pair of cities, irrespective of the routing (direct or connecting) or even whether a single or more than one airline participated in carrying the passenger from the point of origin to the ultimate destination. Indeed, the CAB *required* interline ticketing and joint fare construction such that passengers would realize no direct benefit from travelling on a single carrier nor suffer any penalty if they switched carriers in the middle of their trip.[68] Expressed in terms more familiar to those who deal with telecommunications issues, the CAB required that individual airlines allow passengers unrestricted *interconnection* among their respective route networks.

But deregulation of airline route authorities and fares has led to a fundamental redesign of those airline networks around "hubs" at which passengers may make connections to other flights usually operated *by the same airline*. Under the "hub" system, the carrier fills its seats on each flight by combining local traffic (i.e., passengers travelling between the hub city and some other location) with through-traffic that transits the hub. Thus, flights into and out of the US Air Pittsburgh hub carry a certain amount of local traffic (where Pittsburgh is either an originating or terminating point for the trip) but predominantly carry traffic between points *other than Pittsburgh* that transits the hub for purposes of making a connection. At the same time, there is no longer any requirement that joint fares be offered at rates no higher than on-line fares, such that passengers entering the hub via one carrier can be made to suffer a substantial fare penalty if they choose to switch carriers at the hub (if in fact that option is even available). In other words, carrier interconnection is no longer required by the CAB, and in fact it generally does not occur, other than at an administrative level.[69]

The consequence of this new network structure is that the presence of the network itself — coupled with the near-elimination of unrestricted interconnection (i.e., joint fare construction) — tends to confer market power and create substantial entry barriers which may be far more effective in limiting competition in these hub markets than the pre-deregulation route authority cases administered by the CAB. In fact, because of the enormous benefits that an airline may realize by filling more seats on existing flights, there is a substantial economy of scale and scope that arises from the creation of the largest possible hub-oriented interconnecting network. To see why this is so, suppose that a flight segment between, say, Washington and Pittsburgh can support only 40 local passengers, but by providing connections at Pittsburgh to Detroit, Phoenix, Omaha and Seattle, an additional 10 passengers destined from Washington to each of these four cities will fly the

68. For a discussion of fare construction, *see* Jordan, William A., *Airline Regulation in America*, (Johns Hopkins University Press, 1970), at 73-134.

69. Interline airline ticketing is still supported administratively. However, as a general rule joint fares exist only where a carrier cannot provide end-to-end on-line connections through an intermediate transfer point. As hubs expand and trunk carriers enter strategic "code sharing" arrangements with regional commuter airlines, the incidence of such joint fare construction, at least with respect to domestic US routes, is becoming quite rare.

same Washington-Pittsburgh segment, bringing the total passenger volume to 80. Now suppose the airline adds an additional destination to its Pittsburgh hub (say Chicago) and that as a result another 10 Washington-to-Chicago passengers will now take the Washington-Pittsburgh flight, bringing the total number of passengers to 90. Clearly, even in this highly simplified example, it is apparent that the more network points that are served by the central hub, the higher will be the occupancy level for each flight segment into and out of the hub. In fact, once an airline has established a major hub and has achieved a certain "critical mass" insofar as connecting passenger volume is concerned, the presence of the hub and its associated route network creates an effective barrier to entry against other carriers who might seek to offer local two-point service (but whose passengers cannot interconnect with the hub carrier's network), unless that demand in the specific two-point market is sufficient *by itself* to fill up the airplane (e.g., New York–Washington, San Francisco–Los Angeles).

It has been suggested that this pattern of airline concentration is attributable to limitations on landing slots and gate space at the more congested airports. This physical constraint may, however, be a second-order effect of the network connectivity phenomenon. For example, airports with particularly severe landing and gate constraints — New York LaGuardia and Washington National — do not exhibit the same high levels of concentration as exists in less constrained markets, such as Minneapolis, St. Louis and Pittsburgh. The entry barrier confronting the non-dominant carriers at fortress hubs cannot be cured merely by allocating more gates or landing slots to these competitors; absent a highly interconnected network around the particular hub, the non-dominant airline will simply be unable to fill up its airplanes.

Telecommunications networks and market power

By viewing the airline industry in the context of *network relationships*, we can learn a great deal about the likely nature and extent of competition that can be expected to develop in the telecommunications field, particularly if some of the same corporate strategies and government policies are pursued. And what we learn is that the very property of networks that promotes consolidations and cartelization among airlines will also assure continued market dominance by the incumbent local telephone carriers within their respective market segments for the foreseeable future. The fundamental *networking* characteristics, not to mention scale and scope economies, that are evidently so important in the airline industry are, of course, enormously more important in the case of local telephone networks, where interconnectivity and ubiquity work together to assure the dominant local carriers a level of control of their respective markets that will be difficult to challenge. Indeed, even the nominal fungibility and sunk cost conditions characteristic of the airline industry are even less conducive to competitive entry and exit in the case of common carrier telecommunications because, unlike airplanes, physical switching and transmission resources cannot be easily redeployed from a site of relatively low demand to one of high demand. Thus, the

experience of "deregulation" and "competition" in the airline industry suggests that the pattern of networking and market dominance is likely to be significantly greater in the case of dominant local telecommunications carriers, because (a) they already have ubiquitous networks in place, (b) these individual resources are characterized by far greater economies of scale than even the largest jumbo jets operated by the airline companies, (c) these resources are almost totally non-fungible and exhibit substantial sunk costs, and (d) the confluence of these conditions creates a formidable barrier to entry within a given market segment.

Airline "hubs" and control of adjacent markets

The presence of hub markets dominated by one (or occasionally by two) airlines developed naturally in the years following deregulation. It is not our purpose here to debate the merits or lack thereof of this structure *for the airline industry*, and we shall not attempt to do so. However, the presence of dominant carriers at specific hub markets is instructive with respect to its impact upon adjacent markets, because the properties of airline hubs can be extrapolated to telecommunications hubs (local telephone networks) operated by the local exchange telephone companies.

There is, of course, one essential difference between an airline hub and a local exchange telephone company hub: While both own most (or perhaps virtually all, in the case of telephone companies) of the network *links* entering the "switch" (the central office or the airport), the dominant airline *does not own the airport*, whereas the LEC *does own its central offices*. What might happen if, for example, the airline that dominated a particular hub also owned and controlled the hub airport? Consider these possibilities:

- If the dominant airline also owned or had a financial interest in a particular hotel or hotel chain in that city, it could well prevent any competing hotel from sending its courtesy vans around to the terminal or from maintaining a reservations telephone in the baggage claim area.

- If the dominant airline also owned outright or had an interest in a particular car rental company, it could readily preclude any competing car rental company from setting up a counter in the terminal.

- The dominant airline could prevent any other airline from landing at the airport, which would eliminate even the small amount of competition that it confronts in heavily dominated hub markets.

- The dominant airline could operate its own fleet of taxis, buses, and other ground transportation systems, and could prevent all but its own vehicles from entering the terminal.

- The dominant airline could readily monopolize all food and other retail shops and services in the terminal, denying space to any competitor.

In these examples, the dominant airline, by *owning* and controlling the airport (the exchange), can exert monopoly control over adjacent hotel, car rental and ground transportation markets, and can also foreclose even limited competition with respect to its airline services themselves.[70] In addition, airline ownership and control of the airport would make it much more difficult to monitor and guard against anticompetitive behavior, since all information concerning the airport and its operations would be generated by and/or in the possession of the airline. Where the local telephone company enjoys similar ownership and control over essential points of interconnection, like an airline that owned its airport, the LEC could readily monopolize adjacent markets. Such monopolization does not occur because airlines do not own their airports, thereby establishing an effective wall between the airline business and all adjacent markets that interconnect with the airline at the network node (the airport). Even if an airline did own a hotel chain (as some do or have in the past) or have a financial interest in a car rental company (as United did with respect to Hertz at one time), it had no ability to extend whatever local market power it might have had at certain hub airports into these adjacent markets, *because it had no ability to limit entry at the network node*. If BOCs are to be permitted to enter those adjacent markets from which they were precluded under the *MFJ*, they must be confronted with no less physical and economic separation between the core monopoly and competitive adjacent market as is achieved in the airline industry through public ownership of airports.

The fact or possibility that the owner of a strategic network node could apply market power gained therefrom to control adjacent markets has long been recognized and led the US Supreme Court, in an early antitrust ruling, to establish the "essential facilities doctrine." In *United States v. Terminal Railroad Association*, the Court required the railroads that owned a critical railroad switching junction in St. Louis to provide access to competing railroads "upon such just and reasonable terms and regulations as will ... place every such company upon as nearly an equal plane as may be with respect to expenses and charges as that occupied by the proprietary companies."[71] Sixty-five years later, the D.C. Circuit Court of Appeals reiterated the same principle: " ... where facilities cannot practicably be duplicated by would-be competitors, those in possession of them must allow them to be

70. While one airline may control 80% or more of the total business in a "fortress hub" market, passengers can still choose alternative carriers for trips routed via other hubs. For example, a passenger in Pittsburgh can fly US Air non-stop to San Francisco, or he can fly to San Francisco via St. Louis on TWA, via Detroit or Minneapolis on Northwest, via Chicago or Denver on United, or via Chicago or Dallas on American, among others. While each of these alternatives is less direct than the US Air non-stop, their presence does impose at least some pricing discipline upon US Air's fare between Pittsburgh and San Francisco. If US Air owned the Pittsburgh airport and could thereby prevent TWA, Northwest, United, American, or any other carrier from landing there, it would likely be capable of imposing a considerably higher price for that non-stop Pittsburgh-San Francisco flight.

71. *United States v. Terminal Railroad Association of St. Louis*, 224 US 383, 411 (1912).

shared on fair terms."[72] Control of essential facilities, such as a strategic switching node, provides the *means* for extending the owner's monopoly into any market segment for which such a facility is required. In these and several other cases,[73] the Courts have attempted to resolve the essential facilities problem by imposing market rules upon the owner of the bottleneck. Imposition of such requirements does not, however, remove any inherent incentives confronting the owner to attempt to monopolize the adjacent market or to limit its competitors' access; instead, the approach seeks to counter-balance these incentives with the threat of legal sanction should the unlawful practice be continued.

2.6 Monopoly essential facilities versus competitive services: The MFJ approach

The approach adopted in the *MFJ* to assure the availability of essential facilities to BOC competitors was thus fundamentally different: Here, in addition to requiring that BOCs make essential facilities available to competing long distance carriers on an equal and nondiscriminatory basis, the Court also sought to *eliminate altogether* the monopolization incentives that had dominated BOC behavior by simply excluding the BOCs from markets in which use of their essential facilities would be required. Thus, in addition to requiring that BOCs provide equal access at equal prices to all interexchange carriers, the *MFJ* removed the BOCs' incentives to favor any one long distance carrier by excluding the BOCs from competing in the long distance business.

The current telecommunications policy dilemma arises because the boundary between monopoly essential facilities and competitive services that was envisioned in the *MFJ* may have shifted. As a result, BOC essential facilities may now be utilized and competition — or more generally *potential* competition — has or may soon enter certain segments previously dominated by BOCs. Ironically, rather than retain the *MFJ* approach, updated as required to reflect current competitive conditions,[74] the BOCs now seek not only to retain the ability to compete with new users of their essential facilities, but to *reenter* the very markets from which they had been excluded — for the same reason — in the divestiture settlement. Despite protestations to the contrary, however, the LECs still control the last mile.

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72. *Hecht v. Pro-Football, Inc.*, 570 F.2d 982, 992 (D.C. Cir., 1977).

73. *See*, e.g., *Otter Tail Power Company v. United States*, 410 US 366 (1973).

74. Without revision, the *MFJ* will no longer reflect the current boundary between the core BOC monopoly and those segments in which competitive activity is now possible. So once again the BOCs will have both the incentive and the means to leverage their core exchange monopoly to foreclose entry into potentially competitive adjacent market segments. See at 39, *infra*.

To most users of telephone and other telecommunications services, the involvement of multiple suppliers is a relatively new phenomenon since (prior to the divestiture) the service had traditionally been provided end-to-end by the telephone monopoly. Customers want and demand "seamless" interconnections among the various components of each telephone call, and as a result few know or appreciate precisely where one provider leaves off and another one begins. The interactions among industry segments, and the effects of barriers and boundaries dividing such segments, is far more visible in other highly complex industries such as airlines. Taxis, buses, and rental cars utilizing public streets and highways provide the access links between the passenger's home or destination (the customer premises) and the airport (the switching node). The passenger must physically walk from the taxi to the plane, and from one plane to another at a switching hub. While these mode and carrier changes are obviously visible and are in no sense "seamless" from the perspective of the user, they are in every material respect fully analogous to the manner in which end-to-end telecommunications connections are constructed: Access facilities are interconnected at local switching nodes, which are linked to interexchange switching points (IXC POPs) and to intermediate switching points on IXC networks. The end-to-end service involves multiple suppliers — LECs, CAPs, IXCs, equipment vendors, enhanced services providers, and others. But just as the *airport* is generally the core monopoly element through which all air traffic in an out of a particular city must pass, the local LEC central office and the local switching and transport network that is comprised of LEC central offices and interoffice links similarly constitutes the core monopoly element of most end-to-end interconnections. And for the same reason that control of the airport is separated from *all other service providers* in the airline network, as long as the LEC monopoly persists so too should LEC control over local network connectivity be isolated from all adjacent markets that this resource serves.

The "geodesic network" revisited

In his 1987 report to the Department of Justice in connection with its first triennial review of the *MFJ*,[75] Peter Huber posited the notion that the telecommunications network was "geodesic" in nature and that as a result no single entity, such as a BOC, could exert monopoly control over essential network elements. Huber envisioned a highly interconnected network in which traffic travelled along the outer shell rather than through a central core, where individual nodes were each connected with several others, such that multiple alternate routing was always possible (see Figure 2.9). By implication, with multiple alternative routes always available, no single entity could exert monopoly power, and

75. Huber, Peter W., 1987. *The Geodesic Network: 1987 Report on Competition in the Telephone Industry.* Washington, D.C.: U.S. Department of Justice, Antitrust Division.

control of adjacent markets, or for that matter even the core local exchange market, was thereby foreclosed.[76]

Buckminster Fuller's "geodesic sphere," the architectural analog upon which Huber's model was founded, requires that all interconnecting links be identical as to their length, thickness, and strength.[77] Huber's analogy thus requires essentially equal connectivity at each network node, in effect rejecting the possibility that some nodes, by virtue of their substantially greater connectivity than at others, may afford those who control them strategic market power. Even if the telecommunications network were "geodesic," which it is not, there is certainly no indication that this requirement of uniformity with respect to individual links and nodes can be shown to exist. In fact, such properties are unlikely to be present in any "real world" network. And when they are not, the *economic analogy* to Fuller's architectural construct that Huber sought to create, like its architectural counterpart, will necessarily fall apart.

Consider, once again, the parallels with the airline industry. If one were to overlay all of the individual US airline route networks on top of one another, the result, which constitutes the totality of the "public airline network," might appear to be highly interconnected and, as Huber applies the concept, highly geodesic at a superficial level (see Figure 2.10). By contrast, the US telecommunications network is fundamentally *hierarchical* in structure (see Figure 2.11). Where direct airline routes interconnect more than two thousand individual city-pairs in the US, most telecommunications connections involve routing through several network layers — the local (Class 5) end office, in many cases an "access tandem" switch that interconnects individual end offices with several different IXC networks, and at least one (and frequently more than one) intermediate IXC switching point.

Despite its seemingly "geodesic" character, the US airline network includes a small number of highly interconnected nodes that serve as "hubs" typically dominated by one or at most by two carriers. Notwithstanding the far more "geodesic" character of the US airline system in relation to the hierarchical telecommunications network, from the stand-

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76. Huber has published a sequal to his original paper, but his basic conclusion is essentially unchanged. Huber, Peter W., Michael K. Kellogg, and John Thorne, *The Geodesic Network II: 1993 Report on competition in the Telephone Industry*, (Washington D.C.: The Geodesic Company, 1992). Despite growth of competition at the periphery of the core BOC monopoly, the fundamental architecture of the public network has, if anything, become even more centralized than it was in 1987 when the first Huber report was issued.

77. The geodesic sphere is a particular type of latticed structure that is typified by a series of triangles paired into the form of diamonds. As a result, each joint in the geodesic structure (switching node in a telecommunications network) would have to be interconnected to each other joint by five separate members or struts (links in a telecommunications network). The geodesic sphere's separate members must be capable of bearing loads in some equal measure, in order for the dome to be stable. *See*, e.g., Carpenter, W. C., J. F. Ely, and C. R. Bramer, "Joint Instability of Latticed Structures," in R. M. Davis, ed., *Space Structures* (John Wiley & Sons, 1967), at 444.

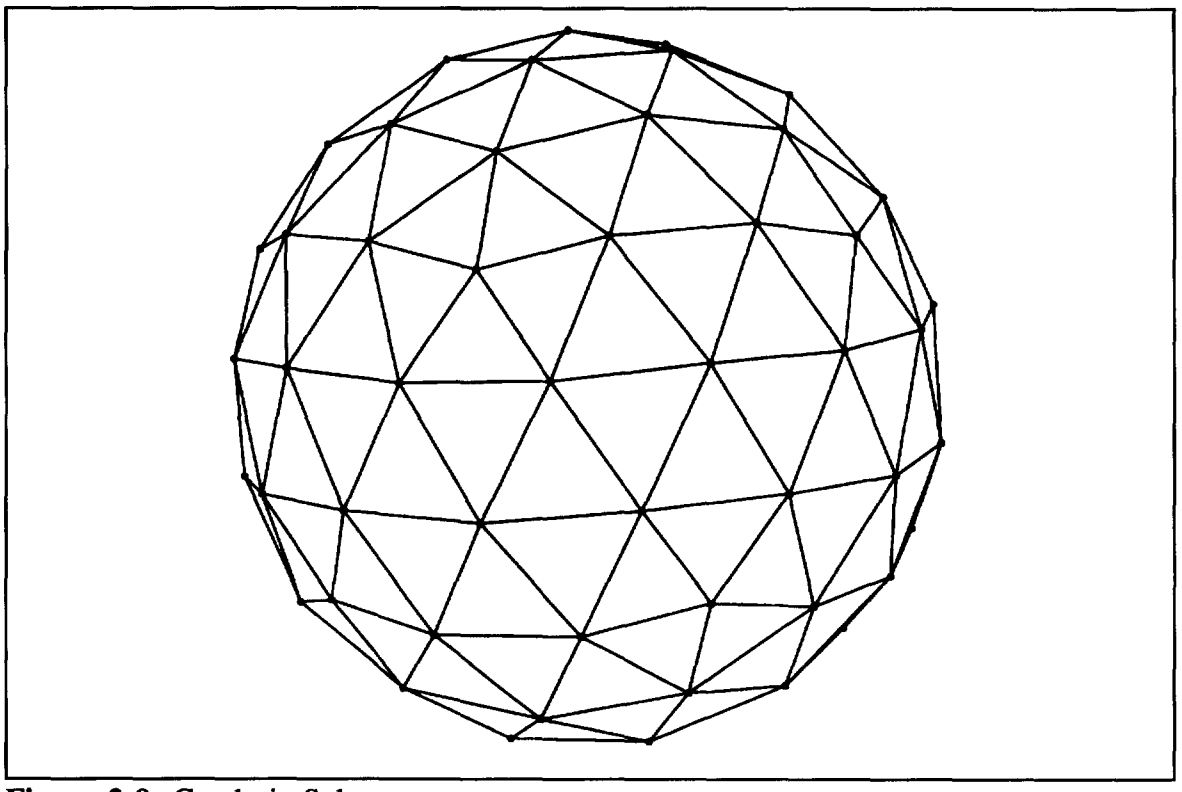

Figure 2.9 Geodesic Sphere

point of market power these "hub" nodes are more important, more *strategic*, than those with lower levels of connectivity. In general, such strategic nodes are those in which the largest number of individual links may be interconnected, such as at hub cities like Pittsburgh, Chicago, Denver, Detroit, Dallas, St. Louis, etc. In Fuller's "pure" geodesic construct, there are exactly the same number of links (five, to be precise) connected to each node in the sphere (see Figure 2.9); while Huber seeks to portray the telecommunications network as possessing connectivity that roughly simulates the "geodesic" analogy, in practice airline and telecommunications networks are not even remotely close to resembling the Fuller/Huber design.

Indeed, contrary to the "geodesic" model posited by Huber, LEC networks are actually becoming more centralized and more highly concentrated. The availability of large-capacity digital switches, coupled with low-cost, high-capacity fiber optic cables, have enabled LECs to consolidate switching intelligence into a smaller number of larger centrallized entities. Intelligent Network architectures, such as the *Advanced Intelligent Network*

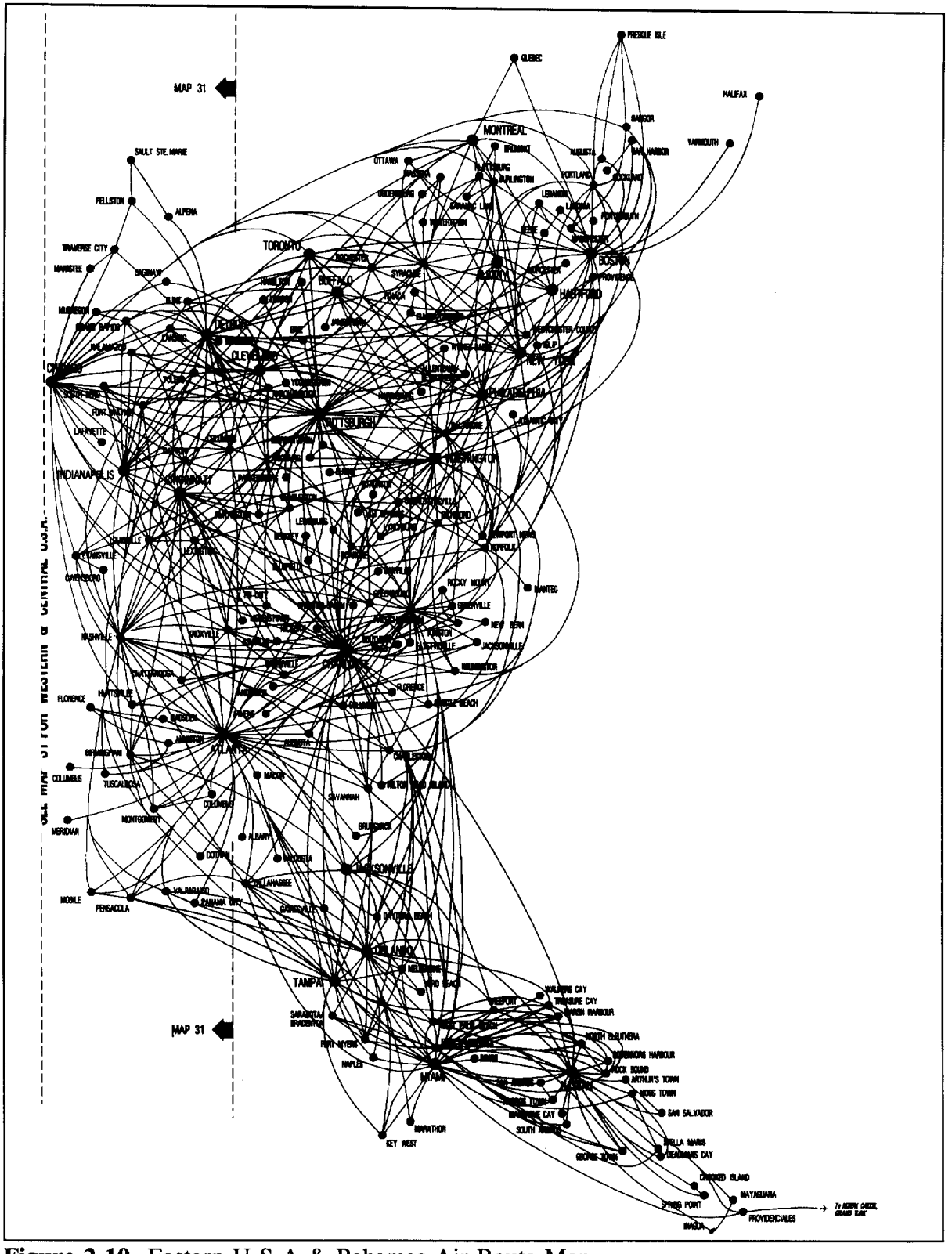

Figure 2.10 Eastern U.S.A & Bahamas Air Route Map

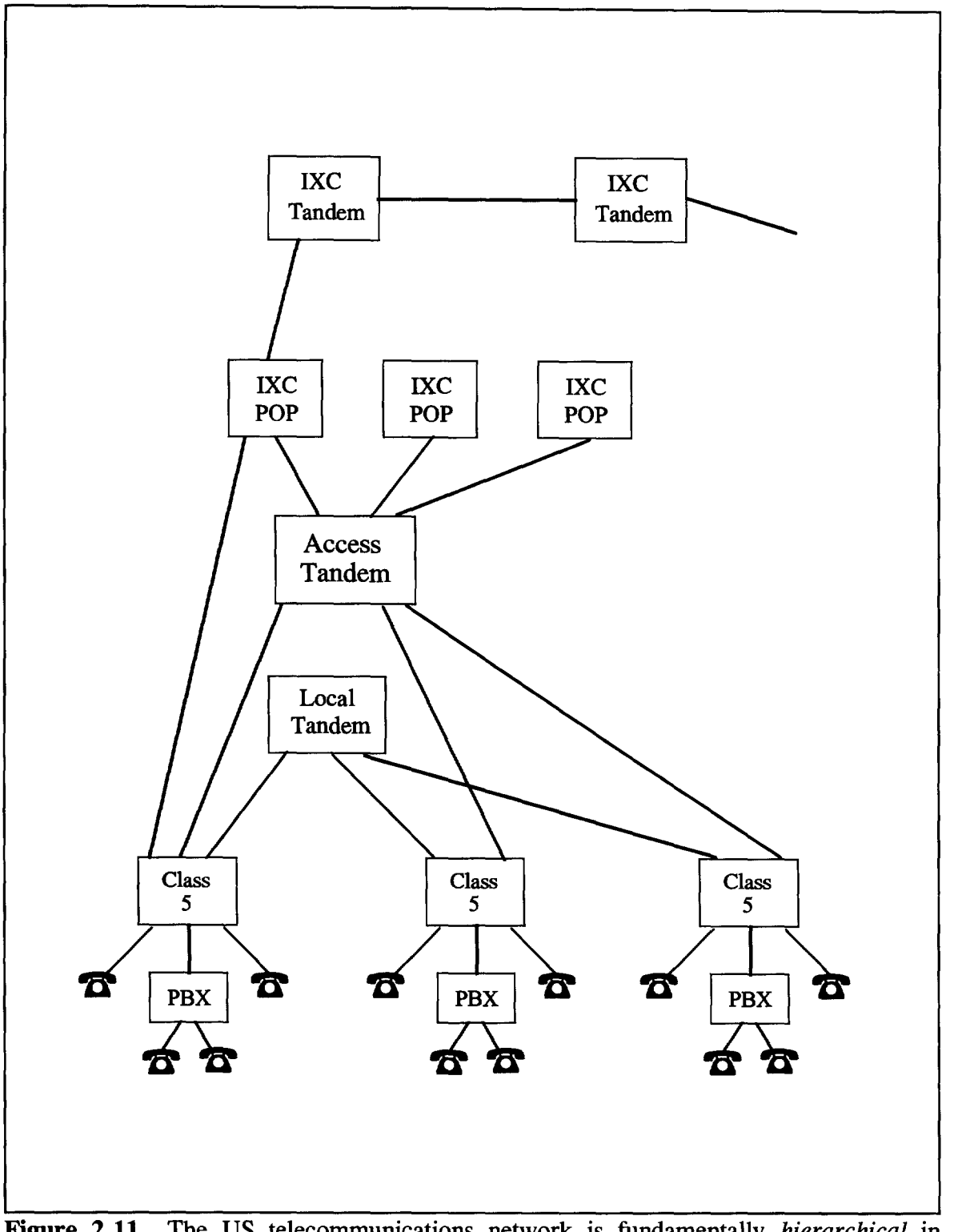

Figure 2.11 The US telecommunications network is fundamentally *hierarchical* in structure

(AIN),[78] contemplate centralization of Service Control Points (SCPs), the databases and processors that will control a broad range of LEC network services. In fact, the BOCs have claimed that the economies of centralization of common channel signalling are so substantial that they sought (but were denied) a waiver of the interLATA line of business restriction that would have permitted them to serve multiple LATAs from the same (possibly out-of-LATA) Signalling System 7 control points.[79]

Recent tariff trends have further shifted the focus of the nation's telecommunications resources away from "point-to-point" connectivity and toward centralized, hierarchical structures. At the time that Huber created his first *Geodesic Network* thesis (1986-87), most large corporations and state and federal governments maintained extensive networks of leased private lines and dedicated switching points that were routed to conform to the organizational communications patterns. There were several reasons why large users elected private, rather than public, network solutions, but the most important one was probably *price*. Interexchange toll and toll-like services (e.g., WATS, 800 Service) furnished over the public network were, both prior to and following the divestiture, required to contribute to the *non-traffic-sensitive* (NTS) costs of subscriber lines. Before the establishment by the FCC of its Part 69 Access Charge Rules,[80] these contributions were accomplished by allocating a portion of NTS costs to the interstate jurisdiction, such that when the level of interstate toll rates was established, the interstate-assigned NTS costs were included within the interstate rate base. At the intrastate level, where no such "formal" allocation arrangement typically existed, the state commissions nevertheless pursued pricing policies that imposed a disproportionately high revenue responsibility on toll (and

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78. *See* Bell Communications Research, *Advanced Intelligent Network Release 1 Proposal*, Issue 1, November, 1989 (SR-NPL-001509); *Advanced Intelligent Network Release 1 Baseline Architecture*, Issue 1, March, 1990 (SR-NPL-001555); *Advanced Intelligent Network Release 1 Network and Operations Plan*, Issue 1, June 1990 (SR-NPL-001623).

79. *U.S. v. AT&T*, Civil Action No. 82-0192; (D.D.C., 1990), July 13, 1990, re *Petition of US West*, 131 FRD 647, 114 PUR 4th 383. Judge Greene noted:

> The Regional Companies and the Department of Justice explain that common channel signaling and Signaling System 7 (SS7-CCS), which is planned to be deployed this year or next, uses a data network separate from the communications channel for transmission of network control signaling information, rather than transmitting that information over the channel used for the communication itself. The waivers should be granted, according to those supporting them, because it is now feasible to separate the signaling channels from those used for the transmission of the communications themselves, and *because the installation of interfaces in just a few central points would be less expensive for the Regional Companies than the provision of the equipment in every LATA as the decree requires.* ... The proponents of the waivers further argue that adherence to the decree would provide no advantage to the public. ... *Id.* at 650; emphasis supplied; cites, footnotes omitted.

80. *See* MTS/WATS Market Structure/Amendment of Separations to Conform to Revised USOA, CC Docket Nos. 78-72, 80-286, 86-297, *Order on Reconsideration and Supplemental Notice of Proposed Rulemaking*, August 8, 1988, and *Code of Federal Regulations*, Part 69.

toll-like) services than on "local" dial tone service, particularly the residential access line. After divestiture and the establishment of a formal "access charge" regime at both the federal and state levels, NTS costs continued to be recovered through toll usage revenues by means of a so-called "Carrier Common Line Charge" ("CCLC") that interexchange carriers were required to pay to the LECs for each minute of switched access to the LECs' local (intraLATA) networks.

In sharp contrast to the implicit and, later, explicit recovery of NTS costs through public switched network usage charges, private line tariffs — and particularly those applicable in the interstate jurisdiction — generally did not capture any consequential portion of local NTS costs.[81] Consequently, by utilizing *private network* as opposed to *public network* services, users could effectively escape most of the implicit and explicit NTS cost recovery components in toll, WATS and 800 service tariffs, affording private line networks a substantial cost advantage vis-à-vis any public network service.

That situation was, however, about to change. Beginning in 1984, when the current access charge regime was first placed into effect,[82] the FCC embarked upon a program of "rate rebalancing" in which much of the burden of NTS cost recovery was shifted away from usage-based charges and onto fixed monthly end-user charges that did not vary with the volume of usage. This shift was accomplished through a five-year-long transition that concluded in 1989, when the residential/single-line business interstate Subscriber Line Charge ("SLC")[83] was increased to its current level of $3.50 per month. Prior to the initiation of the FCC access charge system in 1984, the *implicit* NTS cost recovery component of a two-point interstate toll call was approximately 18 cents per minute. Upon implementation of access charges on May 25, 1984, the Carrier Common Line Charge was set at approximately 5 cents per minute (varying by company), so that the NTS cost applicable to a two-point call was abput 10 cents (5 cents at the originating end and another 5 cents at the terminating end). As of January, 1994, the CCLC had generally decreased to less than a penny at each end, or less than two cents for a two-point interstate call. At the *retail* level, interstate toll rates had dropped by almost 50% from their pre-1984 levels, and various bulk discount and "block-of-time" pricing plans, introduced by all of the IXCs, have brought these prices even lower.

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81. At the state level, intrastate private line rates may have in some cases been set in excess of cost so as to generate contribution to NTS access line costs, but no formal mechanism for this purpose typically existed. In any event, the "contamination" rules then in effect would have treated most in-state links within larger interstate private networks as *interstate* services, subject to the (usually lower) interstate tariff rates.

82. MTS/WATS Market Structure/Amendment of Separations to Conform to Revised USOA, CC Docket Nos. 78-72, 80-286, 86-297, *Order on Reconsideration and Supplemental Notice of Proposed Rulemaking*, August 8, 1988.

83. The SLC is sometimes referred to as the "End User Common Line" ("EUCL") charge.

In the late 1980s, the major interexchange carriers began offering similar "virtual private line" network services which, through customized numbering, dialing and routing patterns, could be made to *look* (to the end user) like dedicated private networks but which were in fact furnished largely or entirely over the public switched network. Within a relatively short period of time (from the late 1980s through the early 1990s) most private corporations and governments had dismantled their private line networks in favor of virtual network services that utilize the public switched network. In 1988, the largest private network in the US, the Federal Telecommunications System (FTS), was replaced by a virtual network service known as "FTS 2000." Other large corporate private line networks were similarly discontinued and replaced by turn-key switched service packages. Thus, whatever geodesic properties these private networks might have indicated to Huber at the time of his initial exposure to the telecommunications marketplace, those conditions no longer prevail.

The process of shifting traffic away from private networks is, moreover, far from complete. The principal use of private networks today is for data transmission. Banks utilize private lines leased from LECs, IXCs, CAPs and other providers to support Automated Teller Machine (ATM) networks, branch teller terminals and other inter-branch data communications requirements, electronic funds transfer, and a variety of other applications. Airlines use private line networks to support reservations terminals at airports, city ticket offices and travel agents, as well as for numerous other management information systems applications. State and federal government agencies make extensive use of private data networks to support a wide range of geographically dispersed information systems, including such applications as state lottery terminals, medicare/welfare eligibility verification, and a number of transactions processing systems. In time, however, most or perhaps all of these applications, like voice services, will be shifted to a public data network as the availability and sophistication of public packet transmission services becomes more widespread, and seamless inter-carrier links are established. In a digital network, voice and data are essentially indistinguishable, and architectures capable of switching digitized voice services can just as easily accommodate data as well.[84] High-capacity packet switching technologies such as Asynchronous Transfer Mode (ATM – not to be confused with Automated Teller Machines) will be capable of supporting all manner of voice, data, video and other broadband services interchangeably on a common public network infrastructure.

Geocentric, not geodesic

The public network of the future will thus be far more geocentric than geodesic, constructed around a hierarchical architecture in which various *distribution* (access) tech-

84. Different traffic characteristics of voice and data might cause the sizing or configuration of a switch to vary, although the basic architechure would be identical.

nologies are interconnected with large-scale intercity networks, all operating under extensive common control intelligent network management systems (see Figure 2.12). The vision of a "network of networks" in no sense implies a "network of equal networks." Distribution networks employing conventional landline (wire) facilities will compete in the future with coax/fiber distribution networks, mobile and fixed wireless networks, and specialized application-specific distribution networks which may continue to utilize dedicated (leased channel) facilities. These will be interconnected with each other and with intercity and international transport networks through local switching/transport "hubs" maintained by existing local exchange telephone monopolies.[85] Various intelligent network functions (for example, number portability) will require common management and control systems, as well as common databases that will ultimately depend upon centrallized management.[86]

Local exchange telephone monopolies control the strategic nodes where interconnections among the various competing distribution systems, *including the dominant landline telephone distribution system maintained by the LEC itself*, take place. LECs will also control key interconnection nodes between disparite distribution networks and interexchange carrier networks, as well as primary intelligent network control points. Increased deployment of high-capacity switching and transport technologies will continue to shift more costs into the "fixed" category, raising entry barriers and reducing marginal usage-sensitive costs in LEC networks almost to zero.[87] The strategic role of the BOCs as the holders of es-

85. Here the analogy to an airport breaks down. Airports, like LECs, support interconnection among airlines (intercity carriers) and between airlines and ground transportation services. LECs, however, provide an *additional* function that airports do not: LECs also provide interconnections *among local transport services*. Thus, the role of the LEC in the larger public telecommunications network architecture is even more strategic than the role of an airport in the larger public transportation network; airports are strategic only with respect to travel involving intercity airline links, whereas LECs are strategic nodes with respect to both intercity and local telecommunications connections.

86. A case in point is the "800 database" that supports 800 number portability and thus facilitates competition in the provision of 800 services. The entire national 800 database, through which the 800 service provider selected by the customer is identified, is managed by a single entity. However, the only way to assure that control of the 800 database does not provide its manager with any competitive edge in the provision of 800 service would be to require that the 800 database management entity be a fully disinterested party, totally isolated from and independent of all providers of any 800 services.

87. *See*, e.g., Park, Rolla E., *Incremental Costs and Efficient Prices with Lumpy Capacity*, Santa Monica, CA: The Rand Corporation, Publication number R-3723-ICTF, June 1989. Park notes (at 1): "Economists have long argued on efficiency grounds that public utility prices should be based on forward-looking incremental costs rather than on historical accounting costs. ... The question becomes more difficult and the answer more complicated when capacity comes in large lumps, as it frequently does in the telephone industry and other public utilities. ... With lumpy capacity, a one unit change in output may result in little or no change in cost most of the time, but the same change will result in a very large jump in cost if it requires the installation of an expensive new lump of capacity. Thus marginal capacity cost may be zero, or it may be very large, and the first best price will not necessarily equal either value."

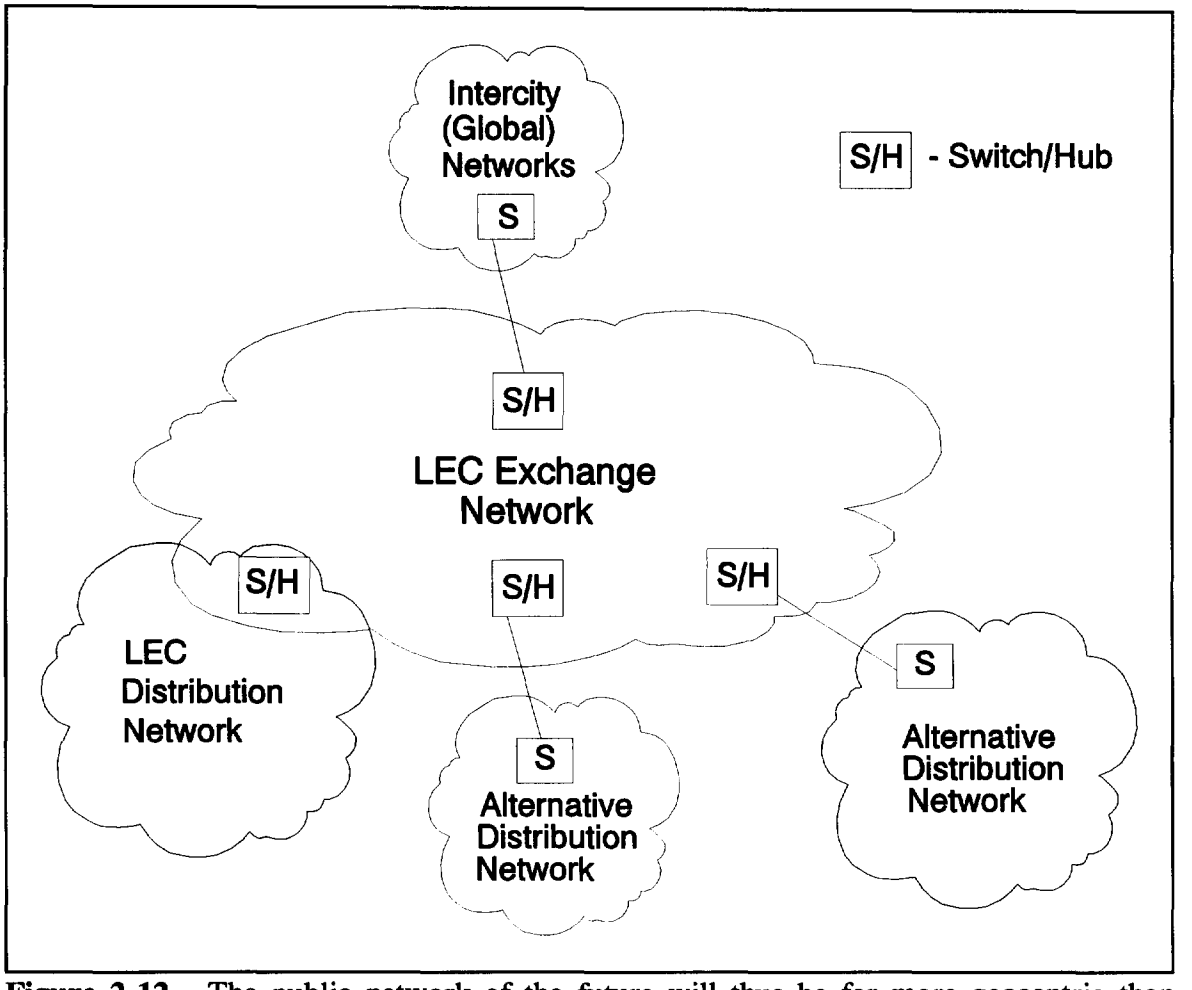

Figure 2.12. The public network of the future will thus be far more geocentric than geodesic

sential bottleneck facilities may grow, not diminish, in the future, and the risk of BOC monopolization of the growing number of adjacent markets that rely upon BOC essential facilities is distinctly greater now than at any time since the break-up of the Bell System.

Pervasive network externalities render many telecommunications markets highly subject to bottleneck control by the LECs.

Huber's "geodesic" construct is advanced to buttress efforts by the BOCs to apply the theory of market contestability to the telecommunications industry. If true, the highly interconnected architecture of a geodesic network would minimize, perhaps even eliminate, the presence and importance of externalities of both demand and supply that have traditionally acted to limit the extent to which market competition can realistically be expected to arise in this sector. There would be no such thing as an "essential facility" in the geodesic network that Huber and the BOCs seek to portray. As we have shown, however, the

geodesic analogy is fundamentally flawed, and externalities are both present and pervasive. In this section, we consider their source and impact, and show that by their existence these externalities render many telecommunications market segments highly subject to bottleneck control by the LECs.

Traditional microeconomic theory adopts a one-dimensional view of the supply function and hence of the presence and sources of economies of scale. In general, average and marginal costs are expressed as a function of quantity of output; where fixed costs are present, average cost tends to fall as output grows, up to the point where congestion or other constraints on individual inputs causes marginal cost to rise. This classic model does not typically consider interactions among consumers of the firm's output, nor does it address interactions between the quantity supplied and the demand that is presented.

The classic model cannot, however, be applied in industries where the production activity involves some form of exchange or connectivity operation among individual consumers. This is because there is a direct linkage between the scale of the production process (expressed in terms of the number of entities having access to the switching mechanism) and the demand for the product or service being offered. Recall our earlier discussion of the switching function that is performed at an airline hub. The more flights into a hub city, the greater will be the demand for seats on flights leaving the hub; conversely the more choices of destinations that are offered out of a hub, the greater will be the demand for seats on flights into the hub. The demand for seats on a US Air flight from Boston to Pittsburgh is thus influenced by the demand for transportation to Pittsburgh, as well as by the demand for travel from Boston to all of the destinations available out of the Pittsburgh hub. Similarly, in a telecommunications network, the demand for access to that network is influenced by the total number of other customers who are connected to the network and who can thus be contacted over the network. There is thus a strong *interdependence* between supply (the scale of the network) and demand for network services. Two separate, but not unrelated, processes are thus taking place as total connectivity in a network increases: First, the increased volume of business (output) results in decreasing average unit costs, as the fixed costs of providing the network service are spread over a larger quantity of output. (In our airline analogy, higher occupancy rates on each flight are achieved, thereby reducing the average cost per passenger-mile of output produced.) Second, the increased connectivity offers each potential participant in the network increased opportunity to establish a connection through the network; all other things being equal, if given a choice with respect to network access, a customer would tend to select the network that offers connectivity to the largest population of other customers, thereby increasing each customer's opportunity to utilize the network.

Modern economic theory supports the view that where an interconnection or exchange function is a primary element of an industry's production activity, one principal firm will tend to dominate the market in a given geographic area, subject to the onset of "congestion" and/or of high transportation costs. Appendix 1 discusses this issue in greater detail,

and demonstrates that it renders notions of market contestability fundamentally inapplicable to such markets. Even if competition develops for a number of (but less than all) functions now provided by the LECs, as well it may, only the incumbent LEC, by virtue of its historic dominance and extensive infrastructure, will necessarily remain involved in effecting connectivity even where another carrier is the primary provider of access for an individual customer. Thus, the new entrants to the local market — and their customers — will continue to be dependent upon the LECs for ubiquitous interconnection.

Telecommunications services rely, to a degree probably unmatched in any other industry, on the need to provide ubiquity. Thus, connectivity is key to control of the market. The exchange function that is performed by local telephone companies involves demand and supply externalities similar to those found in other network-based industries. Telecommunications services involve the connection of two or more geographically separate points, and usually separate individuals or organizations. Even if effective competition develops for *access* and other local public network services, the strategic points of connectivity will remain essentially monopolistic. In this respect, the market for these potentially competitive services must necessarily be viewed as "adjacent" with respect to the LEC network exchange operations. Unless the entities that control strategic connectivity (the LECs) are prevented from extending their exchange monopoly into the adjacent markets, these other services will remain monopolistic as well. While unrestricted and fully "equal" interconnection is clearly a necessary prerequisite to virtually any local competition, by itself it may still be insufficient to prevent the BOCs from monopolizing the adjacent markets.

2.7 "Substantial possibility" of BOC monopolization of adjacent markets results from BOC control of essential facilities

The standard adopted for *MFJ* line of business relief is a showing that there is no substantial possibility that BOCs, if permitted entry, could impede competition in these adjacent markets.[88] The BOCs, in turn, have sought to portray these markets as robustly competitive[89] such that BOC dominance would not be possible even if entry were allowed. These depictions do not, of course, address the condition that would arise *once the BOCs are given financial and business incentives to compete directly in these markets with incumbents that require BOC essential facilities*. For the answer to that question, one must look to past performance under comparable conditions and to the remedial steps that were required to protect adjacent markets. As we have shown here, past experience teaches that

88. *MFJ*, Section VIII (C).

89. Affidavit of Jerry A. Hausman, *US vs. Western Electric Company, Inc., and American Telephone and Telegraph Company*, CA 82-0192, August 17, 1990, at 4, para.7 and at 21, para.43.

where permitted to do so BOCs will use their control of essential facilities to seek to dominate and monopolize adjacent markets, and that the only truly effective solution was divestiture. Each of the seven regions is essentially in the same position today as the consolidated Bell System was at the time of the break-up: They compete with and supply essential services to firms in adjacent markets in which natural monopoly conditions may not prevail and where effective competition may be achievable. Divestiture and exclusion from such adjacent markets was the correct solution in 1982, and it is still the correct solution today.

Rather than rescind existing *MFJ* restrictions as monopoly boundaries shift, policy-makers should consider the appropriateness of establishing several additional structural safeguards (e.g., fully separate subsidiaries) whose effect would be to separate and isolate the core BOC connectivity monopoly from those segments in which competing technologies and suppliers offer the best hope for a robust, efficient and innovative US telecommunications industry for the information age.

Appendix 2 | THE THEORY OF "CLUB GOODS" AND NETWORK EXTERNALITIES

Introduction

For most goods and services, the benefit derived or utility gained from consumption exists independently of the extent to which the product is utilized by others. Thus, the nourishment provided by an individual's consumption of a given quantity and type of food does not depend upon the amount of that food consumed by others. There are, however, certain goods and services for which the utility (benefit) that a user derives from consumption is in part or (in some special cases) in its entirety depending upon consumption of the product by others. This is particularly true for many — perhaps most — telecommunications products and services which, by their very nature, necessarily involve at least two, and sometimes many, individual participants. For example, the usefulness of a fax machine is directly related to the quantity of fax machines in use by others: The more fax machines there are in the world, the more opportunity each owner of a fax machine has to communicate with others using this medium.

When consumption of a product by others affects the benefits derived from — and hence the demand for — a good or service by an individual consumer, the product is said to be subject to *externalities*. Certain types of externalities are probably common to most products because, up to a point at least, the average cost of production is affected by the total quantity produced. Thus, as demand for a product or service grows, the unit cost of its production tends to decrease, which (in competitive markets) should result in lower prices which, for most products, should stimulate increased consumption. Such *supply externalities* are thus present in many fields; they are particularly pronounced in the case of telecommunications network services due to the presence of large capacity plant, high fixed costs, and low variable costs. The existence of substantial supply externalities in decreasing cost industries in fact provides one of the central rationales for "natural monopoly" treatment of public utilities. What is unique to telecommunications — as well as to other "network" industries — is the presence of substantial *demand externalities* that directly affect the value of the service to individual consumers. Demand or "consumption" externalities are generated through the effect of the number of purchasers on the quality or utility of the product as perceived by all consumers. The utility that a consumer derives from connection to a network depends on the number of other consumers that have access to that network.

The effects of externalities on demand, supply and market structure is the focus of "club good" and "network externality" theory, which can be used to analyze the optimum number of providers of an impure public good that provides positive consumption externalities to its consumers. In the case of a network, the benefit to the consumer of membership in the network ("club"), that is, the utility of the right to access the network, increases as the number of members (users of the network) increases. This increase in utility is generated by consumers' demand for the good, as opposed to the more common supply side externalities generated by increasing returns to scale.[90] The purpose of this Appendix is to provide a brief overview of club good and network externality theory and its application and importance to the analysis of telecommunications markets.

Lexicon

At the outset, it will be useful to define certain concepts and terms. A good exhibits *nonrivalry in consumption*, or *indivisibility of benefits* when a unit of the good can be consumed by one individual without detracting from the consumption opportunities still available to others from that same unit. Some examples of goods that are nonrival are national defense, disease-eradication programs, and pollution-control devices. In contrast, rivalry in consumption or perfect divisibility is exhibited by food, clothing and fuel. Once a unit of these goods is consumed, no further benefits can be obtained from that unit. Fixed capital resources, such as telecommunications networks, likely fall somewhere in between these "pure" cases: Use of high-capacity network services is essentially nonrival until the volume of traffic grows to a point where congestion becomes a factor. Also, at least some of the benefits of a telecommunications network are indivisible, in that the existence of the network as a national or community resource provides broad benefits both to users as well as nonusers.[91]

Goods whose benefits can be withheld costlessly by the owner or provider exhibit *excludability of benefits*. Benefits that are available to all once the good is provided are termed nonexcludable. Firework displays, national defense, radio signals, and pollution-control devices exhibit nonexcludability. Homes, automobiles and clothing all yield excludable benefits whenever property rights are protected by law enforcement authorities.

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90. Network-based industries also exhibit unique supply externalities that arise directly from the extent of connectivity. For example, supply externalities account for much of the airline "hubbing" effect discussed in Chapter 2. Similar supply externalities are also present in telecommunications networks which, when combined with the pervasive consumption externalities serve to *magnify* the monopoly character of the network connectivity (switching) function.

91. Nonusers will still benefit from the existence of a telecommunications network because other economic, government and social activities and functions are facilitated.

Access to most over-the-air broadcast telecommunications services is, in general, nonexcludable; access to most other types of telecommunications is excludable.

These two characteristics define the spectrum between *pure public goods*, which are both nonrival and nonexcludable, to *pure private goods*, which are both rival and excludable. Between these two poles are *impure public goods* whose benefits are partially rival and/or excludable. Partially rival refers to the potential for congestion in consumption of the good. For example, use of a national forest is nonrival up to a point where congestion with other consumers will diminish the benefits realized by individuals. The public switched telephone network can be characterized as a partially rival, excludable public good.

Private sector markets fail to assign sufficient resources to the provision of public goods that yield positive externalities. In general, *externalities* can be defined as "[a]n external economy (diseconomy) ... which confers an appreciable benefit (inflicts an appreciable damage) on some person or persons who were not fully consenting parties in reaching the decision or decisions which led directly or indirectly to the event in question."[92]

Club goods are a special case of impure public goods whose benefits are excludable, but partially nonrival.

Club Goods

A "club" is a voluntary group deriving mutual benefit from sharing one or more of the following: production costs, the members' characteristics, or a good characterized by excludable benefits. Clubs must be voluntary because the utility jointly derived from membership and the consumption of other goods must exceed the utility associated with nonmembership status. Sharing leads to partial rivalry of benefits as larger membership leads to crowding, causing a detraction in the quality of services received. Crowding, or congestion, depends on some measure of utilization, which could include the number of members, the number of visits, or a measure of average utilization. A club does not require mutual ownership by its members. Thus, all readers of a particular newspaper, or subscribers for local exchange telephone service, each constitute a club for purposes of this analysis.

As membership size expands, both costs and benefits arise: Costs involve increased congestion, while benefits result from cost reductions owing to the sharing of provision

92. J. E. Meade (1973), *The Theory of Economic Externalities. The Control of Environmental Pollution and Similar Social Costs*, Sijhoff (Leiden, Sweden).

expense associated with the club good. By adding a cost offset to the benefits derived from expanding membership size, crowding leads to finite memberships, which distinguishes club goods from pure public goods. For pure public goods which are "nonrival" by definition, crowding costs are zero, hence the optimal sharing size for a pure public good includes the entire population.

The right to access the public switched telecommunications network can be characterized as membership in a club. As subscribership increases, both costs and benefits are affected. Benefits increase due to the division of fixed costs among a larger membership, resulting in increasing returns to scale from expanding production, as well as through the increased opportunities to communicate with a larger population of users. Unit costs decrease (as fixed costs are shared across a larger population of consumers) but may eventually increase from deterioration of quality of service due to increased congestion of the network. However, the potential for congestion at switching nodes and transport links has decreased significantly as technological advances in digital switching and transmission have provided dramatically increased capacities in these network elements.

Clubs must have an exclusion mechanism whereby users' rates of utilization can be monitored and nonmembers and/or nonpayers can be barred. Without such a mechanism, there would be no incentive for members to join and pay dues or fees. The cost of the exclusion mechanism must be less than the benefits gained from allocating the good within a club arrangement. While public network services are offered to all who request them, the presence of installation, monthly and usage-based fees excludes nonpayers from membership.

Since exclusion is practiced, members with privileges must be distinguished from nonmembers. The provision quantity of the shared good must be determined. Insofar as the membership decision affects the provision choice and vice versa, neither can be determined independently. For pure public goods, however, only the provision decision need be considered, since pure public goods are by their nature nonexcludable and the membership is the entire population.

A model of clubs derives both membership and provision decisions simultaneously. Several characteristics defining the nature of a club can be used to develop a taxonomy of clubs. A homogeneous club includes members whose tastes and endowments are identical. If either tastes or endowments differ, the club is heterogenous or mixed. The entire analysis of homogenous clubs can be carried out in terms of a representative member since everyone has identical preferences. Other characteristics include whether utilization is fixed or variable, and whether the population is partitioned.[93] For fixed-utilization clubs, all members are assumed to use the entire supply of the shared good. If utilization is

93. For discussion of the taxonomy of club goods, see Berglas, Helpman and Pines (1982), p. 345.

variable, some kind of visitation rate is involved. Partitioning of the population is when every member belongs to some club sharing that good, and no member belongs to two different clubs providing the same good. When the population is not partitioned, club and non-club members must be distinguished whenever Pareto-optimal conditions[94] are derived. In that case, a "total economy" viewpoint is taken, since what goes on outside the club is also relevant when optimal behavior is being determined.

The effect of consumption externalities on competition and the form of the market equilibrium can be examined by incorporating the notion of rational or fulfilled expectations equilibrium. Consumers must form expectations regarding the size of competing networks when network externalities exist. Consumption externalities give rise to demand-side economies of scale, which will vary with consumer expectations. For some sets of expectations only one firm will produce output, while for other sets of expectations there will be several firms in the market. These equilibria verify the following intuition: if consumers expect a seller to be dominant, then consumers will be willing to pay more for the firm's product, and it will, in fact, be dominant.[95]

A game theory formulation of club goods allows for determination of the optimum number of clubs, that is, the optimum partition of the population into a system of non-overlapping clubs. The stability of clubs can also be examined with game theory, in which the membership composition and payoffs can be related to the core of the game. In a stable system of clubs, the membership composition remains fixed, since reshuffling between clubs does not improve an individual's net benefits. Game theory also allows examination of the institutional forms which can account for transaction costs. By placing bounds on the extent of discrimination of payoffs between members, game theory can be related to the differentiation between membership subgroups. Cost allocation schemes can be elucidated with game theory, allowing analysis of clubs deriving their benefits from cost sharing, as in the case of goods whose production is characterized by increasing returns to scale.[96]

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94. A position is said to be a Pareto optimum if it is impossible to improve the well-being of one individual without harming at least one other individual. To derive a Pareto optimum position, one individual's utility is maximized, subject to the constancy of the utility levels of the other individuals and subject to the relevant resource constraints.

95. Michael L. Katz and Carl Shapiro (1985), "Network Externalities, Competition, and Compatibility," *American Economic Review*, 75, p. 425.

96. For cost allocation schemes, see Gately (1974), Loehman and Winston (1976), Hamlen, Hamlen, and Tschirhart (1977, 1980), Loehman et al. (1979), Sorenson, Tshirhart, and Whinston, (1978a, 1978b), and Suzuki and Nakayama (1976).

Theory: The basic model of a homogeneous club with fixed utilization rates[97]

In the basic model we assume the existence of two goods: a private good (y) and a club good (x). The homogeneous members possess the same tastes and endowments. A representative member's taste is represented by a utility function,

$$U^i = U^i (y^i, X, s),$$

where y^i = *i^{th} member's consumption of the private good*
X = *i^{th} member's consumption of the club good*
s = *membership size.*

Since the utilization rate is the same for each member, we have

$$x^i = X$$

for all members, where x is a member's utilization rate of the facility and X is the size of the club facility. Each member is viewed as using what is available. The marginal utility derived from additional members may be positive for small memberships owing to camaraderie, but eventually crowding occurs and marginal utility becomes negative. Congestion therefore results in a decrease in utility as membership size expands beyond some point. The existence of both a costless exclusion mechanism and congestion implies that the club good is not a pure public good in the Samuelsonian sense, even though club provision is consumed equally by all members.

Each member attempts to maximize utility subject to a resource constraint,

$$F^i (y^i, X, s) = 0.$$

This resource or budget constraint depends on the two goods used and the overall club membership size. An increase in consumption of either good raises the total cost to the individual. However, since everyone is identical in this example, and since club costs are

97. The presentation of this model is from Cornes and Sandler (1986), pp. 164-7.

equally shared among members, an increase in *membership* (accompanied by a proportionate increase in total consumption) reduces average resource expenditures for each member. In other words, each member must pick up a smaller share of the club's total costs as membership expands and other things are constant.

The representative member maximizes utility subject to the budget constraint above. The following first order conditions result from the maximization:

$$MRS^i_{Xy} = MRT^i_{Xy} \quad i = 1,\ldots, s \qquad (Provision)$$
$$MRS^i_{sy} = MRT^i_{sy} \quad i = 1,\ldots, s \qquad (Membership)$$

The first condition is the provision condition, which indicates that for each member the marginal rate of substitution (MRS) between the club good and the private good must be equated to the marginal rate of transformation (MRT) between these two goods. Thus, for the club good, members equate their marginal benefit with their marginal cost. If, at the margin, the club is breaking-even in providing the public good, the sum of the members' marginal cost (or payments) must equal the club's marginal cost of provision. In the basic model, the provision condition of the club good does not differ significantly from that of a pure public good, except in terms of the number of individuals and the interaction between the provision and membership condition. In a case such as a modern local telecommunications network, where substantial consumption externalities are present and congestion even at high levels of penetration is relatively low, the similarity with club goods is quite strong.

The novel aspect of club analysis shows up in the membership condition. For "within-club" optimality, a representative member equates the MRS between group size and the private good, thereby achieving an equality between the marginal benefits and marginal costs of having another club member. These marginal benefits are normally negative owing to crowding, and the corresponding marginal costs are negative owing to cost reductions derived from sharing. However, for telecommunications networks, where congestion is typically not an important factor, marginal benefits of increased membership will almost always be positive.

In the basic model, utility is maximized for the representative member; that is, the average net benefits are maximized. This within-club viewpoint ignores nonmembers.