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Satellites for Rural Development

Telecommunications Alternatives for Developing Countries

by Ronald E. Rice and Edwin B. Parker

Three models for satellite systems are compared and contrasted with other communications systems to show their most efficient and economical forms.

A large and growing body of research and reports has addressed the range of development applications a telecommunications system can support (see 7 and 11 for reviews). Some of the proposed and empirically demonstrated benefits are related to the primary function of telecommunications: to provide communication links for a geographically dispersed population. In addition, knowledge may be generated and distributed in greater and more equal amounts (18, 19), and travel or transport costs can be reduced by transmitting information instead. On the aggregate level, the economic benefits of communication have been considered in numerous studies (see 4, 5) indicating the high correlation between communication variables (mass media as well as telephones) and wealth variables (such as GNP). However, such measures of economic development are also limited, as they do not capture dimensions such as distribution, access, social development, appropriateness, and dependency (see 2 and 8 for a review of such studies). It is important to keep in mind that all potential benefits are conditioned (and often prevented) by local contexts, existing structure,

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and the lack of a "community of interest" (7, p. 23; 13; 15; 28). Access is only the first stage of the communication process and indicates nothing about exposure, content, information outcomes and, finally, social outcomes (26).

Thus we do not see telecommunications technology as a panacea for rural development. Denis Goulet calls technology the uncertain promise: it is needed for development, yet can introduce destructive values or maintain prior constraints. The goal is to manage the technology *for* people, and *by* the people affected by it. Local needs, goals, and social values must be linked with development strategies and particular technology choices. In many cases it is likely that other development or investment strategies should have a higher priority. In this context, the introduction of satellite communication technology should be considered as only one element in indigenous development.

How can satellite communications be appropriate to a situation demanding low-cost communications?

In general, communication is more costly for poorer countries, as the relatively small message traffic costs more per circuit than heavy traffic of developed countries, which can be trunked with numerous circuits to save on material costs. This situation can be resolved by reducing the material costs of thin-route telephone systems and by coordinating national communications systems into regional systems to provide service to a number of nations. Satellite systems may play a useful role in this process.

Satellite capacity in the form of earth stations can be installed in the order of priority of need, independent of the location of previous sites, unlike terrestrial systems. This ability may reduce total cost because incremental expenses may be deferred until fully justified. In addition, satellite communication cost is insensitive to distance, so remote locations are not under cost disadvantages. Other media (such as radio or television) and additional circuits may be added later to ground stations, providing a flexibility impossible in terrestrial systems. In fact, coordinated national planning of several communication services would take advantage of this flexibility, and reduce unit costs for each service (20). For example, microwave relays must be designed for maximum end-to-end capacity, and significant rural expansion of wire lines entails high system-wide costs. Satellite systems are notably more reliable than terrestrial links, reducing remote maintenance problems and overall operational cost. The availability of satellite point-to-point service may also lessen the pressure on high frequency allocations, a bone of contention between developed and developing countries in the upcoming WARC (see 27).

In terms of actual costs, our primary hypothesis is that geosynchronous[1] communication satellite systems can provide a viable alternative to traditional

[1] A geosynchronous satellite orbits at a height (22,282 miles at the peak of the ellipse) and velocity sufficient to allow it to remain essentially stationary over one portion of the earth.

terrestrial telephone links and, further, that the circuit[2] cost per year of such a system can be lowered considerably *if* the satellite system is designed *specifically* to permit rural use—to accommodate a large number of thin-route circuits as well as low-cost earth stations. The tradeoff for achieving such a design is, of course, higher costs for the satellite. Will the advantages from such a system design overcome the increased satellite cost?

Major factors involved in increasing the capacity and power of the satellite segment include increased bandwidth, transponder power efficiency, gain and power (EIRP), the use of frequencies, antenna diameter,[3] and demand assignment. Factors involved in lowering earth station cost include smaller ground station antennas,[4] non-tracking antennas, solid state receivers, lower power requirements, frequency use or site location which avoids terrestrial signal interference, and the mass production of hardware. Manipulation of these factors is implied in a satellite communication system designed to permit low-cost rural communication service. Martin (14, pp. 149, 361) explains these and other factors and provides several graphs which summarize the design trade-offs for both the space segment and the ground segment.

What combination of satellite design, earth station design and cost, access technique, and management arrangement will provide the lowest-cost yet appropriate rural telephony service?

The general service model under consideration is one capable of providing thin-route (low traffic) rural telephony, probably for a global or regional consortium of countries, thus involving more than 10,000 earth stations. For any particular alternative system model, such an arrangement would allow the sharing of the space segment and the creation of a large market (with the attendant advantages of economies of scale) for ground hardware. Domestic production of such equipment could be an integral part of overall development policy, as suggested in Mexico's telecommunications policy (12). Summaries of costs, specifications, and comments on three satellite system models are offered in Table 1.

[2] By a circuit, we mean a complete *two-way* link (duplex channel) between two communicating nodes (whether it be telephone, computer terminals, etc.). This is an important distinction, as most telecommunications other than telephone are *one-way*, such as TV or broadcast radio.

[3] Increased size of the antenna in the spacecraft will increase the effective received power on the ground for a fixed level of satellite transmitter power. This permits increased satellite capacity for a fixed size of earth station, or fixed satellite capacity with *smaller* earth station antennas.

[4] The standard antenna sizes for INTELSAT ground stations range from 30 meters to 6 meters (used in Saudi Arabia). For the purposes of this paper, we are considering the antenna size for INTELSAT small ground stations to be 4.57 meters. A 4.57 m. antenna can meet INTELSAT specifications. INTELSAT *has* tested these in Nigeria (2), and ORI (27) provides summary cost estimates for rural telecommunication designs which assume the smaller size. The 4.57 m. earth station antenna size may be too small for economical telephony use with the INTELSAT global beams because too much space segment capacity per circuit would be required. The smaller antenna size may be appropriate for use with the more powerful hemispheric beams which INTELSAT first offered for lease in late 1978.

Table 1: Summary of three models

	Model 1
Satellite segment	INTELSAT IVA hemispheric beam. EIRP from 26 dBW (higher at beam center). 36 MHz/ transponder channel. Capacity: 180 circuits/transponder. Lease cost: $1.2 million/transponder/year (see 11; 16; INTELSAT Tariffs BG-30-73, BG/T-22-5E and attachments). Annualized cost per circuit per year is $6667 (PA) and $667 (DAMA). (This is the minimal cost, from INTELSAT. Carriers between INTELSAT and the end user including the national INTELSAT member mark-up final circuit charges by as much as a factor of 4 [see 7]).
Ground segment	4.57 m. antenna (this article, p. 127, footnote 4). G/T of 19 dB/K°. 6 watts/circuit (see 16). Cost: $32,000 in quantities in the hundreds (that is, the prices per item for a large quantity of the item is less than the price for small quantities. Based upon what vendors call a "learning curve," it represents something like the marginal cost and includes development cost). Annualized location cost $5664 (PA) and $6018 to $9024 (DAMA).
Advantages	Easy to initiate; technical and management support from INTELSAT; low risk; reliable; permits gradual entry into domestic and rural satellite communications.
Disadvantages	Not economical for large scale system because low EIRP requires expensive ground segment, although it may be an adequate means of transitioning into a full scale domestic system. These larger stations can later be used as "hub" stations in a national/domestic system.

Model 1. The currently available space segment system is leased capacity on INTELSAT IVA satellites (hemispheric beams) which could be usable for rural telephony with 4.57 to 6 meter ground antennas. National common carriers or government entities which are INTELSAT signatories can lease small capacity (say, ¼ transponder) as it is needed without a large capital outlay. If an entire transponder is leased, the variable transponder gain setting could be set at a position more appropriate for small ground station use than the standard setting.

Model 2A. The second set of alternatives involves a higher-power satellite system and earth stations designed specifically for rural service. This second alternative involves a more costly and more powerful space segment than IN-

for satellite communication systems

Model 2A	Model 2B
This system designed for, operated by, and owned by a global or regional consortium of developing countries. Two prime satellites in orbit, one common spare in orbit, one spare on ground. Cost including launches is $200 million. Life 10 years. Syncom IV type. EIRP 36-39 dBW. G/T of 32.2 dB/K°. 1.83 Kw power. 30 MHz/transponder channel. Link calculations available upon request. Capacity: 500 circuits/transponder, 24 transponders. Fill factor 50 percent on prime satellites. Lease cost: $1.5 million/transponder/year. Annualized cost per circuit per year is $2600 (PA) and $260 (DAMA).	The same technical system as in Model 2A would be managed by an organization such as INTELSAT. It is assumed that such an organization would make a more conservative seven-year satellite life assumption or otherwise increase lease costs. Lease cost: $2.5 million/transponder/year. Annualized cost per circuit per year is $5000 (PA) and $500 (DAMA).
3 m. antenna. Technical specifications available. Station gain (and satellite EIRP) near optimal settings (9). Cost: very lowest cost for simplest CMI station including power source is $11,000 in quantities in the thousands. A more appropriate station with a cost of $20,000 (industry sources) will be assumed. Annualized location cost $3540 (PA) and $3894 to $7080 (DAMA).	Same as for Model 2A.
Designed for rural applications and regional systems. Technically optimized solution and least expensive for large ground complement. Provides the impetus for the formation of a technical cadre of native personnel competent in this technology.	Designed for rural applications and regional systems. Technically optimized solution for large ground complement. Involves an experienced organization to manage system and act as buffer to political problems. Nations can lease capacity as desired or as their system grows, thus at the onset, capital outlays by user nations may be less.
Involves the aggregation of a large number of nations for the purpose of utilizing a common resource. Political problems need to be resolved. Requires initial investment outlays. Necessitates formation of management group to administer program.	In the long run more expensive and, because of INTELSAT or other monopoly management, potentially less responsive to needs of individual nations.

TELSAT IVA which can provide more circuits per transponder while reducing earth station power and antenna size requirements (to 3 meter diameter). Like Model 1, this system could be designed for, bought by, and operated by one or several developing countries. This is a lower-bound cost estimate based on the estimated purchase price of the satellite without the expense of a large operating organization (as in Model 2B). Four higher-power 24-transponder C-band frequency ($^4/_6$ Ghz) satellites plus three launches are assumed to cost $200 million. This provides two prime satellites in orbit, a common spare in orbit, and a spare on the ground. Global coverage can be provided except for the U.S., U.S.S.R., and some islands in the Pacific Ocean.

Model 2B. The upper-bound cost of the same technical system in 2A is associated with system management by a consortium of countries involved or by an international arrangement such as INTELSAT. This would allow countries to lease only as much of the custom-designed satellite system as they needed. In addition, such an arrangement would be congruent with current international telecommunications practice and leasing arrangements. In our calculations, typical INTELSAT operating costs are added to the equipment and launch costs included in Model 2A.

The use of permanent assignment of channels (or circuits) (PA) or demand-assignment multiple-access (DAMA) in each model is also important to consider. PA assigns fixed circuits to specific terminal pairs, and PA operation is more efficient as the amount of traffic between a given pair of terminals increases. A DAMA control system, on the other hand, assigns a circuit to a requesting terminal on demand, and then returns the circuit to the access pool when the terminal has completed its call. Its advantages are that (a) terrestrial costs may be reduced because the same equipment can provide increased connectivity and flexibility to reach all destinations with only a single transit through the satellite, (b) transponder capacity can be more efficiently used, (c) establishment of new destinations is encouraged because of the corresponding reduction in cost (3), and (d) fewer circuits can serve a given number of terminals under DAMA than PA, other things equal.

The complexity of system design, the variability and interdependence of cost calculations, and the generality of our purpose require some broad assumptions in order to compare the three system models (see Table 2):

Table 2: Cost comparisons for system Models 1, 2A, and 2B

	Satellite option	Circuit space cost/year U.S. $	Annualized station cost/year U.S. $	Location cost/year U.S. $
1:	INTELSAT IVA			
	without DAMA	6700	5700	12,300
	with DAMA	700	6000-9200	6700-9900
2A:	Syncom IV owned			
	without DAMA	2600	3500	6100
	with DAMA	260	3900-7100	4200-7300
2B:	Syncom IV managed by INTELSAT			
	without DAMA	5000	3500	8500
	with DAMA	500	3900-7100	4400-7600

Note: Cost figures rounded. Cost ranges for "with DAMA" figures based upon lower and upper bound of DAMA equipment.

System alternative of all PA or all DAMA operation are alternative maxima; a combination of PA and DAMA circuits is more realistic and usually less expensive than either extreme alternative. PA or DAMA circuit capacities are likely conservative figures, producing higher than possible costs. Models involving INTELSAT capacity may involve higher circuit costs due to intermediate carrier mark-ups.

- Channel capacity, lease charges and equipment costs are based upon recent price estimates from ORI (16), Lusignan and associates (12), INTELSAT (Tariffs BG-30-73, BG/T-22-5E and attachments), and industry sources (Hughes, IT & T, Prodelin, Andrews, and California Microwave, Inc.).
- Cost calculations do not include maintenance, operation, land acquisition, salvage or indirect costs, and are based on present value annuities.
- An interest rate or social discount of 12 percent per year is assumed. Satellite life of 7 years (except 10 years for model 2A to provide a lower-bound cost estimate) and ground equipment life of 10 years are assumed.
- Although an actual *link* involves two ground stations, and would imply a communication cost of two earth stations and the pro-rata space segment charge (19), we are only considering the incremental cost of adding one more (rural) service location to existing capacity.
- One circuit per remote ground station is implied required capacity for a rural location. This assumes single channel per carrier (SCPC) operation.
- INTELSAT IVA space charges are actual tariffs for pre-emptible service.

As Table 2 shows, when DAMA is not used, the per-location cost is unambiguously less for a communication satellite system designed specifically for rural telecommunication than for currently available INTELSAT IVA capacity. In the case of the lower-bound alternative of buying such a system, the cost is almost half. Although the range in DAMA cost estimates[5] is wide enough to produce overlaps across configurations, for a given DAMA cost, the per location cost associated with INTELSAT IVA capacity would continue to be higher than the alternatives. However, the range in per-location costs for a 2A and 2B system *without* DAMA essentially lies in the same range as INTELSAT IVA location costs *with* DAMA. It is important to keep in mind, however, that the figures are subject to broad assumptions mentioned above and considerable approximation. In particular, the assumption of one circuit per location is a crucial condition. Costs *per circuit* (particularly for PA circuits) will be lower when more than one channel per ground station is required.

To put these costs in perspective, it is useful to consider, briefly, terrestrial telephony costs as compared to satellite systems.

As satellite circuit costs are insensitive to link distance, while the cost for terrestrial circuits is roughly proportional to their distance, there is a link distance after which satellite communications will be less expensive than terrestrial communications. If the breakeven distance is small, then a satellite system with numerous ground stations is favored over a terrestrial system. For example, using the standard INTELSAT (30 m.) station, the breakeven distance between

[5] DAMA, as considered in each model, will cost somewhere in the range of $2000 (21) to $20,000 (industry sources) for each station. The latter number is a more realistic current cost, although a larger volume market could eventually drive costs toward the lower bound. Cost comparisons use these extremes for sensitivity analysis.

satellite and terrestrial circuits ranges from 500 miles to 2000 miles, for high density routes. This last qualification leads us to two very significant points about terrestrial-satellite cost comparisons.

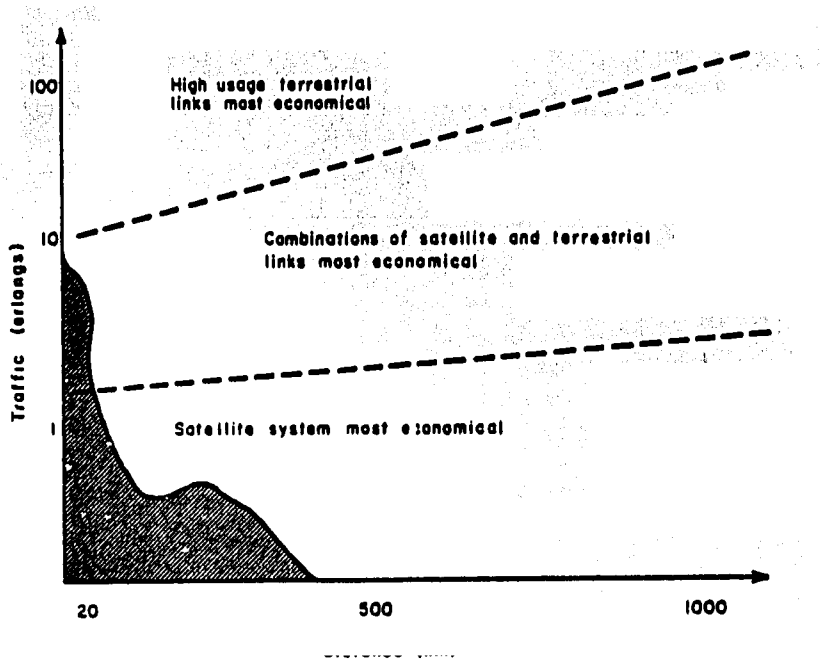
First, the minimum annual cost per circuit of a total telephony system depends greatly on the range of lengths and the traffic demand (present and future growth) (see Figure 1). Second, local conditions sometimes completely determine the most appropriate equipment: small mountains or high buildings can obstruct radio transmission and make ground stations economical; pre-existing terrestrial facilities in a small town can eliminate the need for a ground station.[6] Thus, a fully optimal system involving both rural and urban service would usually involve some large and small earth stations as well as interconnection with terrestrial transmission media. In addition, as discussed previously, circuits might be optimally served by a mix of PA and DAMA operation. This "hybrid" total system can result in an overall least-cost solution which routes around 6 percent of total traffic via a satellite system (21).

In no case, especially for small nations with pockets of higher demand, would a satellite system handle a majority of the telephony traffic. Existing terrestrial facilities plus new terrestrial facilities on short distance high density routes would mean that a significant percentage of circuits would continue to be terrestrial. In fact, satellite networks are usually considered as providing supplemental capability to an existing network. The economic advantage of satellites for thin-route telephony may, however, lead to a significant number of locations being served by satellite (such as remote rural areas), possibly with a mix of PA and DAMA circuits. And, as noted above, unit costs for a variety of services would be decreased further when joint telecommunications planning produces shared facilities.

Because a satellite designed for low-cost thin-route service to rural communities is not currently available in orbit, it may be appropriate to note some policy issues that need to be resolved before such capacity could be made available.

One problem is to demonstrate the economic and social effectiveness and benefits of rural telecommunications. The benefits of telecommunications depend heavily upon local contexts, socio-political structure, and policy goals, and must also be related more directly to alternative technologies and applications. We do not underestimate the significance of the issues involving socio-political structure; they are being increasingly discussed and analyzed throughout the literature and in international debates (see, for example, 15, 27, and 28). It is true, however, that because previous technologies have been high in cost, very few rural communities in developing countries have service. In addition, traditional

[6] In fact, the cost trade-offs particular to any locale are so complex that several computer programs (33, 39) have been developed by the Communication Satellite Planning Program at Stanford University.



Source: Adapted from (20, section V-8; results from Iranian case study).

Note: The region boundaries are approximate and intended for demonstration only. Their placement is sensitive to changing assumptions. For example, they will shift upward *considerably* if, under the assumption of a purchased satellite system, the expenditure is considered a sunken cost. Then it would be advantageous to shift some terrestrial traffic to satellite links. No data points are available for shaded area, for *this* particular solution.

Figure 1: Minimum cost solution regions for high usage terrestrial links and satellite systems links as a function of voice traffic and link distance

economies produce investment strategies biased *against* consideration of the social benefits of a public good such as information, and *toward* technologies suitable for urban telecommunications applications. The result is lack of evidence of comparative effectiveness and benefits needed to justify any investment in any particular telecommunication system. The priority attached to investment in communication as opposed to (or in conjunction with) transportation, agriculture, etc., is not clear-cut, as we noted earlier (see, however, 4, 5, 7, and 24, among others). A series of carefully evaluated rural telecommunication projects is necessary to obtain better evidence of the benefits and of the particular constraints of prior social and political structure. Such projects must not, however, be mere transfers of sophisticated technology, and should include, for example, training components and funding to develop, test, and produce new services *for* and *by* developing countries (as in the Mexican plan).

Another problem is the difficult market aggregation issue. The high-power satellites necessary to have low per-circuit or per-location costs for thin-route applications are expensive in total cost. Few countries could afford all the capacity—many already sustain foreign debts which are too large—and none

could utilize it all at the outset because of the time and cost associated with putting the ground stations in place. Excessive debts may create pressures by lending countries to reduce demand for foreign exchange in ways which may inhibit economic growth in the borrowing country, as well as curtailment of redistribution and social spending policies. The combination of low unit-cost and high total cost make it desirable to work out some kind of multinational sharing procedure, just as INTELSAT permits capacity sharing for international traffic. INTELSAT or some other comparable management facility permitting shared use of capacity (such as system 2B) will be essential if the nations most in need are to obtain the benefits.

A third problem concerns issues to be debated at this year's WARC. Regional/cooperative satellite systems are one element in the process of resolving growing orbital congestion and allocation disputes. Issues related to the New World Information Order (15, 17, 27) are not limited to matters of media *content.* WARC decisions can affect which technologies are usable and determine whether their services and costs are appropriate for developing countries. A hybrid satellite system designed for rural telecommunications, owned or leased by developing countries, may allay those countries' fears that access to and control of communication satellite service will soon be unavailable, due to the former "first-come-first-served" approach to allocation. Such service may also reduce contrasting proposals for allocation of separate orbital positions to countries well in advance of their ability to use the resource and, in fact, provide actual access and control rather than empty orbits. Therefore, WARC delegates might consider issues such as pilot demonstrations, training programs, flexibility in technical specifications for rural applications (6), and arrangements for a shared satellite system. Such arrangements are not to be construed as permanent, total solutions to world information imbalances, however. As a member of the Nairobi Conference wrote (17, p. 26), supporters of the New Information Order "feel that various types of assistance are not enough and that what is needed is a fundamental restructuring of relationships, the elimination of all forms of inequality and foreign domination through the powerful media of contemporary communications."

A fourth problem is that of capital formation. Developing countries may well be able to finance the ground station costs and lease charges for the kind of satellite system discussed here. But they are unlikely to have the capital necessary to provide the satellite system in the first place. It may be appropriate for developing countries to request that international funding institutions provide the capital for a revolving fund that could provide initial capacity. Usage charges could be planned to make the system self-supporting from that point (including depreciation costs to raise funds for later replacement of the satellite system). It should be noted that even this source of support is controversial: Sunkel and Fuenzalida (in 28) argue that these institutions simply help maintain the system of transnational capitalism and thus, in the long run, obstruct true development goals.

Developing countries have, at one time, proposed that the International Telecommunications Union expand its budget to include communication development assistance (22). In addition, support for increased access to information

resources by developing countries was a major United States promise at the November 1976 Nairobi UNESCO Conference. The U.S. commitment at the 1978 General UNESCO Conference is a start (23). Any funding plan, however, needs to take into consideration the issues surrounding the sources of funding, the proper mix of those sources, the conditions attached to such funding, and the short- and long-term effects upon national debt and foreign exchange and economic dependencies.

These policy implications indicate the potential significance of telecommunications in current international debates. The New World Information Order meets head on with technical communication issues in the 1979 WARC, providing one dramatically consequential forum for all these and many other forces. The implicit challenges are already on the agenda.

REFERENCES

1. Astrain, S. "The Role of the Intelsat System in Meeting International and National Telecommunications Needs." Paper presented at International Satellite Communication Seminar, Lima, Peru, 1978.
2. Cherry, C. *World Communication: Threat or Promise?* (revised edition). New York: John Wiley, 1977.
3. Dill, G. "Comparison of Circuit Capacity of Demand-Assignment and Pre-Assignment Operation." *COMSAT Technical Review* 2(1), Spring 1972, pp. 243–251.
4. Gilling, E. "Telecommunications and Economic Development: Inter-Country Comparisons of the Catalytic Effect of Telephone Services on Development." Unpublished M.B.A. thesis, McGill University, Montreal, Canada, 1975.
5. Hardy, A. "Role of the Telephone in Economic Development." Unpublished Ph.D. dissertation, Institute for Communication Research, Stanford University, Stanford, Cal., 1979.
6. Hudson, H. "Implications of Development Communications." *Journal of Communication* 29(1), Winter 1979, pp. 179–186.
7. Hudson, H., D. Goldschmidt, E. Parker, and A. Hardy. *The Role of Telecommunications in Socio-Economic Development: A Review of the Literature with Guidelines for Further Investigation.* International Telecommunications Union Special Service Agreement 9-GLO-001-11-02. Palo Alto, Cal.: Keewatin Communications, 1978.
8. International Consultative Committee on Telecommunications (CCITT). *Economic Studies at the National Level in the Field of Telecommunications.* Geneva: International Telecommunications Union, 1973.
9. Janky, J. and J. Barewald. "Interference Control in Broadcast Satellite Applications: Antenna Sidelobe Patterns and Transponder Transfer Gain." In *EASCON-77 Record*, IEEE 77CH 1255-9-EASCON, Arlington, Va., September 26, 1977.
10. Kiesling, J. and M. Zisserson. "Extension of Satellite Services through Low Cost Earth Stations." American Institute for Aero-Astronautics 7th Communications Satellite Systems Conference, April 24–27, 1978, San Diego, Cal., pp. 572–581.
11. Klees, S. and S. Wells. "Costs and Satellites: Implications of the ATS-6 Health/Education Telecommunications Demonstration." Washington, D.C., Academy for Educational Development #CHMA-147-159, 1977.
12. Lusignan, B. *et al. A Rural Telecommunications Plan for Mexico.* Stanford, Cal.: Satellite Systems Planning Center, Dept. of Electrical Engineering, Stanford University, 1979.
13. McAnany, E. (Ed.) *Communication with the Rural Poor in the Third World: Does Information Make a Difference?* Stanford, Cal.: Institute for Communication Research, Stanford University, 1978.
14. Martin, J. *Communications Satellite Systems.* Englewood Cliffs, N.J.: Prentice-Hall, 1978.
15. Nordenstreng, K. and H. Schiller. *National Sovereignty and International Communication.* Norwood, N.J.: Ablex, 1979.

16. Operations Research, Inc. (ORI). *Assessment of Candidate Communications Satellites for Developing Countries.* Silver Spring, Md.: ORI, U.S. Agency for International Development Contract AID/TA-TA-1428, 1977.
17. Osolnik, B. "UNESCO: The Mass Media Declaration." *Review of International Affairs* 690, January 5, 1979.
18. Parker, E. B. "Communication Satellites for Rural Development." *Telecommunications Policy* 2(4), December 1978, pp. 309–315.
19. Parker, E. B. "The Economic and Social Development Potential of Communication Technologies." Paper presented at the 48th Congress of Australia-New Zealand Association for the Advancement of Science, Melbourne, Australia, 1977.
20. Parker, E. B. and B. Lusignan. "Technical and Economic Considerations in Planning Radio Services." In P. Spain, D. Jamison, and E. McAnany (Eds.) *Radio for Education and Development,* Volume Two. Washington, D.C.: World Bank, 1977, pp. 443–459.
21. Pinheiro, R. "Investments and Traffic Assignment in a Hybrid Ground and Spatial Communication Network." Stanford University, Dept. of Engineering, Satellite Systems Planning Center, Technical Report No. 4, Stanford, Cal., 1978.
22. Pool, Ithiel de Sola. "The Problems of WARC." *Journal of Communication* 29(1), Winter 1979, pp. 187–196.
23. Reinhardt, J. "General Policy Statement Delivered at UNESCO 20th General Conference." November 3, 1978.
24. Shapiro, P. *Communications or Transport? Decision-Making in Developing Countries.* Cambridge, Mass.: MIT Research Program on Problems of International Communication and Security, 1967.
25. Sharma, R. "Rural Communications Planning Methodology for Integrating Satellite and Terrestrial Facilities." Stanford University, Dept. of Engineering, Satellite Systems Planning Center, Technical Report No. 66, Stanford, Cal., December 1978.
26. Shore, L. "Mass Media for Development: A Reexamination of Access, Exposure, and Impact." In E. McAnany (Ed.) *Communication with the Rural Poor in the Third World: Does Information Make a Difference?* Stanford, Cal.: Institute for Communication Research, Stanford University, 1978, pp. 26–80.
27. "U.S. Faces WARC, The." Symposium in *Journal of Communication* 29(1), Winter 1979, pp. 143–205.
28. Villamil, J. J. (Ed.) *Transnational Capitalism and National Development.* Brighton, England: Harvester, 1979.