Telecommunications in Alaskan Villages

Alex Hills and M. Granger Morgan

Summary. A recently installed satellite system now provides modern long-distance telecommunication services to 100 rural Alaskan villages, most of whose residents are Alaska Natives. In most villages no local telephone or television distribution facilities have yet been installed. Local telephone exchange service appears to be economically marginal unless modest regulatory changes are made. Television delivery presents more difficult problems involving technical and organizational structure. If, after weighing the potential social and cultural effects, village residents elect to acquire television, a delivery system based on low-power transmitters in the villages, local government as the basic organizational and economic unit, and a statewide nonprofit service organization, is the feasible system best suited to village needs.

A telephone in the home and good radio and television reception are commonplace in the lives of most Americans, but such a complement of modern telecommunication services is still not available to most of the approximately 35,000 residents of Alaska's villages. During the last 5 years satellite communication links have been installed to serve 100 (Fig. 1), or approximately half, of these villages (*1*). However, the availability of an earth station and the long-distance communication services it can provide neither ensures local telecommunication services nor determines the way in which they will evolve. This evolution depends upon a complex mixture of technical, economic, organizational, and political factors.

We can loosely define an Alaskan village as a rural community with a population of less than 1000 people, the majority of them "Alaska Natives," a generic term used to refer to several racially and culturally distinct groups which occupy different regions within the state. There are enormous variations in natural environments across these regions, and the traditional life-styles that Alaska Natives have evolved reflect this great diversity. These traditional lifestyles still exist, but they have been much affected during this century by the technology and culture of modern America. A cash economy has developed in parallel with the traditional village subsistence economies. Some villagers hold part-time or full-time cash jobs. Many cannot find such jobs. Public assistance programs provide an additional source of cash. Most village residents strive to attain the best from both the cash and the subsistence economies.

Village residents want modern telecommunication services. Though small in numbers, villagers are a strong political force within Alaska, and Alaska Natives command significant political influence at the federal level. Many Alaskans, both urban and rural, see village telecommunications as an important tool in the economic, political, and social development of the state. But with limited cash resources, limited skilled manpower, diverse cultural perspectives, and hostile climatic conditions, Alaskan villages present difficult technical, economic, and institutional challenges to telecommunication planners, engineers, and policy-makers.

Most villages are served by AM radio. In 1970 the Alaska state legislature created what is now the Alaska Public Broadcasting Commission (APBC), to facilitate the provision of broadcasting services not available from commercial stations. The APBC stations are owned and operated by local nonprofit corporations but are supported largely by state grants dispersed through the APBC, which verifies that minimum technical and operational standards are met but does not interfere in programming.

Telephone and television services are far less developed. For a number of reasons the telephone and television problems are quite different. First, most Americans view low-cost telephone service as something verging on a right but are still content to let economic cost and ability to pay be the primary determinants of access to television. Second, the "best" technical solution for service delivery in Alaskan villages is fairly clear for telephone, far less clear for television. Third, there are important differences in the institutional structures that are needed to support the delivery of the two different services.

State of Alaska Satellite Project

Alaska's long-distance telephone facilities were operated, until 1971, by the Alaska Communications System (ACS), an arm of the U.S. Air Force. In most cases villages were served by a series of high-frequency (HF) "land radio" stations. This system was often unreliable because of ionospheric disturbances common in the auroral zone. During the late 1960's the ACS experimented with a very-high-frequency (VHF) radio system. A single VHF mobile telephone was installed in each of several villages on the Seward Peninsula. Problems from auroral disturbance were largely overcome, but some reliability problems persisted because of equipment difficulties. In 1971 the ACS was purchased by RCA Alaska Communications (RCA Alascom), a subsidiary of the Radio Corporation of America. As a condition of its certification by the Alaska Public Utilities Commission (APUC), RCA Alascom promised to provide telephone service by 1973 to 142 villages that had none in 1970 (*2*, *3*). RCA chose to do this by expanding the ACS pilot project. The project quickly fell behind schedule and eventually overran its budget. RCA encountered a variety of difficulties including hindrances by weather, unreliable electric power, employee problems in coping with village conditions, and villagers' lack of sophistication in dealing with the new system.

During 1974 and 1975 these problems became a subject of growing concern to APUC, the Alaska Office of Telecommunications (OT), and the Alaska state legislature. During the same period it became evident that satellite communication technology offered a more effective

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means of providing village services. OT applied pressure to RCA to revise its plans for the rural areas, using the new satellite technology. At first RCA refused. Later it proposed systems that OT considered unacceptable.

Eventually, at the request of OT, the legislature appropriated $5 million in 1975 for the construction of small satellite earth stations in 100 Alaskan villages. At that time it was envisioned that the state would be the sole owner and operator of the earth stations, but RCA was later given the opportunity to become a partner in the project. The company accepted, and under the joint venture arrangement the state purchased the earth station equipment and RCA handled installation, operation, and maintenance. Ownership of the earth stations has been held in trust by the Federal Communications Commission (FCC), which is now in the process of deciding ultimate ownership.

Installation has been completed in all 100 villages (Fig. 1). Only one telephone was installed in each village, to be shared by the residents. In addition, a "push to talk" circuit was provided to the village health aide for communication with doctors and other hospital personnel. Village earth stations can also be used, with some modification, to receive television signals. This is being done in a number of villages (*4*, *5*). Furthermore, the earth stations can be modified to provide two or more telephone circuits, making local exchange service possible.

In 1979 RCA sold RCA Alascom. It

Table 1. Company-wide data on operating expenses and revenues for eight telephone companies that serve only small Alaskan communities. [Data from (*10*) and (*11*)]

Company	Communities served	Number of main stations		Annual expenses and revenues per main station				Company's share of collected tolls (%) 1976
		1976	1977	Operating expenses (dollars) 1977	Local service revenue (dollars) 1977	Total toll revenue (dollars) 1976	Toll settlement revenue (dollars) 1976	
Bristol Bay	King Salmon Naknek	221	245	216	222	624	343	55
Bush Tell	Aniak	60	69	500	211	701	475	68
Interior	*	703	826	868	220	644	761	118
National	Craig Hydaburg Tok Skagway	668	828	248	116	630	365	58
Nushagak	Dillingham	210	356	449	265	777	321	41
OTZ	Kotzebue	334	342	521	371	769	298	39
Whittier	Whittier	93	93	250	152	359	299	83
Yukon	Tanana	98	102	343	142	463	299	65

*Communities served are Cold Bay, Cooper Landing, Fort Yukon, Galena, Iliamna, Unalaska, Sand Point, Port Lyons, and King Cove.

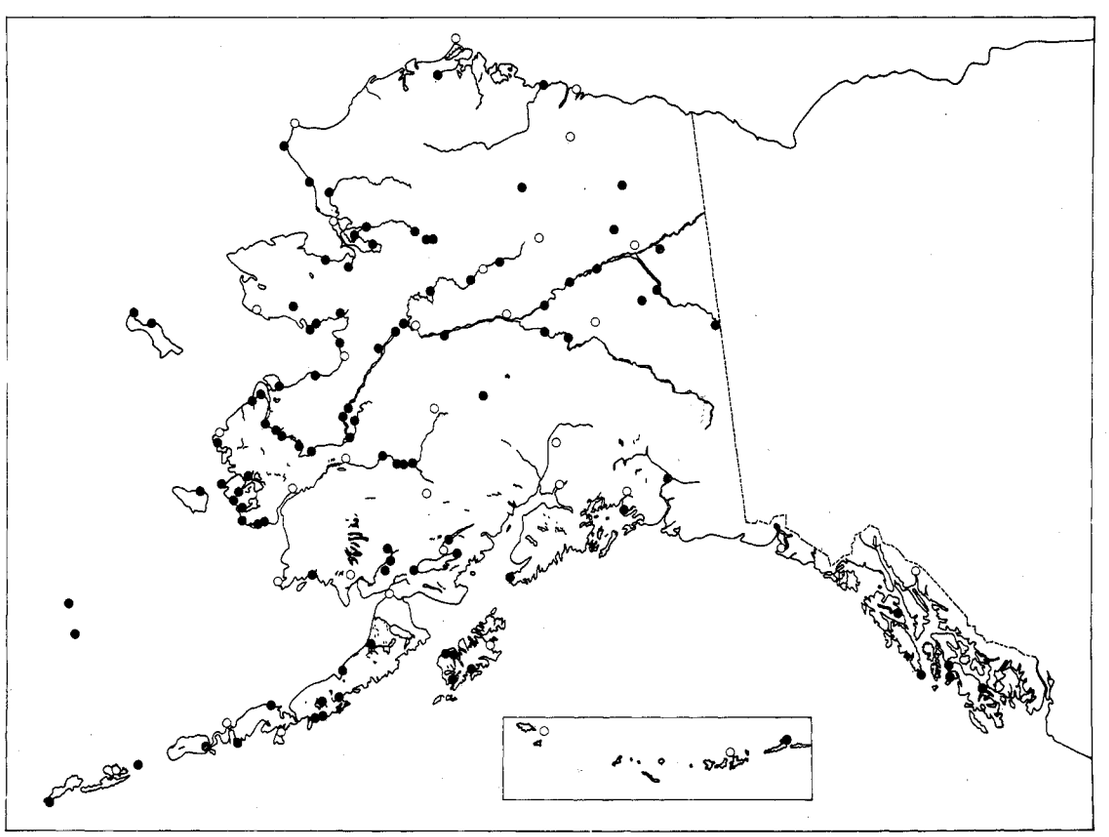


Fig. 1. Location of satellite earth stations in Alaska. The 100 village earth stations served by small (4.5-meter) dishes are shown as closed circles, locations served by larger earth stations as open circles. [Data from (*1*)]

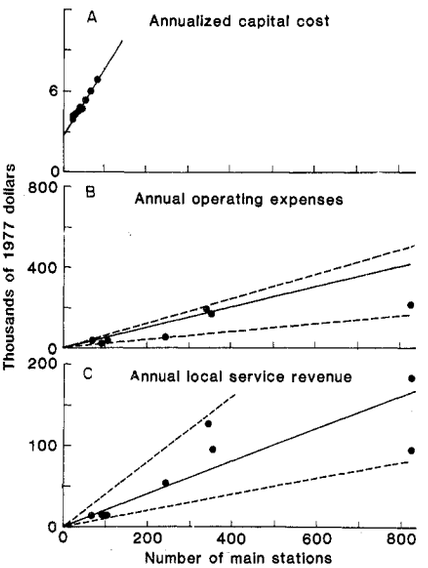
is now known simply as Alascom and is owned by Pacific Power and Light, an Oregon-based public utility firm.

Telephone Service

Providing rural telephone service is almost always costly. Two formal mechanisms are used to offset the high cost. The first is "toll settlements," by which revenue from a long-distance call is divided between the local operating company from which the call originates and the various long-distance carriers who handle the call. These allocations are currently made under a nationwide agreement known as the Ozark formula (*6*), and provide a significant income to most rural companies. The second mechanism involves federal subsidies in the form of low-interest loan programs administered by the Rural Electrification Administration (REA) (*7–9*). Both mechanisms are available to local exchange services operated in Alaskan villages, but it is not obvious that they are sufficient in the Alaskan context.

A few companies have moved to construct local exchange facilities in villages with small earth stations. The OTZ Telephone Cooperative has been certified by the APUC to provide local exchange service in ten villages in northwest Alaska, and construction is now complete in all but one. United Utilities has been certified to serve 20 villages, and construction is complete in six. Two other companies, Circle Telephone and Interior Telephone, each operate local exchange facilities in one small earth station village.

Since just a handful of village exchanges have been built and most have only recently begun operation, it is not yet possible to determine by direct observation whether local exchange service is economically viable in Alaskan villages under existing circumstances. It is, however, possible to examine this question analytically. A local exchange service will be economically viable only if the revenue that it generates equals or exceeds its costs. Revenues consist primarily of local revenue, R_L, derived from monthly subscriber fees, and toll settlement revenue, R_T. For simplicity we will consider a nonprofit company. The costs involve annualized capital costs, C_C, and operating costs, C_O. Thus $R_L + R_T \geq C_C + C_O$. The minimum toll settlement revenue, R_T^*, that the company must receive to allow local exchange operation is thus $R_T^* = C_C + C_O - R_L$. If we can develop reasonable estimates of C_C, C_O, and R_L, we can determine the minimum toll settlement revenue that is required for economic viability and then assess the feasibility of achieving it.



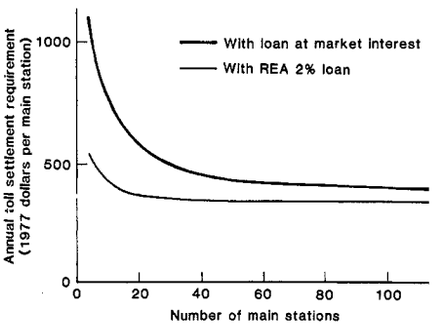


Fig. 2 (left). Annualized capital and operating costs and local service revenues for telephone companies serving small Alaskan communities. (A) Capital costs of local exchange service to nine villages served by modern solid-state plants of the OTZ Telephone Cooperative. (B) Operating expenses and (C) local service revenues of eight companies serving small Alaskan communities, many of which are somewhat larger than villages. Dashed lines indicate the range of subsequent sensitivity analysis. The number of "main stations" is the number of separate telephone numbers. Fig. 3 (right). Annual minimum toll settlement requirement per main station for nonprofit break-even operation.

Capital costs can be accurately estimated from the nine modern solid-state exchanges with aerial plant constructed by OTZ Telephone Cooperative. The system is apparently of high quality and was built efficiently in order to minimize cost. In Fig. 2A annualized capital cost is plotted as a function of S, the number of "main stations" or separate telephone numbers. In annualizing costs we have assumed market interest (a real interest rate of 4 percent) and a plant life of 35 years. The data are well represented by a linear relation of the form $C_C = 3800 + 67\ S$.

Annual data on operating expenses and revenues are reported to the APUC by Alaska's telephone companies on a company-wide basis. Data for the eight reporting companies exclusively serving small communities in 1977 are reproduced in Table 1. Although many of the small communities served by these companies are somewhat larger than villages, we believe that the operating costs and revenues provide a reasonable first approximation to village costs.

Annual operating cost data are plotted in Fig. 2B. They suggest that we represent operating costs as $C_O = K_O S$, where K_O is the annual operating expense per main station. This value ranges from \$216 for Bristol Bay to \$512 for OTZ and \$868 for Interior (Table 1). The wide range is explained by the differing circumstances experienced by the companies. Some use old equipment that is expensive to maintain. In addition, transportation and labor costs vary widely from place to place within Alaska. In our analysis we use K_O = \$500 (solid line in Fig. 2B). In subsequent sensitivity analysis we have allowed K_O to range from \$200 to \$600 (dashed lines in Fig. 2B).

Local service revenues reported by the same eight companies are plotted in Fig. 2C. We represent revenues by $R_L = K_L S$, where K_L is the local service revenue per main station. This ranges from a low of \$116 a year for National to a high of \$371 for OTZ. In our analysis we use K_L = \$200 (solid line in Fig. 2C) and in subsequent sensitivity analysis allow it to range from \$100 to \$400 (dashed lines in Fig. 2C).

These results allow us to estimate the annual required toll settlement per main station as $R_T^*/S = 3800/S + 370$. This relation is plotted as the bold curve in Fig. 3. Actual toll settlement revenues achieved by seven of the eight companies lie in the \$250 to \$475 range (Table 1). If toll settlements in excess of \$500 per main station can be achieved, local exchange service is feasible for villages with more than about 30 main stations. At \$400 per main station the minimum system size grows to approximately 100 main stations. At significantly below \$400 per main station, local exchange service in villages appears infeasible.

If we ignore the special case of Interior Telephone, the 1977 toll settlement revenues per main station (Table 1) suggest that local village telephone exchange service is an economically marginal enterprise. This is particularly true when

one considers that most of these companies are serving rural communities that are somewhat larger than villages and have a significantly higher proportion of commercial customers than village exchanges can expect. One interesting result of our analysis is that annual operating cost is, for all except the smallest exchanges, substantially larger than annualized capital cost. Thus, low-interest financing of capital costs by the REA will reduce toll settlement revenue needs by only about 20 percent for village-size systems (Fig. 3).

Of course, these results are critically dependent upon the values assumed by K_O and K_L. Figure 4 suggests that if, through effective management, annual operating costs can be held between $300 and $400 per main station, local village exchange service will be viable. Five of the eight companies in Table 1 met this objective, but most were not operating in communities that can be called villages. The climatic, social, economic, and physical realities of village operation make it doubtful that such an objective can be met by improved operating efficiency. Nor does increasing local service revenue appear to be a likely prospect. Local service revenue per main station of $200 a year is equivalent to a monthly fee of about $16.75. It is unlikely, given the objective of universal low-cost service, that the APUC would approve significantly higher rates. Table 1 shows annual local service revenue of $371 in Kotzebue, but private customer rates in Kotzebue are only $14.50 a month. The balance is made up by revenues from commercial customers.

Toll settlement revenues are computed in one of two ways: through formulas called "average schedules" or through a complete calculation of cost separations for the local company ("going on cost"). The average schedules essentially reflect the results of applying curve-fitting procedures to the results of a number of full cost-separation calculations for companies operating in the lower 48 states. Since going on cost is complex and expensive, most small companies choose to use average schedules. Of the sample reported in Table 1, only Interior Telephone settled on the basis of cost. Cost data for local exchange operation are generally unavailable, but there is reason to believe that the average schedules, which are based on data from companies in the lower 48 states, do not properly reflect the costs of rural Alaskan service. If the average schedules were revised with rural Alaskan data, the result would likely be increased toll settlements for companies operating village exchanges. These higher settlements are likely to be somewhat lower than those currently being received by Interior Telephone, which some observers characterize as a special case, but they are likely to exceed the 50 to 60 percent or more of revenue that is currently being retained by most urban Alaskan companies that are "on cost" (*11*).

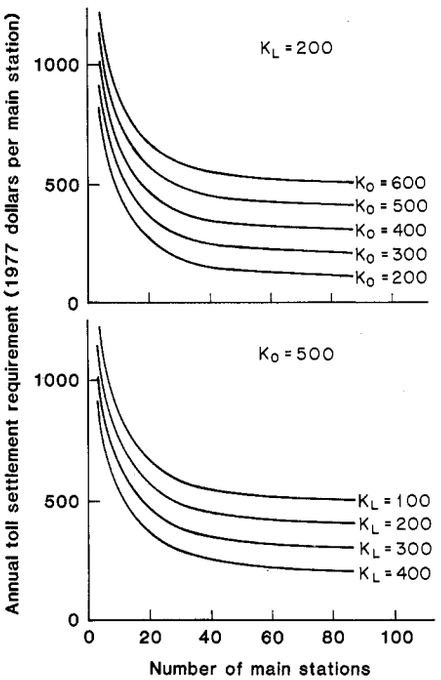


Fig. 4. Sensitivity of the annual minimum toll settlement requirement per main station to operating expense per main station (K_O) and local service revenue per main station (K_L).

An FCC joint board is now considering the special problems of Alaska's telephone industry and may decide to recommend a modification of the present toll settlement arrangements in order to allow rural Alaskan telephone companies somewhat greater returns. Such a modification should include a revision of the average schedules used in rural Alaska.

On the basis of our analysis, we conclude that cost-based toll settlements are probably barely adequate to sustain local exchange service in Alaskan villages. Proposals that would modify or replace current settlement arrangements are being considered by Congress (H.R. 6121, S.611, and S.622) and the FCC (Dockets 78-72 and 80-286). To the extent that these proposals would reduce payments to local companies, they threaten the viability of local exchange service. In evaluating these proposals, their impact on Alaskan villages and other rural areas should be carefully considered.

Early Village Experience with TV

Since 1973 television service has been provided to a number of villages under the APBC's "Mini-TV" program. Video cassette tapes are mailed to villages and locally broadcast with a low-power transmitter of the type used elsewhere in the United States for television translator service. These transmitters are licensed under special FCC waivers. Programs can be received by anyone with a conventional television receiver in any of the 18 villages now served by the Mini-TV program. The program has proved very popular with villagers (*12*). Like the rural public radio stations, Mini-TV stations are locally owned and operated, typically by village government. Most villages have paid for both construction and operation of Mini-TV stations from their own resources. Village governments rarely use their taxing authority and depend primarily on grants and on revenue sharing for their funds.

Between 1973 and 1975 tv short-lived demonstration programs rought television into a number of Ala an villages, raising villagers' expectations but leaving them without permanent service. A cable system delivered one channel of entertainment programming and one channel of educational programming to each home in the village of Wales for a 6-month period in 1973 (*13*). During 1974–75 service was provided in 14 villages through an experiment funded by the Department of Health, Education, and Welfare and managed by OT, using the NASA ATS6 satellite. This experiment provided Alaska-oriented educational and health care programming to village schools. Village response was very favorable (*14*). At the end of the 1-year experiment service was terminated.

In its 1976 session the Alaska state legislature appropriated $1.5 million to modify 23 village earth stations for the experimental provision of television service for a 1-year period. Under this "demonstration project" the signals received by a village earth station are distributed by a low-power transmitter. The cost of this demonstration is borne entirely by the state of Alaska. No local organization is involved, but regional representatives are periodically polled for their reaction to the programming. Broadcasting began in January 1977 and has been continued with annual appropriations by the state legislature. Efforts are now under way to expand the number of communities served. Like the other television projects, this one has been very favorably received by villagers (*4*).

Indications are that it will be continued for a while, but it appears unlikely that the legislature or the administration will be willing or able to fund the total cost of village television indefinitely.

Design Alternatives for TV Delivery

We have evaluated 12 alternative hardware designs for village television delivery. All these systems use satellite communication because of its convenience, the rapid access it allows to time-sensitive programs such as news, and its cost competitiveness with systems based on mail distribution of video cassette tapes (*15*). The designs differ from each other in two major ways: (i) in the location of the program-delay capability that is required by the time difference between Alaska and the lower 48 states and (ii) in the way in which television signals are distributed within a village. Delay center locations in the lower 48 states, in Anchorage, and in the villages are considered. Delay in the villages is provided with video cassette tape recorders. More than one broadcast channel can exist in a village with only one satellite transmission channel. For example, if the satellite channel is active 24 hours a day, two recorded channels and one "live" channel can be active for 8 hours of "prime time" each day. Three techniques for distributing the television signal in the villages are considered.

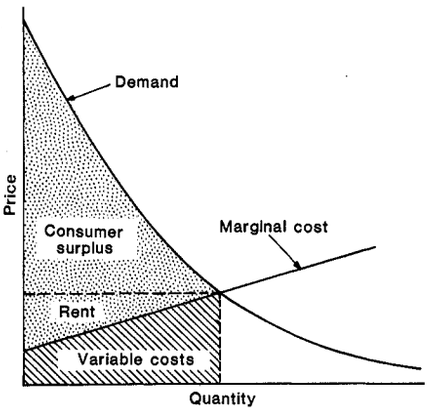


Fig. 5. Elements in the computation of "benefit" in benefit-cost analysis. Benefit is defined as the area under the demand curve and above the marginal cost curve. It is composed of consumer surplus and rent.

These are cable, low-power VHF transmitters, and low-power transmitters that are operated with scramblers, decoders being rented to viewers. We will call the last subscriber TV. High-power regional transmitters, the dominant delivery mode in the lower 48 states, do not appear suitable for rural Alaska, where the population is concentrated in small, widely dispersed villages.

Table 2 summarizes our estimates of annualized capital and operating costs as a function of the number of broadcasting channels and the number of subscribers for systems that serve 120 villages. In estimating costs we have tried to accurately reflect the difficulties of operating in the village environment. Details of the cost estimates are reported elsewhere (*5*). The single largest uncertainty in these estimates is the rental cost of the satellite transponder and the "uplink" from the lower 48 states. We have estimated these costs as $500,000 a year in 1977 dollars.

Before evaluating these systems in a broader context we can apply two simple economic evaluations. First, do the benefits of these systems exceed their costs in the conventional microeconomic sense? Second, since advertising revenue will not begin to cover the cost of these systems, can they be operated so as to be locally self-sufficient through subscriber fees?

We begin with the benefit-cost calculation. Benefit is defined as the area under the demand curve but above the marginal cost curve. In the case of a service priced at marginal cost this area consists of the benefit to the consumer (the "consumer surplus") and the benefit to the producer (the "rent"), as shown in Fig. 5. The area under the marginal cost curve reflects variable costs. The technical delivery systems we are looking at all have, to very good approximation, horizontal marginal cost curves. Thus, in our computations of benefit-minus-cost we take benefit as the consumer surplus and cost as the fixed cost (*16*).

Although several studies indicate that demand for television in Alaskan villages

Table 2. System descriptions and summary of economic factors in the selection of the technical portion of a television delivery system for Alaskan villages. Costs and benefit-cost comparisons are for a 120-village system (N = number of channels, S = number of subscribers).

Design No.	Delay location*			Village distribution			Total annual costs (1977 dollars)	Benefit-cost comparison for one-, two-, and three-channel service† (millions of 1977 dollars)					
								A			B		
	Anchorage	Village	Lower 48	Cable	Mini-TV	Subscriber		One	Two	Three	One	Two	Three
1	+				+		1,486,920	0.05			−0.56		
2	+			+			1,540,880 + 80S	−0.30			−0.89		
3	+					+	1,543,440 + 53S	−0.21			−0.81		
4		+			+		1,031,120 + 899,760N	−0.39	−0.42	−0.72	−1.00	−0.55	−0.22
5		+		+			1,114,720 + 876,120N + 80S	−0.75	−0.78	−1.06	−1.34	−0.91	−0.56
6		+				+	1,031,120 + 956,280N + 3NS + 50S	−0.66	−0.76	−1.14	−1.26	−0.89	−0.64
7			+		+		1,236,920	0.28			−0.33		
8			+	+			1,290,880 + 80S	−0.05			−0.64		
9			+			+	1,293,440 + 53S	0.04			−0.56		
10		+	+		+		359,840 + 899,760N	0.28	0.25	−0.05	−0.33	0.12	0.45
11		+	+	+			443,440 + 876,120N + 80S	−0.05	−0.11	−0.39	−0.64	−0.24	0.11
12		+	+			+	359,840 + 956,280N + 3NS + 50S	0.04	−0.09	−0.47	−0.56	−0.22	0.03

*Designs 1, 2, and 3, which employ a delay center located in Anchorage, require two passes through the satellite, one for the link from the lower 48 states to Anchorage and a second for the link from Anchorage to the villages. Designs 4 through 12 only use the large-diameter earth station at Anchorage and the medium- and large-diameter earth stations at Juneau, Bethel, Fairbanks, and other communities only occasionally for distribution of special Alaskan programming. Designs 4 through 6 and 10 through 12 have one or more video cassette tape recorders located in the villages. †Comparisons in A are based on demand estimate of Noll *et al.* (*21*), in B on Park demand estimate (*17*).

is very high (*4, 12-14*), a demand curve has not actually been estimated in any of them. There have, however, been a number of demand estimates made for cable television service in the lower 48 states (*17-21*). Of these, the studies by Park (*17*) and Noll *et al.* (*21*) are the most convincing and the most readily adapted to the Alaskan village context. The details of our adaptation are provided elsewhere (*5*). However, a few cautionary remarks are required here. First, our estimates of village income are for cash income and do not include subsistence income such as from hunting and fishing, which typically constitutes a significant fraction of villagers' total incomes. For this reason, and because there are few other sources of entertainment in villages, Alaskan villagers may be willing to spend a larger fraction of their cash incomes on television than are residents of the lower 48 states, in which case our analysis will underestimate village demand. Second, the sample used by Park took in 63 cable systems for all of which at least three on-the-air signals were also available. Noll *et al.* (*21*) selected 31 cable systems with varying on-the-air reception. Neither sample corresponds to the situation in Alaskan villages, in most of which no television signals are now available. However, the functional form of the models in both studies is designed to account for a wide range of on-the-air viewing alternatives, including having none. A fundamental result of both demand studies is that customers value primary network programming much more highly than duplicate network, independent, or educational stations. Alaskan villagers have shown similar preferences in previous village television experience (*4, 12, 13*). In adapting the demand curves to the village context we have assumed that one, two, or three channels of commercial network programming are available to villagers for a fee, that this service has been available for longer than 18 months, that no other viewing options are available, and that all sets are in color.

The two solid curves in Fig. 6 reproduce the two demand curves for the case of one channel of available service. Similar plots are available for the case of two and three channels (*5*). Agreement between the two demand models improves in these two- and three-channel cases. Marginal cost curves for the 12 cases we examined appear as horizontal dashed lines near the bottom of Fig. 6. For each ot the design alternatives, the term "benefit-minus-cost" has been computed on an annual basis (Table 2). Design

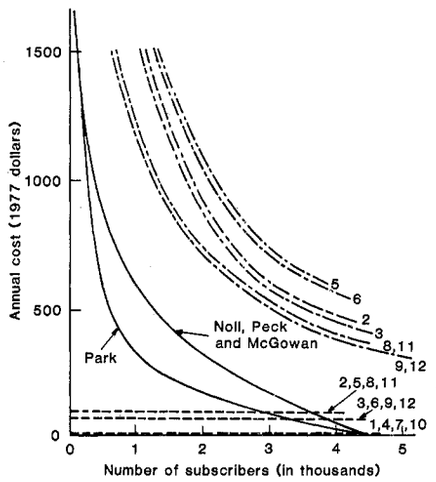


Fig. 6. Demand curves (solid curves), marginal cost curves (horizontal dashed lines) and average total cost curves (dashed curves) for delivery of one channel of television service to 120 Alaskan villages. Each cost curve is for one of the 12 design alternatives described in Table 2. Average total cost curves are not shown for designs 1, 4, 7, and 10 because these designs do not provide for the collection of revenue. Similar sets of curves have been produced for two- and three-channel operation (*5*).

number 10 is the most attractive solution from a benefit-cost perspective. A sensitivity analysis indicates that this result is unchanged when the number of villages served is significantly increased (*5*). Because of the various uncertainties that we have discussed, the annual benefit-minus-cost figures reported should be viewed only as first-order estimates, but we feel reasonably confident that the provision of village television service is justified in classic benefit-cost terms and that the uncertainties will not affect the ranking of design number 10 as the most attractive.

Our second economic criterion was that the system be able to generate enough revenues from local subscriber fees to cover its own costs. Revenue collection is possible with the eight system designs in Table 2 that employ cable TV or subscriber TV. In order for self-sufficiency to obtain, the average total cost curve must at some point be tangent to, or fall below, the demand curve. The dashed curves in the upper portion of Fig. 6 display the eight average total cost curves for the case of one-channel operation. Plots for the two- and three-channel systems are similar (*5*). None of the systems can generate enough revenue from subscriber fees under any pricing scheme (not just marginal cost pricing) to cover operating costs. Designs 9 and 12, under single-channel operation, come closest to meeting the self-sufficiency criterion, but even when transponder costs are reduced to $100,000 dollars a year self-sufficiency is not achieved (*5*). Similarly, the availability of capital funds at 2 percent interest does not allow self-sufficiency (*5*). We conclude that self-sufficiency from local subscriber fees cannot be achieved at present.

Hence if village television is to be developed, the financial support must come from some other source. We believe major state or federal support would be inappropriate. Like most Americans, we do not view access to television as a right. We believe that if television is to be supplied in Alaskan villages it should be done in such a way as to assure that system costs are borne proportionally by those who receive the benefits. Village residents will be the primary beneficiaries of village television, but there will be others. Social service organizations, particularly the schools and the health care system, will find village television a useful tool. Easy institutional access should be one of the principal design requirements. If they become significant users, social service organizations should be able to provide some financial support. The state of Alaska should find village television beneficial to the extent that it brings village residents more directly into the mainstream of Alaskan political life. Hence some modest state support, particularly for program production, may be justified. A small fraction of the required revenue might be obtained from advertising.

If the bulk of the revenue for village television ($285 dollars per household per year for design 10) must come from the villages themselves, and if covering costs by charging customers for the service is infeasible, the only remaining mechanism is the local taxing authority. A use tax on television receivers is probably politically impracticable and legally questionable. Villages have the authority to levy sales taxes or property taxes. In urban America the idea of using local tax revenues to fund television delivery would certainly receive a mixed reaction, but in the rural Alaskan context we think it would be reasonable. Indeed, there are already a number of rural communities in the lower 48 states that are using local taxing authority to fund the operation of television translator services (*22*).

The imposition of a tax will alter benefit-minus-cost in the market where the tax is applied (*23*), making it lower, overall, than we have estimated. Data on the Alaskan village housing market (property tax) and retail sales market (sales tax) are inadequate to allow a direct computation of this effect However, we are

moderately confident that even with a tax the overall benefit-minus-cost of alternative 10 would remain positive. This is because for that design our estimate exceeds costs by 22 percent assuming one-channel operation and the Noll *et al.* (*21*) demand estimate and because, as previously explained, we have probably underestimated demand.

Social Impact and Local Control

There have been a variety of studies of the impact of television on Eskimo and northern Indian communities both in Alaska (*12, 13, 24, 25*) and in northern Canada (*26–31*). Despite many specific differences these studies share some common findings.

Television watching takes time, some of which might otherwise be devoted to more traditional activities. At Rankin Inlet in Canada, Watson (*26*) reports a notable drop in children's interest in traditional activities such as hunting and camping. At the same time he reports that the group that watches television least is older teenagers. They have remained active in athletics and various other recreational activities such as pool. Madigan and Peterson (*13, 24*) report that villagers told them there was little or no decrease in the traditional social activity of "visiting" during project Wales, but a study by Anthropos Inc. (*12*) does report a reduction in visiting in three "mini-TV villages," and Watson (*26*) documents very substantial reductions in visiting. All three studies report that attendance at social club meetings, children's library story hour, and similar functions appears to have collapsed or been seriously affected in a permanent way.

Several studies report an increased sense of time and greater punctuality, not just in the context of television viewing but also in school and work attendance. Several report indications of reduction in alcohol use and associated violence. Most report positive effects on language skills, even among the most traditional elderly. At the same time, Granzberg (*29*) has reported an inability to differentiate between fiction and reality in television viewing and a possible reduction in critical skills in evaluating verbal communications.

Studies among viewers in the lower 48 states have suggested a variety of causal relations between the viewing of acts of violence and other antisocial behavior on television and the growth of undesired behavioral patterns (*32–35*). There are preliminary findings that suggest northern Indian and Eskimo communities are not immune to such effects (*30, 31*). However, Granzberg *et al.* (*28*) caution against making too many cross-cultural generalizations. Television, they argue, "is a different thing to different people and its impact varies according to the cultural traditions that surround it." This warning is forcefully illustrated by their analysis of how cultural traditions involving the shaman's ceremony of the "shaking tent" and the importance of dreams have influenced Cree response to television.

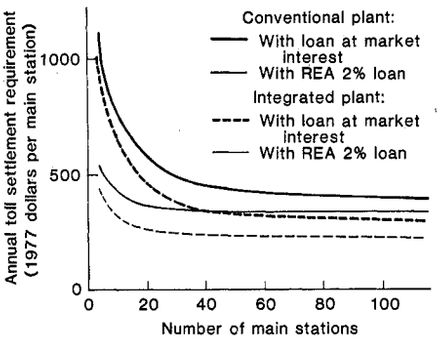


Fig. 7. Comparison of the annual minimum toll settlement requirement per main station for conventional telephone plant and for the telephone portion of an electrically integrated telephone-television cable system. While integrated systems are cost-attractive from a telephone perspective, television costs are too high to make them attractive in Alaskan villages at this time.

All the impact studies agree that the demand for television is very strong in northern Indian and Eskimo communities. Given television's potential for strong impacts, both positive and negative, the fundamental issue for rural Alaska is who will make the decisions of whether to offer television and, if it is offered, when the service should operate, what should be shown, and when it should be shown. So far as possible, we believe, these decisions should be made by the villagers. Local control over the choice and airing time of programs is possible in the 6 of our 12 designs that involve video cassette tape recorders in the villages. Since design 10 has the strongest benefit-cost rating and meets the criteria of local control and easy institutional access, we adopt it as the preferred hardware system and turn now to a consideration of the organizational aspects of the design problem.

Organizational Issues

A system to deliver television in Alaskan villages will require both hardware and organizational components. The organizational arrangements may be the more important, since they will probably endure far longer than any particular technical solution. An acceptable arrangement must provide equitable distribution of costs and benefits, local access and control, ease of institutional access, and political and organizational feasibility (*5*). It must be efficient and workable, and flexible but stable. During construction it must handle system design and equipment acquisition and installation. During operation it must handle equipment operation and maintenance and program procurement and production. Further, it must be able to deal with the problems of integrating the Alaskan village television system with the broader U.S. system through interactions with the commercial networks, other program suppliers, communications interconnect suppliers, and the FCC. Finally, it must make arrangements for the production of special Alaska-oriented programming.

Routine technical operation, program selection and scheduling, and organization and management of the local financial support system all are functions which can and should be performed by a village-level organization. A regional or statewide organization is required to deal with system design, purchase and installation of equipment, and the broader issues of external negotiations and most program production and program procurement.

At both levels of this structure we have used our criteria to evaluate the alternatives of profit, nonprofit, and government organizations (*5*). Since a number of village governments are already operating television systems, since funding for the new system would come primarily from village taxes, and since village government is probably the most democratic source of local control, local operation of television service by village government seems to be the most reasonable local organizational solution. At the higher level a single, statewide, nonprofit organization seems most appropriate. A single organization can maximize the villages' effectiveness in dealing with the outside world. By drawing its board of directors from the participating villages this organization can be kept responsive to village needs and desires. A nonprofit corporation appears preferable to an arm of state government by the criteria of local control and equity, and preferable to a profit organization because of its political and economic advantages. The statewide organization should be capable of dealing with long-term changes in available technology, the needs and desires of village resi-

dents, and the economic and organizational environment within which the television system operates. An example is provided by the case of integrated telephone-television systems that use a single coaxial cable for the distribution of both services (*9, 36, 37*). Such systems are economical for telephone (Fig. 7), but television revenues would fall far short of covering the television costs of such a system. If at some time in the future integrated operation becomes attractive in some of the villages, village telephone companies might become involved in television distribution.

Conclusion

Delivery of both television and telephone service in Alaskan villages is technically and organizationally possible, but is probably not economically feasible without certain regulatory and organizational arrangements.

In the case of television, the main issue is structure, both organizational and technological. The structure that has been recommended includes low-power transmitters for local signal distribution, a delay center located in the lower 48 states, video cassette recorders located in the villages, local government as the basic organizational unit with most of the costs borne through the village tax base, and a statewide service organization operated as an association of local government entities. State leadership will be required to begin the planning and to provide organizational seed money. There are good reasons to believe that such leadership will be forthcoming.

There may be substantial political pressures to expand the role of state funding in village television, perhaps even to the point where the state would pay for the full system. For reasons outlined earlier we believe that total state support would be a mistake. If the state does find it feasible and desirable to play a wider financial role than we have proposed, that support should be directed through the nonprofit statewide service organization and should be used to facilitate the production and distribution of special state, regional, and local cultural and educational program materials. Ultimate control of program decisions should remain at the local level.

With telephone, neither structure nor direct state or local funding are an issue. The telephone system will evolve as it has throughout the rest of the United States, supported largely by the fees paid for services received. Federal support of capital costs through existing low-interest REA loan plans does appear to be essential. REA has shown a willingness to make such loans to rural Alaskan telephone companies and appears to have funding available for this purpose.

Present arrangements for cost-based toll settlements appear to be barely adequate to sustain local exchange service in Alaskan villages. Alternative arrangements now being considered by Congress and the FCC may not be adequate. These arrangements require careful evaluation in the context of Alaskan villages and other rural areas.

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