable installed to their premises, because the existing copper twisted pair is incapable of providing the service. With this second local loop, voice services can then be provided as a by-product. For these customers, the traditional local loop is not a natural monopoly. Further, with the significant sunk costs for installing each local loop, each supplier has a strong incentive to compete. These consumers, typically business and cable TV customers, would likely face little market power, if any, from the LEC's control of the local loop.

While an optical fiber to a high-bandwidth customer provides a second local loop today, a coaxial cable is not yet generally usable for a local loop, though it soon will be. The technologies naturally used for cable and telephony are not the same, as cable sends the same information to everyone and telephony sends individual messages both to and from individual customers. To provide a second local loop, additional investments are necessary to provide two-way, addressable capabilities to the cable network. While a number of trials have been held,[10] few have yet moved to regular service.[11] Even so, the technology for economically sharing the coaxial cable between broadcast TV signals and switched telephony is expected to have a significant impact soon.[12] Another option for relative latecomers to cable TV is to lay traditional twisted-pairs along with cable to share installation costs.[13]

The economics of switches have also changed significantly. First, since optical fiber allows signals to travel longer distances without boosts, each switch can now serve a much broader geographic market. Second, just as computer mainframes have given way to more distributed computer power, the minimum efficient scale for switches has declined. Together, new entrants can now efficiently deploy a switch with even a small market share. Except in unusually small, isolated markets, switches are not a natural monopoly.

Wireless technologies have also changed the economics of providing local loops to customers, so that now wireless connections provide economic competition for the wireline local loop for three types of customers. First, since wireless technologies have costs that vary much less with distance than a wireline network, they provide a local loop at the least cost for a customer in a low-density area and some distance from major telecommunications facilities. Scattered rural customers, especially those in difficult terrain, are most cheaply supplied with a wireless connection.[14] Second, the incremental cost of adding a wireless connection for the fixed location of a customer who values mobility sufficiently to pay for mobile service may be less than a wireline local loop. Where cellular transmission facilities are close enough to provide strong reception indoors, as may often be the case in a relatively high-density urban or suburban area, the incremental cost is virtually zero. At some further distance, the customer may require additional equipment that boosts the signal for this use indoors, but still the incremental cost may be lower than a wireline alternative. Third, customers that demand voice services only, or at most few data services, can be supplied by a cellular technology that provides sufficient bandwidth for voice calls but no, or a very slow, data service. This lower quality wireless technology has even lower fixed costs and can provide services over greater distances than the higher quality wireless service with quality that matches wireline service. Together, scattered rural customers some distance from major telecommunications facilities, existing mobile customers, and customers that demand only voice services may find a wireless local loop less expensive than a wireline local loop. As costs have dropped, and they are expected to drop further (for example, with the deployment of the CDMA technology), these boundaries shift to include more and more customers.

The economics of other network elements may have been significantly changed by these technological advancements as well. The signaling system and facilities providing operator services may now efficiently serve a larger geographic area. Databases for managing calls and providing intelligent services may now be located in regional or national depositories, as may operator tandems. Public data suggest that, again, even an entrant with a small market share could operate at an efficient scale.

Conclusion

Thus, with these technological advancements, if an incumbent were to raise its prices significantly above those necessary to earn competitive profits for transmission between central offices, its switches, or local loops to scattered rural customers, existing wireless customers, or some customers that demand only voice, public data suggest that customers would shift to a competitor's facilities. Actual and threatened competition would constrain incumbents to competitive pricing for these network elements. While a definitive finding requires more detailed data on telecommunications costs, existing public data indicate that, except in quite unusual circumstances, these network elements do not now naturally generate any significant market power concerns.

At the same time, this competition does not constrain the pricing of the local loop to the competitive level for other customers. For some customers, the local loop is still most economically provided by the standard twisted pair of copper wires, and no substitute can yet be efficiently provided for it. In conclusion, significant market power concerns appear likely, except in unusual circumstances, only for the local loop of the network, and then not for some customers of local loop substitutes offered by cable, optical fiber, or wireless telephony.

1. *AT&T et al. v. Iowa Utilities Board et al.*, No. 97-826 (S.Ct. Jan. 25, 1999).

2. "In determining what network elements should be made available for purposes of subsection (c)(3) of this section, the Commission shall consider, at a minimum, whether-

> "(A) access to such network elements as are proprietary in nature is necessary; and
> "(B) the failure to provide access to such network elements would impair the ability of the telecommunications carrier seeking access to provide the services that it seeks to offer."

47 *U.S.C.* §251(d)(2).

3. For the Court's discussion of its reasoning, see *AT&T v. Iowa Utilities Board*, §III(B).

4. *AT&T v. Iowa Utilities Board*, ¶1.

5. The Court may not require exactly the same legal tests, but conceptually they must be quite close. Requiring no significant market power means the LEC could not profitably maintain a price above the competitive level for a significant period of time. Since the competitive market sets prices equal to the marginal cost of the best alternatives, the test for significant market power becomes whether the marginal cost of the LEC's network element is significantly below the marginal cost of these alternatives. This is effectively the same test as for the "necessary and impair" standard.

6. *AT&T v. Iowa Utilities Board*, §I, ¶1.

7. As an illustration, in the U.S., interexchange carriers increased the mileage of their fiber lines by approximately five times from 1985 to 1995, and local exchange carriers increased theirs nearly 15 times in the same period. See FCC, Industry Analysis Division, *Fiber Deployment Update* (1998).

8. Proprietary data networks may offer high-quality voice services first, since the packets can remain on the facilities of a single owner. Nevertheless, this should be only temporary, because it does not capture the efficiencies of interconnecting networks.

9. Much of this description of the telecommunications network is taken from *HAI Model Release Version 5.0a Model Description* (1998) from HAI Consulting, Boulder, Colorado.

10. In the U.S., Time Warner has offered local telephone service within Kansas City, Indianapolis, Rochester, and Orlando; Jones Intercable and MCI outside Chicago and in Virginia; Cablevision on Long Island; MediaOne in Phoenix and Michigan; Cox Communications in California; and TCI in several areas. Similar trials have also been held in the UK. In the same time frame, cable modems are being tested and rolled out for broadband Internet access. The largest supplier of this service in the U.S. is @Home, an affiliate of TCI.

11. In Australia, Optus offers switched telephone service on coaxial cable in Sydney and Melbourne.

12. AT&T recently announced a merger with TCI, the largest cable operator in the U.S., expressly to upgrade cable facilities to offer, among other services, local telephony. Time Warner and Comcast/Media One are also now pushing fast to offer integrated broadband and voice services as well as cable TV.

13. In New Zealand, Saturn Communications has done this in Wellington and the surrounding area.

14. Microwave connections have been cheaper than wireline connections for very low-density customers for decades. Newer wireless technologies are now cheaper than wireline connections for somewhat higher densities. A number of trials or plans around the world use wireless technology in fixed telephone networks. One of the largest was conducted by AT&T. AT&T now intends to use a fixed wireless technology in many areas where it cannot reach a customer through its cable partners. Additionally, the fact that some wireless technologies can also offer broadband services further increases the range of economically viable local service locations that they may serve.

For a more detailed overview of wireless technologies in the local loop, see A. Pulido and I. Svanberg, *Wireless Local Loop: Quantifying the Real Costs of Installation and Implementation of Wireless and Wireline Networks*, SR Telecom, St. Laurent, Quebec, Canada, 1998. For additional discussion, see D. Gable and D. Kennet, The Effect of Cellular Service on the Cost Structure of a Land-based Telephone Network, *Telecommunications Policy*, 21(5):411-422, 1997, where they calculate that it would be economic to replace wire with wireless (cell phone) service in certain areas of rural New Zealand.