Appendix B

Sample Costs of Transmission Systems

Costs for distance learning transmission systems vary widely depending on system design and complexity, range and scope, capacity, large volume purchase agreements, and lease v. buy options. In general, the declining costs of electronic components have made telecommunications equipment more affordable. Continued declines in prices are expected.

Costs can be divided into two basic categories, initial costs including transmitting and receiving equipment, and continuing costs such as programming and operation. Not all schools will face all these costs. Some schools cart take advantage of existing telecommunications resources to cut costs, while other schools may have to build a completely new transmission system. Schools sharing existing teaching resources and using local facilities may have low programming costs, while schools receiving programming from outside providers will face higher expenditures. Finally, costs can differ greatly between those who only receive programming and those who originate and transmit it. In a satellite system, for example, production and transmission facilities can cost millions of dollars. Costs to the local schools, however, are much lower, several thousand dollars for hardware, $5,000 to 10,000 for subscription and tuition fees, and any local personnel costs.

The costs described below are only sample costs for basic systems. These costs, therefore, should serve as only a rough guide to distance education transmission costs.

Instructional Television Fixed Service (ITFS)

ITFS is a relatively low-cost way of delivering one-way video to multiple remote sites.

Transmit Sites

200 ft. transmitting tower $50,000
transmitter (one for each channel) $15,000-20,000
transmitting antenna $10,000-15,000
miscellaneous electronics $10,000

(A rough figure for a transmit site is $60,000, not including the tower)

Receive Sites

receive antenna and tower . . . . $3,000-$50,000
(costs are based on the height of tower needed for reception; higher towers cost more)
downconverters and electronics ... ...$350-$3,000
ITFS voice response system $2,500-5,000

Operating costs for ITFS are minimal compared to other broadcast technologies. For example, the system run by WHRO in Norfolk, Virginia, consists of one hub location and seven repeater stations broadcasting four channels of ITFS. The annual operating cost, including salaries for personnel and technical support, is $213,000. The average cost per hour of transmission is $45.[1]

Satellite

Transmission Costs

A complete uplink facility, including studio and all electronics, can cost between $500,000 and $1 million. Some providers have their own facilities, while others lease. Added costs associated with uplink facilities include operating and personnel costs, and the cost of getting the signal from the originating site to the uplink.

Transmission time for satellite delivery is based on the time and capacity desired. The cost of satellite transmission is distance insensitive. Unlike the telephone system, which charges by the mile, satellites reach anywhere in their footprint with no higher cost to transmit 2,000 miles than for 200. Type of satellite (C- or Ku-band) and time of day (prime or nonprime time) also affect the cost of transponder time. Lower rates are frequently available for those users willing to commit to long-term contracts or minimum numbers of hours per year. C-band time ranges from under $200 per hour up to almost $500. Ku-band prices also start under $200 and range up to $600 per hour.

Pricing can be flexible, allowing users to lease only the capacity or amount of time they need. A full transponder leased 24 hours per day can cost $170,000 per month, while leasing only a portion of the transponder can cost as little as $5,200 per month. Most educational users buy time on an "occasional use" basis, meaning that they buy a full transponder, but for only a certain number of hours per day.

Receive Site Costs

Satellite downlinks cost from $800to$18,000 depending on the type (C or Ku) and features required. Some factors affecting cost include: voice, data, and video capabilities; receive only or send/receive; and local site requirements including fencing around the dish and cabling to connect the dish to the user premises. Steerable dishes, which allow users to aim at many satellites, cost three or four times as much as fixed dishes, which remain aimed at a particular satellite.

C-band receive-only downlinks , ... $5,000-$10,000
Ku-band receive-only downlinks . . . .$800-$5,000
C/Ku-band receive-only downlinks $8,000

[1]Richard Daly, Narrowcast Services Manager, WHRO Norfolk, VA, personal communication, Apr. 25, 1989.

In some cases, schools can obtain volume discounts through a State-arranged contract or through arrangements made by programming providers.[2]

Programming Costs

Subscription rates are another (ongoing) cost associated with satellite delivery of educational services from multistate providers. For example, an annual subscription to TI-IN is $5,050, courses cost **$240 per student per** semester (with $50 for additional students over a set limit), and staff development costs between $2,200 to $8,000 per year depending on district size.

Cable

Basic cable television connections for schools are often provided free to schools as part of the local cable franchise agreement. A single cable drop, however, often reaches only one location in a school. Complete internal wiring for cable reception can be very expensive. The Dallas Independent School District is in the process of wiring all classrooms in 235 schools with both cable and telephone (data communication) lines at a cost of $3.8 million. When completed, the system will deliver 30 cable television channels to each classroom. The system will also make four video return channels available, and allow two-way data transmission for administration and computer networking.[3]

The initial cost for an interactive cable system depends on how much work is required to add two-way capability to the system. Additional equipment needed to bring the signal back upstream will increase costs.

Initial Costs

coaxial cable installation . . . $18,000-$25,000 per mile[4]
modulators , ., ... , ... , , , , . $500-$2,000
demodulators . . . . $2,000-$4,000
reverse flow amplifiers . . . . $3,500[5]
(for two-way capability)

Ongoing or operational costs also vary, There are no transmission costs in systems that use the public or an institutional cable system. Maintenance budgets average between 2 and 5 percent of system cost, but will likely increase as the system ages.

Microwave

Since each site in a point-to-point microwave system is both a transmit and a receive site, the cost of installing and operating a microwave system can be relatively high. Duplex microwave systems cost between $40,000 and $65,000 per channel, including transmitters, receivers, and all electronics. Adding additional channels can cost almost as much.[6]

Microwave towers vary widely in cost. One New York State study identifies costs ranging between $100,000 and $150,000 each.[7] Others report costs for short-haul towers at $5,000 to $50,000, and longer spans requiring bigger towers range from $25,000 to $75,000 each.[8] However, tower costs could be reduced or eliminated by using existing towers or placing multiple antennas on a single tower. Insurance, maintenance, and repairs can average between 3 and 5 percent of system cost per year.[9]

Public Switched Telephone Network (PSTN)

Start-up costs for using PSTN to deliver distance education cart be very low. All that most users will have to pay are usage, access charges, and installation. However, line termination charges for each site can run into thousands of dollars, and installation charges can be very high if many of the school's classrooms have to be wired.[10] (See the example of the Dallas Independent School District in the Cable Cost Section.) The telephone company bears the cost for all equipment outside the school, including most upgrades, maintenance, and repair, as well as the transmission hardware.

Transmission costs on PSTN depend on the length and duration of the call and the type of line used. Local telephone transmission costs also vary from State to State, and can add a significant amount to ongoing system costs,[11] In Texas, for example, terrestrial voice/data (56 kbps) costs public institutions 52 cents per mile per month. For the higher capacity T1 lines (1.544 Mbps),

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[2] For example, a complete receive site for the Missouri Educational Satellite Network costs $8,000 which includes: dual frequency antenna, receiver, data controller, VCR, color monitor, printer, equipment rack, and speaker phone. Maintenance is offered for $300 per year.

[3] Diana Radspinner, coordinator of cable communications, Dallas Independent School District, personal communication, Aug. 16, 1989.

[4] Robert Luff, vice president for technology, Jones Intercable, personal Communication, August 1989.

[5] Richard Labrie, executive director, South Berkshire Education Collaborative, personal communication, May 5, 1989.

[6] Jack Beck, WHRO, Norfolk, VA, personal communication, Apr. 10, 1989; Karen Kitchen and Will Kitchen, Two-w@' *Interactive Television for Distance Learning- A Primer* (Alexandria, VA: Nationat School Boards Association, May 1988). p. 19; Linda Lloyd, "Telecommunications and Distance Learning: Trends in the U.S.," paper presented to the American Educational Research Association 1988 Annual Meeting, Apr. 5-9, 1988, *New* Orleans, LA.

[7] New York State Legislative Commission on science and Technology, *Distance Learning: The Sky's the Limit* (Albany NY: August 1988), p. 11.

[8] Kitchen and Kitchen, op. cit., footnote 6, p. 19.

[9] Ibid.; New York State Legislative Commission on Science and Technology, Op. cit., footnote 7, P. 11.

[10] The Telecommunication Technical Advisory Committee, "A Report to the Texas Higher Education Coordinating Board," unpublished document, November 1988, p. 5.

[11] E. Kent Ellerston, "Report on Distance Learning: A National Effectiveness Survey," prepared for the Pennsylvania Teleteaching Project, December 1987, p. 9.

which can carry limited (compressed) motion video, the cost is $12.49 per mile per month. Long distance charges will increase costs significantly.

Distance learning systems requiring simultaneous communication among multiple sites may need an audio or data bridge. These bridges can either be purchased ($1,000 to $2,000 per port--each port represents one line per user that can access the bridge), or rented through services such as AT&T's Alliance Teleconferencing Service, which charges 25 cents per port per minute. On this system, for example, a three-way l-hour call would cost $45.

Fiber Optics

The cost of constructing a fiber optic system is relatively high, but is expected to decrease rapidly as electronics and cable costs decline. The cost of fiber cabling is widely expected to fall below that of coaxial or copper cabling by the early 1990s.[12] The cost to connect an individual household or school to the public network is approximately $1,200 for copper and $1,500 for fiber for new construction.[13] In general, the price of electronics is steadily declining,[14] and the cost of fiber optic technology should continue to drop as economies of scale are realized.[15]

analog transmitters and receivers $12,000
repeaters (spacing varies) $24,000
laser modulators $2,000-3000
coders/decoders (codecs) $8,000-60,000
(depending on capability)

Additional termination equipment at each site can cost up to $45,000.[16]

Sample Fiber Optic Contract Agreements[17]

Northwest *Education Technology Cooperative*
lo-year lease with a national telephone company
lo-year renewal period option
70-mile network
$28/mile/month lease rate includes al1 maintenance
2 dark (unused) fibers
Schools own terminal equipment
Prohibited from T-1 and bypass use

Pottowattomie County, Oklahoma
5-year lease with the local telephone company and renewal periods of *5 years* thereafter based on maintenance expense and rate of return regulation
18-mile network
$70/mile/month including most maintenance
2 dark fibers
Schools own terminal equipment
Prohibited from T-1 and bypass use

Girard, Kansas
15-year lease with local telephone company with 15-year renewal
60-mile network
$38/mile/month includes maintenance
2 dark fibers
Schools own terminal equipment
Prohibited from T-1 and bypass use

Dodge Center, Minnesota
7-year lease with a national telephone company and annual renewal period
60+ mile network (not complete)
$53/mile/month including all maintenance
2 dark fibers
Schools own terminal equipment
Prohibited from T-1 and bypass use

Big Fork, Minnesota
Direct ownership with four local telephone companies and one long distance carrier
134-mile network
$8,955 per mile including some maintenance
2 dark fibers
Schools own terminal equipment
Prohibited from bypass use

Computer-Based Applications

Compared to other technologies used for distance learning, computer-based systems can have relatively low start-up costs.

personal computers ... ...$1,200-$5,000
modems $300
graphics tablets $400
scanners $1,500
printers $300-2000
software for communication/
audiographics $0-3,500

Total costs per site are under $10,000.

[12] U.S. Department of Commerce, National Telecommunications and Information Administration, NT/A *Telecom 2000* (Washington, DC: U.S. Government Printing Office, October 1988). p. 76.

[13] Robert M. Pepper, *Through the Looking Glass: Integrated Broadband Networks, Regulatory Policy and Institutional Change* (Washington DC: Federal Communications Commission, November 1988). p. 8.

[14] National Telecommunications and Information Administration, op. cit., footnote 12, p. 220.

[15] "In a report on fiber deployment released in January of 1988, the Federal Communications Commission noted that a 50 percent decrease in the cost of electronics is typical, and that fiber itself has declined in price by approximately 50 percent over the past six or seven years." Andrew C. Barrett, "The Potential of Fiber Optics to the Home: A Regulator's Perspective.'' Public *Utilities Fortnightly*, Jan. 19, 1989, p. 15.

[16] Kitchen and Kitchen, op. cit., footnote 6, pp. 20-21.

[17] The following examples were provided by Dennis Pellant, executive vice president, Tele-Systems Associates, Inc., Bloomington, MN.

Transmission costs associated with computer conferencing and audiographic systems are the costs of using the public telephone system. (See the cost section on PSTN). The costs of wiring all classrooms with data connections (telephone jacks) can be high, especially for schools having to wire existing classrooms. Packet radio modems may help schools avoid some of this cost.[18] Wiring done at the time the building is constructed is less expensive. Installation charges will depend on the arrangements made with the service provider (the telephone company, cable, or other independent contractor).

18A device has been developed using packet radio technology, which essentially functions as a wireless/radio modem allowing computers in any part of the school building to access outside phone lines with out being physically connected to them. The modem at each computer wirelessly communicates with another radio modem that is connected physically to one of the school's telephone jacks, thus allowing communication anywhere in the school building without the necessity of expensive wiring. Each unit (two are required, just as with traditional modems) may cost $600.